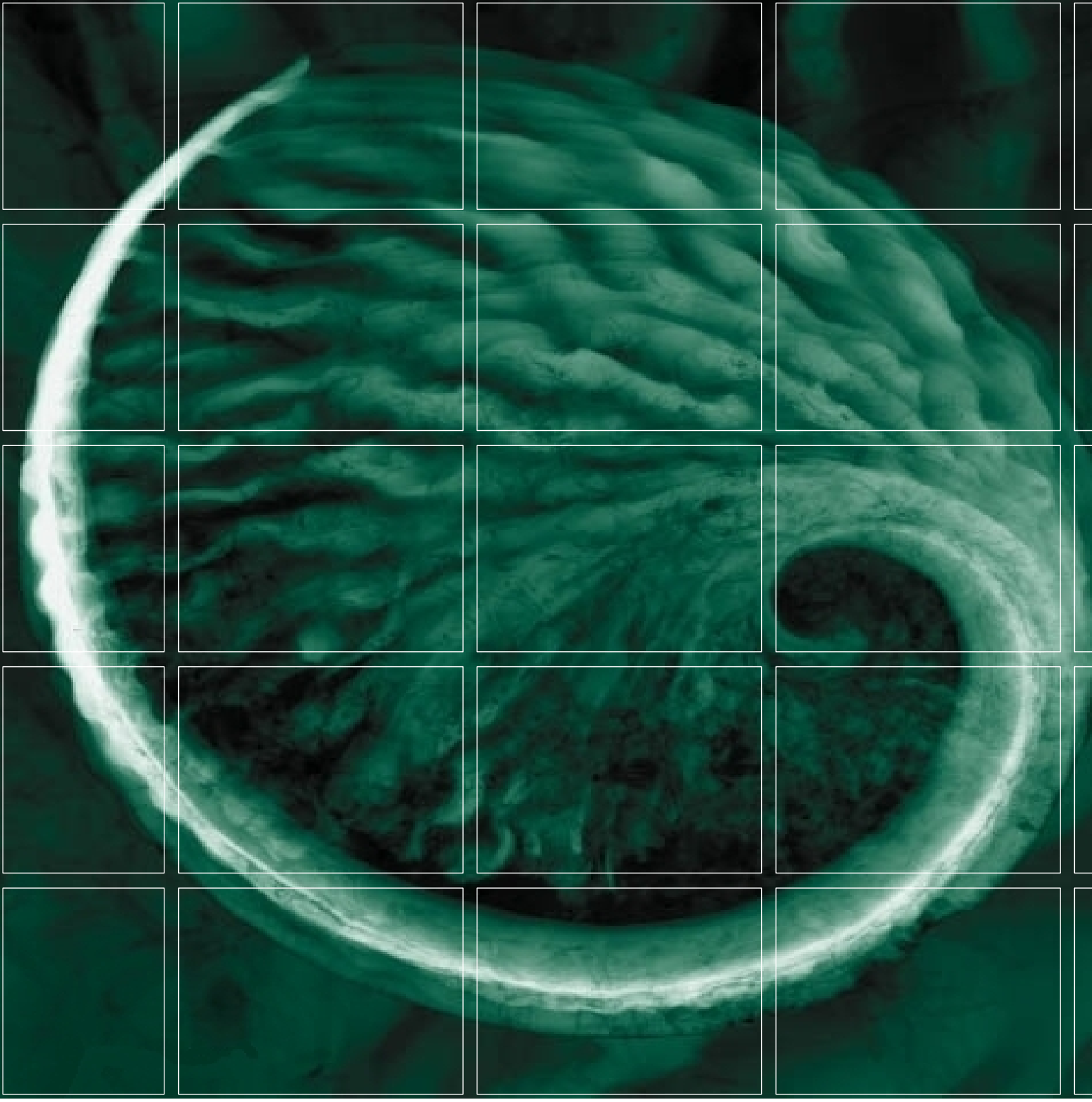


Fern Bay Seaside Village Project Application

Submission Report

Aspen Group

0063154 Final

December 2009

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Fern Bay Seaside Village Project Application

Submission Report

Aspen Group

0063154 Final
December 2009
www.erm.com

Date:	*23 December, 2009*
Partner:	Paul Douglass

Environmental Resources Management Australia Pty Ltd Quality System

This report has been prepared in accordance with the scope of services described in the contract or agreement between Environmental Resources Management Australia Pty Ltd ABN 12 002 773 248 (ERM) and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client and ERM accepts no responsibility for its use by other parties.

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1 INTRODUCTION

1.1 BACKGROUND

An Environmental Assessment (EA) Report was prepared by Environmental Resources Management Australia Pty Ltd (ERM) on behalf of Aspen Group (the proponent) for a 683 lot community title subdivision at Fern Bay, NSW. The site locality is shown on *Figure 1.* The EA was prepared in accordance with the Director-General's Environmental Assessment Requirements (DGR's) issued on 22 November 2006 for a Project Application.

The purpose of this report is to provide a response to submissions received during the public exhibition period, provide further clarification and details of proposed changes to the project resulting from consideration of the issues raised by Government agencies, Port Stephens Council (Council) and the local community.

The format of this report is:

- *Chapter 1* provides background information and states the purpose of the report;
- *Chapter 2* presents a summary list of the issues raised and provides a response to each issue. A detailed list of each submission and a response is provided in *Annex A*;
- *Chapter 3* documents the project in its amended form;
- *Chapter 4* contains the amended Statement of Commitments; and
- *Chapter 5* draws conclusions based on the information provided in the preceding chapters.

1.2 OUTLINE OF PROJECT

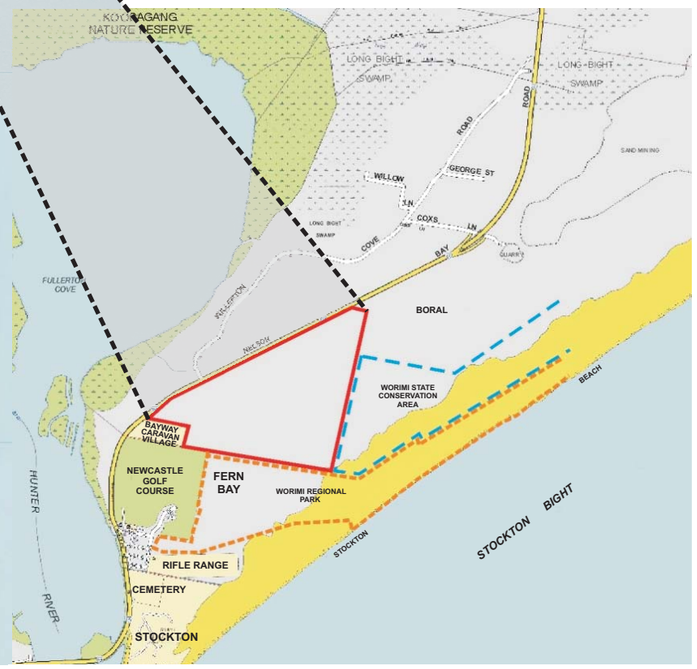
1.2.1 Project Application

The Project Application for the Fern Bay Seaside Village included:

- creation of 683 residential lots (Stages 4 to 20);
- creation of ecological conservation areas to be managed as Community Conservation Lands;
- recreational and open space network providing for areas including formal parks and a Aboriginal Cultural Heritage Reserve;







Legend

Fern Bay Seaside Village

Figure 1

Locality Plan

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_01		
Date:	30/11/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:	-		
Scale:	Not to Scale		

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- creation of sites for commercial areas and community centre area;
- construction of roadways including internal roads, pedestrian pathways and a shared footpath/cycleway on part of Nelson Bay Road;
- construction of stormwater management measures;
- creation of asset protection zones; and
- associated landscaping and infrastructure works.

1.3 PUBLIC EXHIBITION

The EA was placed on public exhibition for a period of 30 days from 8 May 2009 to 9 June 2009.

The EA was made available for public viewing at the following locations:

- Department of Planning , Information Centre, 23-33 Bridge Street, Sydney;
- Department of Planning, Newcastle Office, Price Waterhouse Coopers Centre, Level 2, 26 Honeysuckle Drive, Newcastle;
- Port Stephens Council, 116 Adelaide Street (Old Pacific Highway), Raymond Terrace;
- Newcastle City Council, City Administration Centre, 282 King Street, Newcastle;
- Tomaree Library and Community Centre, Town Centre Circuit, Salamander Way, Salamander Bay;
- Stockton Library, King Street, Stockton; and
- Nature Conservation Council of NSW, Level 2, 301 Kent Street Sydney.

1.4 SUBMISSIONS RECEIVED

The Department of Planning (DoP) received submissions from:

- Port Stephens Council;
- Newcastle City Council;
- Department of Environment and Climate Change;
- Department of Primary Industries;

- Department of Water and Energy;
- NSW Rural Fire Service;
- NSW Roads and Traffic Authority;
- Ministry of Transport;
- Hunter New England Health;
- Department of Education and Training;
- Housing NSW;
- Department of Defence; and
- Hunter Water Corporation.

In addition, six submissions were received from community members.

2 *RESPONSE TO SUBMISSIONS*

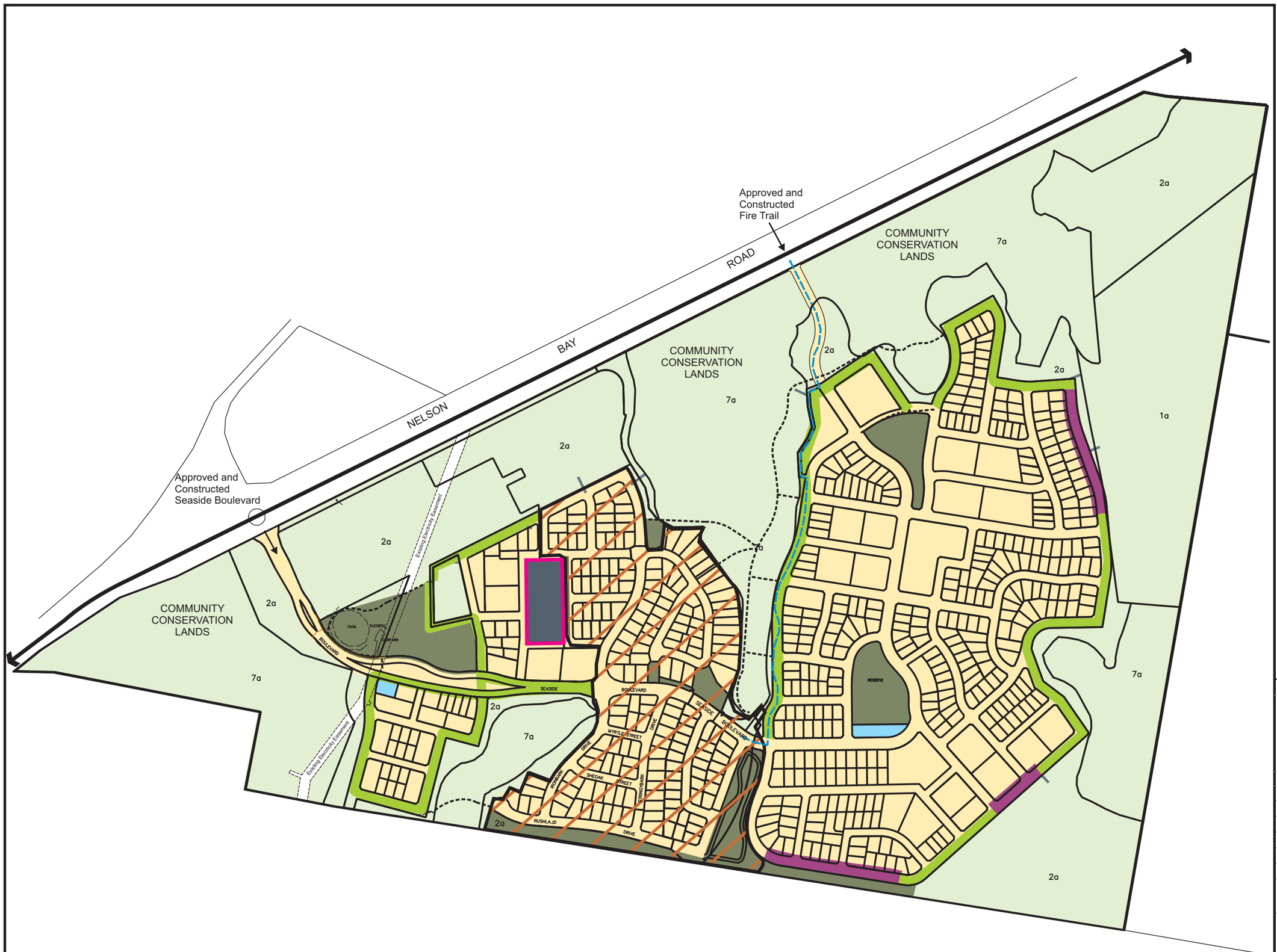
This chapter provides a summary of the submissions received and a response to each of the issues raised in those submissions.

2.1 RESPONSE TO SUBMISSIONS

Responses to the issues raised by Council, statutory authorities and the community are contained within *Annex A*. Detailed supporting information is provided within the annexure at the rear of this report. A summary of the issues raised is provided in *Table 2.1*.

Table 2.1 Summary of Submissions

Issue	Response	Submission Reference
SUBDIVISION LAYOUT AND DESIGN		
• Super lots, density, built form.	The DoP and Port Stephens Council (PSC) raised issues with lot sizes below 500sqm. Lot sizes below 500sqm have been consolidated into super lots, as required by DoP. The project plan has been amended and is provided in *figure 2* and amended subdivision plans are provided in *Annex B*. The subdivision plans and project plans have been adjusted to identify super lots. A density plan for proposed developments within super lots has been developed. The design guidelines will be updated for Stages 4 to 20 to address concerns with the built form for lots of less then 500sqm within the super lots and a commitment has been added to the revised statement of commitments that the developer will prepare design guidelines for future stages (see *Table 4.1*).	1a, 1c, 1e, 1ll, 6b, 6c, 10a,
• Design Guidelines	The DoP and PSC raised issues with the design guidelines. The design guidelines will be updated to cover the full spectrum of dwelling types to be included in the development. The design guidelines have also been updated to consider environmental requirements including bushfire, ecological issues, roof colours, Koala friendly fencing and visibility of solar panels and water tanks. Typical street planting is identified in *Figure 4*.	1c, 1d, 12bb, 12dd, 12ee, 12ff, 12gg, 12hh,
ECOLOGY		
• Ecological impacts of the development	The ongoing maintenance of the Community Conservation Lands will be ensured through inclusion of references to the Community Lands Environmental Management Plan (CLEMP), included in *Annex H*, in the Community Management Statement (CMS), included in *Annex I*. Vegetation within 100 metres of Owl Roost Tree to be retained. Support rezoning of Community Conservation Lands for environmental protection and negotiated a Voluntary Planning Agreement. Significant reduction in the area required for	1ee, 1ff, 2b, 2c, 2e, 2f, 12x, 12y, 12z, 12aa, 12bb, 12cc, 12dd, 12ee, 12ii, 12jj, 12kk, 17a, 18a, 19a, 20a, 20c, 20e, 20h,



Legend

- Managed Community Reserves/Parks[1]
- Community Conservation Lands[2]
- Local Activity Centre
- Mixed Use Residential Development
- Commercial Development
- Cultural Heritage Reserve
- Part of the Approved Subdivision Area
- Potential Stormwater Management Infrastructure
- Pathway
- Fire Trail
- 10 metre Asset Protection Zone
- 20 metre Asset Protection Zone (width of road reserve)
- 25 metre Asset Protection Zone

Notes:

1 Managed Community Reserves/Parks are areas of active and passive recreation for community purposes and do not form part of the community land.

2 Community lands are the 'Conservation Lands' to be managed for ecological and environmental values.

Figure 2

Preferred Project Plan

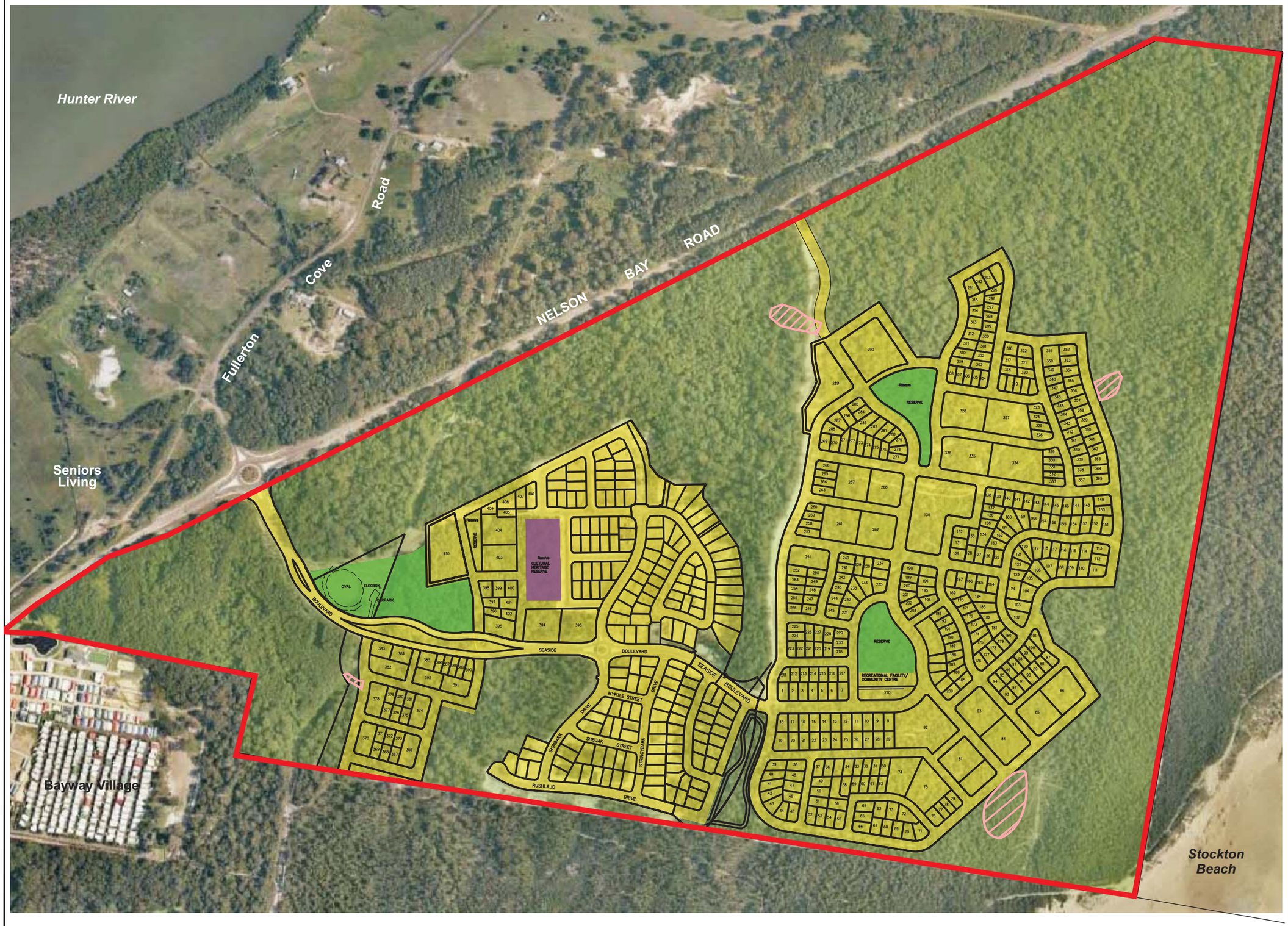
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Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_02		
Date:	30/11/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:			
Scale:	Refer to Scale Bar		

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Legend

- Fern Bay Seaside Village
- Vegetation to be Retained
- Vegetation to be Removed
- Managed Vegetation
- Cultural Heritage Reserve
- Vegetation to be Modified

Figure 3

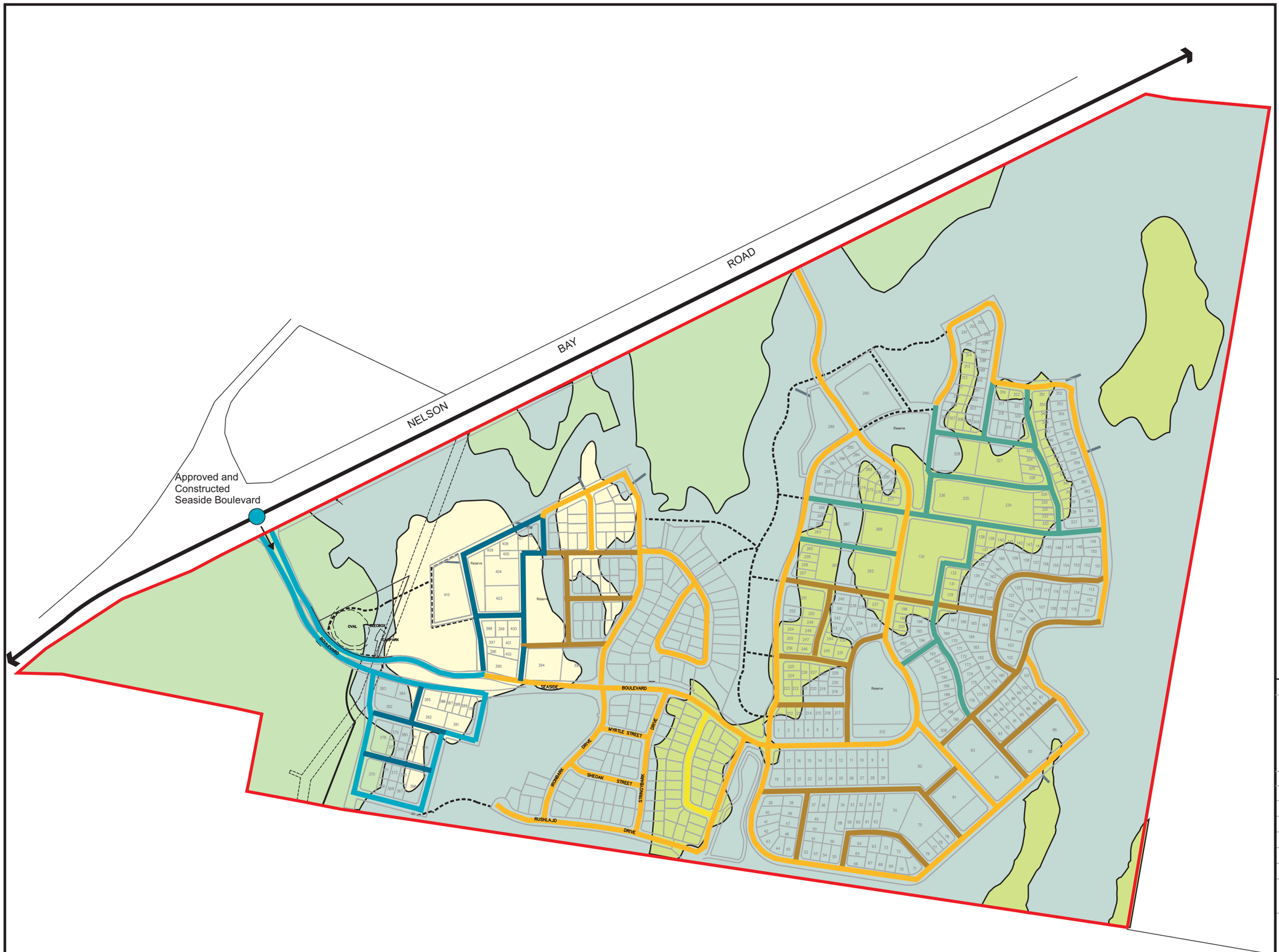
Vegetation Management Areas

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_03		
Date:	14/12/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:	-		
Scale:	Refer to Scale Bar		

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ERM



Legend

Proposed Streetscape Planting

- Swamp Mahogany Paperbark Forest - bush palette with complementary street trees.
- Swamp Mahogany Paperbark Forest - urban palette with complementary street trees.
- Apple Blackbutt Forest - bush palette with complementary street trees.
- Apple Blackbutt Forest - urban palette with complementary street trees.
- Heath - bush palette with complementary street trees.
- Heath - urban palette with complementary street trees.

Note: Streetscape planting will also apply to the Controlled Vegetation Zones (CVZ) within individual lots

Existing Vegetation

- to be retained and managed according to ecological principles and bushfire reuirements

- Swamp Mahogany Paperbark Forest
- Apple Blackbutt Forest
- Wet Heath
- Swamp Sclerophyll Forest

- Potential Stormwater Management Infrastructure
- Pathway

Figure 4

Street Planting

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_05		
Date:	11/12/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
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Scale:	Refer to Scale Bar		

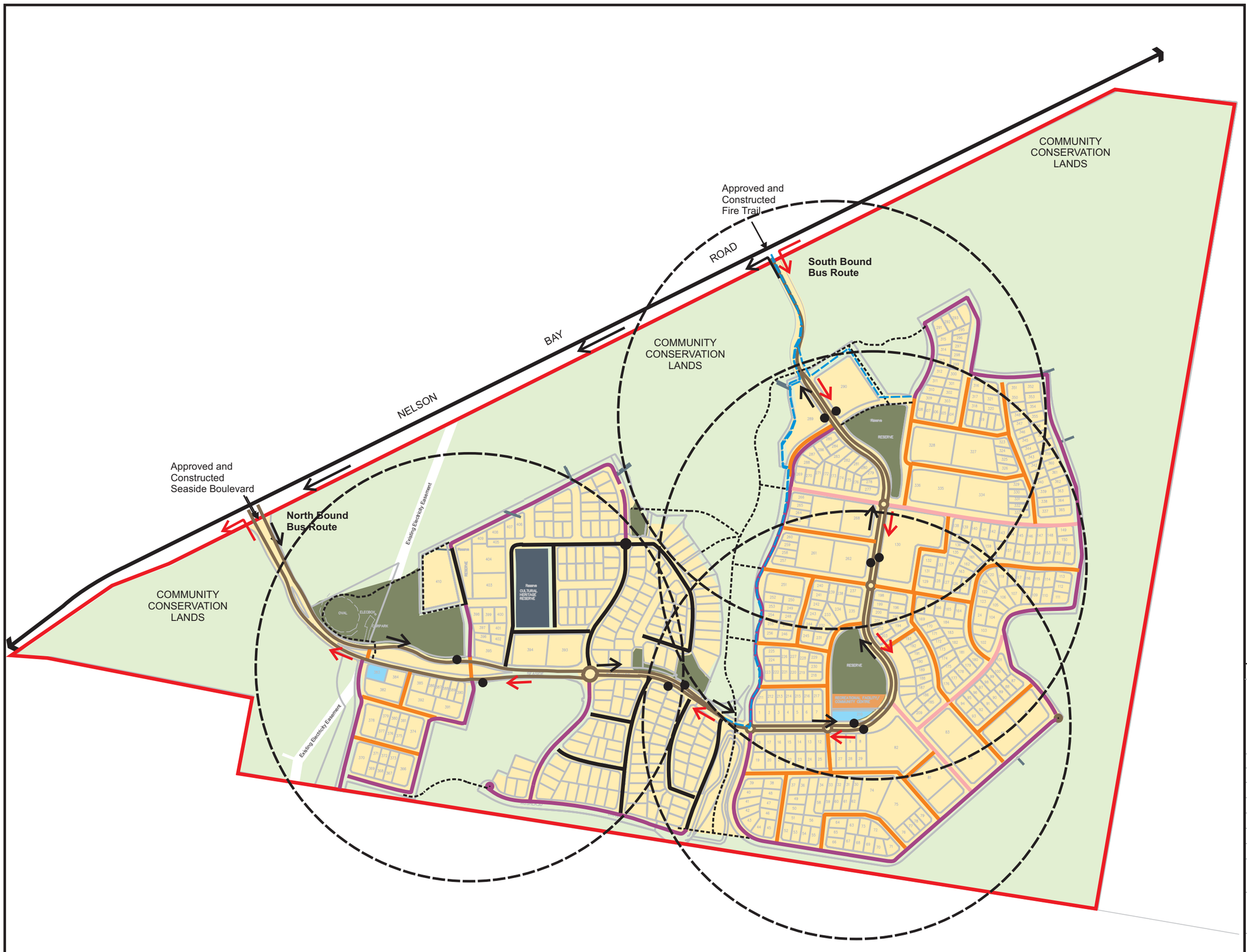
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Issue	Response	Submission Reference
	stormwater management based on Amended Water Cycle Management Strategy with recalculation of vegetation clearing provided in *Annex J*. In addition, the pumping stations have been located to avoid vegetation clearing see *Annex B*, Plan 15 of 22. An assessment of the development against the biodiversity offset principle has been undertaken and is provided in *Annex J*. Design guidelines to be updated prior to construction of Stage 4 to consider ecological considerations including Koalas. The CLEMP has been updated to ensure mosquito management reflect Port Stephens Council DCP 20007, the Mosquito Risk Assessment 2004 and Living with Mosquitoes in the Hunter and Mid North Coast Region of NSW 2005. A commitment has been added to the Revised Statement of Commitments (see *Table 4.1*) to prepare a Construction Environmental Management Plan to manage and mitigate potential impacts of construction prior to release of construction certificate for Stages 4 to 20.	
DRAINAGE		
• Water Cycle Management Strategy	Sewer pumping stations to be located to avoid the need to clear vegetation. Areas disturbed by construction of pumping stations will be maintained in accordance with the CLEMP. The Cardno report has been considered in the Amended Water Cycle Management Plan dated December 2009 provided in *Annex D*. Based on preliminary data from the Amended Water Cycle Management Strategy, a detention basin need to be constructed in Community Conservation Lands (see Plan 15 of 22)) and an update of the vegetation management areas is provided in *Figure 3*. As identified previously conveyance swales will be constructed to naturally low lying areas. The landscape plans will be updated prior to release of construction certificates and consider landscaping of drainage infrastructure. Development will occur in accordance with Amended Water Cycle Management Strategy so as not to intercept the water table or ground water aquifer.	1y, 1z, 1aa, 1ff, 1rr, 1uu, 2f, 3a, 3b, 3c, 4e, 12p, 12q, 12r, 12s, 12t, 12u, 12v, 12w,
Community Title		
• Management and ownership of community land, including community conservations lands.	A number of issues were raised regarding the ownership and management of the community lands. The Community Management Statement (see *Annex I*) has been amended to address concerns raised including: • responsibilities of the Community Association; • inclusion of reference to Community Conservation Lands and the Community Lands Environmental Management Plan, By-Law 35B; • management of drainage features located on community land, By-Law35F.2; • incorporation of Asset Protection Zones within the	1f, 1g, 1h, 1i, 1j, 1k, 1l, 1m, 1n, 1o, 1p, 1v, 1ee, 1nn, 1pp, 1qq, 2a, 2d, 2e, 2h, 2i, 2j, 2l, 12m, 12o, 12kk, 12ll,



Legend

- Managed Community Reserves/Parks[1]
- Community Conservation Lands[2]
- Local Activity Centre
- Mixed Use Residential Development
- Commercial Development
- Cultural Heritage Reserve
- Part of the Approved Subdivision Area
- Potential Stormwater Management Infrastructure
- Pathway
- Fire Trail
- Collector Road with minor bus route- variable width (minimum 17m wide road reserve)
- Neighbourhood Street - 20m wide road reserve
- Neighbourhood Street - 17.5m wide road reserve (existing approved DA and proposed adjacent development)
- Neighbourhood Street - 15m wide road reserve
- Perimeter Road - 20m wide road reserve
- Bus Route Direction
- Bus Stop
- 400m Radius from Bus Stop

Notes:

1 Managed Community Reserves/Parks are areas of active and passive recreation for community purposes and do not form part of the community land.

2 Community lands are the 'Conservation Lands' to be managed for ecological and environmental values.

Figure 5

Road Hierarchy

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_04		
Date:	11/12/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:			
Scale:	Refer to Scale Bar		

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Issue	Response	Submission Reference
	development footprint and management of APZ's, By-Law 35D; • maintenance of pedestrian pathways on community land By-Law 35B and 35F; and, • maintenance obligations for the Aboriginal Cultural Heritage Reserve, By-Law 35C.	
Traffic and Access		
• Intersections, Road widths, footpaths and Cycleway	Submissions included: • requirements to obtain RTA approval for design of the northern intersection and the design and construction to occur at full cost to the developer; • outline variations in standard road widths: • provide a cycleway on Nelson Bay Road; and • the provision of footpaths. The Draft Statement of Commitments has been amended to address these requirements including the staging of infrastructure (see *Table 3.1*). There are no longer any variations in standard road widths as updates to Port Stephens Council Development Control Plan 2007 allows minimum road reserve for local access to be 13.5 metres and all roads are now >15 metres.	1r, 1s, 1t, 1u, 1w, 1x, 4q, 5a, 6d, 6e, 12l, 12n, 17b,18d, 18f, 20i, 20j,
• Provision of public transport	Various submissions were received regarding the provision and viability of public transport for the development. Existing bus services operate in the locality connecting the development site with Fern Bay and Stockton and would be able to service the development. The proposed final location of bus stops has been identified Figure 4.1 of the Traffic Impact Assessment (*Annex M* of the EA) and will provide access less then 400 metres to all residents within the development as shown in *Figure 5*. Interim arrangements for bus stops will be discussed with Port Stephens Council prior to the release of Construction Certificates for each stage and a statement has been added to the Statement of Commitments to this effect.	1tt, 4m, 4n, 6a, 6b, 6c, 6f, 20i,
• Detailed design of drainage, parking, local area traffic management, internal intersections and pedestrian access.	A number of submissions were received relating to the detailed design of drainage, parking, local area traffic management, internal intersections and pedestrian access within the development site. These issues will be addressed at the detailed design stage in consultation with Port Stephens Council when seeking construction certificates.	12d, 12e, 12g, 12h, 12i, 12j, 12k,

Issue	Response	Submission Reference
Draft Statement of Commitments		
• Update Draft Statement of Commitments.	Many submissions received required the Draft Statement of Commitments to be updated. The Draft Statement of Commitments provided in *Table 4.1* has been updated to address the following issues: • to update design guidelines; • construction of northern intersection; • provision of footpaths; • to review and update CLEMP prior to construction of stage 4; • place restrictions on lots containing APZs; • to identify responsible parties and timeframes; • commitments specifically referenced in relevant specialist reports; • Voluntary Planning Agreement; • incorporation of commitments contained in Community Lands Environmental Management Plan; • provision and management of Asset Protection Zones; • management of Aboriginal Cultural Heritage Reserve; • retention of all vegetation within 100 metres of the Owl Roost Tree; • location of pumping stations so as to minimise clearing native vegetation and avoid clearing of mature and hollow bearing vegetation; • updating and finalisation of Aboriginal Reserve Cultural Heritage Management Plan; • management requirements of existing and additional Aboriginal Reserves; • Aboriginal Reserve Cultural Heritage Management Plan to be referenced in Community Management Statement; • Community Management Statement to be implemented in consultation with local Aboriginal community; • Construction Environmental Management Plan to be prepared prior to the commencement of construction of Stage 4; and • Section 94 contributions to be made consistent with Port Stephens Council's Development Control Plan requirements.	1a,1c, 1d, 1r, 1s, 1v, 1cc, 1ii, 1jj, 2a, 2b, 2c, 2d, 2g, 2h, 4h, 7a, 10b, 12bb, 12dd, 12ff, 12gg, 12hh, 12ll, 13a, 13b, 20c
Update plans		
• Update development plans	Subdivision plans have been updated to address submissions received on the following issues: • identification of super lots; • identification of Community Land; • location and extent of drainage infrastructure; • incorporation of APZs within development	1a, 1e, 1i, 1k, 1l, 1t, 1u, 1w, 1x, 1z, 1bb, 1cc, 1dd, 1kk, 1mm, 1nn, 1pp, 1qq, 1rr, 1ss, 1uu, 2g, 4m,

Issue	Response	Submission Reference
	footprint for Stages 4 to 20; • connection to existing 4WD track; • clearly identify Stages 1 to 3 that are not subject to the current application; • provide an allotment breakdown plan; • show community land as Lot 1; • provide more detail on revegetation and landscaping; • provide clear definition of commercial areas; • depiction of whole subdivision and access roads in detail on one plan; and • removal of lane ways.	6g, 7a, 10a, 12h, 12i, 12l,
Update Community Management Statement		
• Update Community Management Statement	The Community Management Statement has been updated to address the following issues: • confirm community property will be owned and managed by the community association; • clarify requirements for the use and maintenance of Community Association property; • make reference to the CLEMP; • specify that Port Stephens Council is responsible for maintenance of drainage facilities; • confirm that APZs within Community Land will be managed by the Community Association; • make reference to the Community Association's responsibility for the ongoing management of the Aboriginal Cultural Heritage Reserve in accordance with the Aboriginal Heritage Reserve – Cultural Heritage Management Plan; • make reference to detailed plans included in the CLEMP	1f, 1g, 1i, 1j, 1k, 1l, 1m, 1n, 1v, 1ee, 1nn, 1pp, 2a, 2e, 2h, 12kk,
Community Profile		
• Update of community profile based on 2006 census data	Analysis of 2006 Census data has been completed and is provided in *Annex C*.	1q
Bushfire Protection		
• Location of Asset Protection Zones (APZs) and restrictions on lots containing APZs	The project plans have been updated to ensure all APZs are included within the development footprint and not on Community Conservation Lands. Restrictions will be placed on use of land on lots containing APZs and a statement has been added to the Statement of Commitments to this effect. Bushfire management plans will be prepared for each stage from Stages 4 to 20. It should be noted that the APZs for Stages 1 to 3, which have already been approved and established, are not addressed in this Application.	1bb, 1cc, 1dd, 2g, 7a, 20c

Issue	Response	Submission Reference
Aboriginal Cultural Heritage		
• Additional Aboriginal Cultural Heritage reserve, pathways, Aboriginal Reserve Cultural Heritage Management Plan.	A pathway will be provided through Aboriginal Cultural Heritage Reserves as suggested by Local Aboriginal community. Pathways will be constructed in consultation with the local Aboriginal community. The provision of an additional Aboriginal Cultural Heritage Reserve identified by the local Aboriginal community based on the size of the development and the proponent has no objection to this being located within two identified areas in figure 7.5 of the EA. The Aboriginal Reserve Cultural Heritage Management Plan will be updated in consultation with the local Aboriginal community and a commitment to do so has been added to the Statement of Commitments. The Aboriginal Reserve Cultural Heritage Management Plan has been referenced in the Community Management Statement.	1gg, 1hh, 2d, 2k, 2l, 2m,
Section 94 contributions		
• Development impact on existing services, provision of additional services, works in kind and monetary contributions, cross boundary issues, utilisation of public parks and spaces by the wider community.	Section 94 contributions will be made consistent with Port Stephens Council's DCP requirements. The draft Statement of Commitments has been amended to identify this commitment. Parks and public spaces will be available for public use, without any maintenance or depreciation costs to council.	10b, 12ll, 13a, 13b

3 PREFERRED PROJECT

This chapter details the changes to the project that have resulted from consideration of the issues raised by Government agencies, Council and the local community and describes the Preferred Project.

3.1 INTRODUCTION

Following consideration of the issues raised by Government agencies, Council and the local community (refer to *Chapter 2* and *Annex A*), a number of amendments have been made to the project to further minimise any potential negative environmental impacts and enhance the creation of sustainable urban outcomes. These amendments are discussed in the following section.

Accordingly, the proposed development as described in the exhibited Environmental Assessment report (dated January 2009), together with the changes outlined in this report and summarised below, comprise the Preferred Project.

3.2 AMENDMENTS TO PROJECT

The proposal has been amended as follows:

- creation of 336 residential lots (Stages 4 to 20);
- creation of 31 residential Duplex lots (Stages 4 to 20);
- creation of 36 super lots with potential yield of 294 dwellings (approval for dwellings is not sought at this time);
- creation of four integrated housing lots that will yield 102 dwellings;
- creation of two commercial lots;
- all APZs contained within development footprint (see *Figure 2*); and
- location of sewage pumping stations to minimise clearing native vegetation.

The Development has also been amended to be in accordance with:

- amended Statement of Commitments;
- amended Community Management Statement;
- amended Community Lands Environmental Management Plan;
- amended Water Cycle Management Strategy; and
- updated Subdivision Plans.

3.3 PREFERRED PROJECT

Project approval is now sought for the following:

- creation of 336 residential lots (Stages 4 to 20);
- creation of 31 residential Duplex lots (Stages 4 to 20);
- creation of 36 super lots that will yield 294 dwellings (as shown on master plan approval);
- creation of four integrated housing lots that will yield 102 dwellings;
- creation of two commercial lots;
- creation of ecological conservation areas to be managed as Community Conservation Lands;
- recreational and open space network providing for areas including formal parks and a Aboriginal Cultural Heritage Reserve;
- creation of sites for commercial areas and community centre area;
- construction of roadways including internal roads, pedestrian pathways and a shared footpath/cycleway on part of Nelson Bay Road;
- construction of stormwater management measures;
- creation of asset protection zones; and
- associated landscaping and infrastructure works.

The Project Plan will be developed in accordance with:

- amended Statement of Commitments;
- amended Community Management Statement;
- amended Community Lands Environmental Management Plan;
- amended Water Cycle Management Strategy; and
- updated Subdivision Plans, provided in *Annex B*.

3.4 STAGING OF WORKS FOR PREFERRED PROJECT

For each stage in the proposed development, the standard works are required and these include clearing, earthworks, roadwork, stormwater, and landscaping as well as servicing provisions for sewer, water supply, power and communications.

In addition to these works, various stages will require other works as part of the overall development. A summary of the stage and the applicable works is provided in *Table 3.1*.

Table 3.1 Staging of Works

Stage	Works Required
Stage 4	Sewer pump station P4 (see Sheet 11 of 17 in *Annex B*)
	Construction of shared pedestrian/cycle way from bus shelter in front of Bay Way Village to the intersection of Seaside Boulevard and Nelson Bay Rd
Stage 6	Sewer pump station P5 (see Sheet 11 of 22 in *Annex B*)
	Detention Basin 6 (see Sheet 15 of 22 in *Annex B*)
Stage 8	Sewer Pump Station P6 (see Sheet 11 of 22 in *Annex B*)
	Conveyance Swale to Dispersion Area 5 (see Sheet 15 of 22 in *Annex B*)
Stage 12	Construct Community/Recreational facility (adjacent to commercial lot 210)
Stage 13	Construct Swale to Dispersion Area 4 (see Sheet 15 of 22 in *Annex B*)
Stage 14	Extend Seaside Boulevard to the intersection of Nelson Bay Rd
Stage 15	Construct Recreation Area in adjacent reserve
Stage 19	Sewer Pump Station P3 (see Sheet 11 of 22 in *Annex B*)
	Construct Drainage Swale to Dispersion Area 1 (see Sheet 15 of 22 in *Annex B*)

4 STATEMENT OF COMMITMENTS

This chapter sets out the revised Statement of Commitments having regard to the various issues raised.

A revised Statement of Commitments is provided in *Table 4.1*. The revised Statement of Commitments has been compiled based on the environmental assessment undertaken in the preparation of the Project Application and following review and consideration of issues raised in agency and community submissions. *Table 4.1* indicates the responsibilities and timing to implement measures to prevent potential environmental impacts that have been identified through assessment, to ensure that the project is environmentally, socially and economically sustainable.

Table 4.1 Revised Statement of Commitments

Item Number	Item	Commitment	Responsibility	Timing
1	Scope of Development	The development of the subdivision will be carried out as outlined in the documentation and subdivision plans detailed below, except where amended by other items of this Statement of Commitments. • Environmental Assessment Report (EA), prepared by ERM, February 2009 and supporting reports; • Subdivision Plans prepared by Daly Smith Pty Ltd; and • Submission Report, prepared by ERM, November 2009 and supporting documentation and plans.	Aspen Group Pty Ltd	Ongoing
2	Statutory Requirements	The following licences, permits and approvals will be obtained and maintained for the subdivision and construction infrastructure: • Construction Certificates for engineering works (including earthworks, soil and water management, road works, and drainage); • Compliance and Subdivision Certificates for each stage; • Telstra Compliance certificate; and • Section 50 Certificates from Hunter Water Corporation.	Aspen Group Pty Ltd	For the duration of subdivision.
3	Urban Design	The Design Guidelines will be updated for Stages 4 – 20 and will consider environmental requirements, including bush fire and ecological issues.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for Stage 4.

Item Number	Item	Commitment	Responsibility	Timing
4	Conveyancing	A final community title and community management statement will be prepared for the development.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for Stage 4
5		Easements will be provided for utility services that encroach onto private land or common space.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
6		Aspen Group will prepare work as executed plans for construction work in each stage and provide such plans to the relevant authority for each stage.	Aspen Group Pty Ltd and the relevant authority.	Prior to the release of the Subdivision Certificate for each stage.
7	Community Association	Any amended to the Community Management Statement (CMS) required as a result of conditions of consent will be prepared prior to the release of Subdivision Certificate for Stage 4. Draft CMS is included in Annex I	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for Stage 4.
8		The draft Community Lands Environmental Management Plan (CLEMP) included in Annex H, will be reviewed and amended to detail the land management requirements for community lands. The draft CLEMP will include plans for the: • Management of threatened species, including their habitat and endangered ecological communities; • Management of retained habitat features within the development footprint, including during the construction phase; • Management of specific habitat enhancement measures;	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for Stage 4.

Item Number	Item	Commitment	Responsibility	Timing
		• Regeneration and landscaping works; • Weed management; • Pest animal control; • Fencing; • Bushfire management; • Public access management including path maintenance; and • Stormwater management.		
9		The indicative work plan in the CLEMP will be updated post approval as timing of measures can not be updated before approval is granted.	Aspen Group Pty Ltd	Prior to release of the Construction Certificate for Stage 4.
10	Construction	Construction of the subdivision will be generally in accordance with the Staging Plan (Sheet 1 of 17) prepared by Daly Smith Pty Ltd or as otherwise approved in Construction Certificate plans.	Aspen Group Pty Ltd	Ongoing.
11		A Construction Environmental Management Plan (CEMP) will be prepared and will include the following: • a description of the work program outlining relevant timeframes and activities; • a description of the roles and responsibilities for all relevant employees involved in the construction phase; • the minimisation of rubbish and debris at the site from development activities during the construction phase;	Aspen Group Pty Ltd	Prior to the commencement of construction for each stage.

Item Number	Item	Commitment	Responsibility	Timing
		• erosion and sediment control during construction; • details of environmental management procedures, monitoring and reporting during construction and operation phases; • details of revegetation to be undertaken following construction activities; • details of statutory and other obligations that must be met during construction and operation, including all approvals and agreement required from authorities and other stakeholders; • an education strategy for construction contractors; and • the construction commitments outlined in the Community Lands Environmental Management Plan (CLEMP)		
12		Construction work shall only be carried out between 7.00am to 6.00pm Monday to Fridays and 7.00am to 12.00 midday on Saturdays.	Aspen Group Pty Ltd	For the duration of the construction of the subdivision.
13		Inspections will be carried out by an accredited certifier and following each inspection, compliance certificates will be forwarded to the Principal Certifying Authority.	Aspen Group Pty Ltd	For the duration of the construction of the subdivision.
14	Flora and Fauna	Update the Community Lands Environmental Management Plan (CLEMP) prepared by ERM, February 2009 to include: • maintenance of pedestrian pathways	Aspen Group Pty Ltd	Completed. Reference to Maintenance of pedestrian pathways included in draft CLEMP included in Annex H.

Item Number	Item	Commitment	Responsibility	Timing
15		Implement the Community Lands Environmental Management Plan (CLEMP) prepared by ERM, February 2009 as amended November 2009, Included in Annex H.	Aspen Group Pty Ltd and Community Association	Ongoing
16		The Community Lands Environmental Management Plan (CLEMP) will form part of the Community Management Statement for implementation by the Community Association.	Aspen Group Pty Ltd and Community Association	Ongoing
17		A qualified fauna handler will be on site when clearing occurs.	Aspen Group Pty Ltd	During clearing activities.
18		Suitable koala feed trees will be planted around the areas of the site.	Aspen Group Pty Ltd	At the completion of construction of each stage.
19		All vegetation within 100m of the identified owl roost tree will be retained.	Aspen Group Pty Ltd and Community Association	Ongoing
20		The proponent offers to enter into the Voluntary Planning Agreement (VPA) between Aspen Group Pty Ltd, Winten (No 2) Pty Ltd and DECCW publically notified in accordance with the requirements of section 93G of the EP&A Act 1979, in accordance with the terms contained in the draft planning agreement annexed to the Statement of Commitments.	Aspen Group Pty Ltd, Winten (No 2) Pty Ltd and DECCW	Ongoing
21	Bushfire Management	The measures contained in the Bush Fire Hazard Assessment, prepared by ERM, 2009 (provided in Annex L of the EA) will be implemented.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.

Item Number	Item	Commitment	Responsibility	Timing
22		A restriction to the land use pursuant to Section 88B of the Conveyancing Act 1919 will be placed on all lots which provide and manage an asset protection zone within their boundaries.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
23	Heritage	The development shall adhere to the recommendations of the Aboriginal Heritage Assessment Report, prepared by ERM, April 2005 (and the addendum report dated May 2008) (provided in Annex I of the EA), including the following site specific recommendations: • provision for representatives of the Aboriginal community to recover Aboriginal objects during excavation work. Local Aboriginal community representatives will be invited to monitor ground disturbing works within the project area; • consultation with the Aboriginal community regarding interpretation of archaeological information that could be presented in the form of public display, such as interpretive signage. The endorsement of the Aboriginal stakeholder groups will be sought on the style and content of the signage / displays; • maintain liaisons with the Aboriginal community throughout the development process; • exclusion of the ridgeline marked blue on Figure 3.2 of the Aboriginal Heritage Assessment Report (Annex I of EA) from development and conservation within the proposed Cultural Heritage Reserve; and • follow the procedure identified in the Aboriginal Heritage Assessment Report and associated Addendum (Annex I of the EA) if human skeletal remains are identified during construction works.	Aspen Group Pty Ltd	For the duration of the construction of the subdivision.

Item Number	Item	Commitment	Responsibility	Timing
24		The draft Aboriginal Reserve Cultural Heritage Management Plan (ERM, 2006) will be updated and finalised in consultation with the local Aboriginal community. The plan will identify the management requirements of the existing Aboriginal Cultural Heritage Reserve, as well as the additional Aboriginal Reserve as requested by the Aboriginal community. The Management Plan will form part of the Community Management Statement and will be implemented by the Community Association in consultation with the Aboriginal Community and will include: • A clause relating to the amendment of the Cultural Heritage Management Plan, in consultation with the Aboriginal Community, to include specific reference to the additional cultural heritage reserves; • A commitment confirming that management of the above areas by the Community Association will be approved by the Aboriginal Community; and • Inclusion of a clause relating to the education and induction of construction workers in relation to cultural heritage.	Aspen Group Pty Ltd	Updating of the plan to occur prior to the release of the Construction Certificate for Stage 4.
25		The final Fern Bay Estate Aboriginal Heritage Reserve – Cultural Heritage Management Plan will be implemented by the Community Association through the Community Management Statement.	Community Association	Ongoing

Item Number	Item	Commitment	Responsibility	Timing
26		An Aboriginal Cultural Heritage Reserve shall be created within the Fern Bay Seaside Village in order to retain an area that represents the key aspects of the Aboriginal archaeological record at Fern Bay. A second reserve, as requested by the local Aboriginal community, will also be created at one of the two possible locations identified in Figure 7.5 of the EA. The site selected will be subject to consultation with the local Aboriginal community.	Aspen Group Pty Ltd	Prior to the release of the Construction Certificate for the respective stage of construction.
27	Water Cycle Management	All works will be carried out in accordance with the Stormwater Assessment and Stormwater Management Plan and will reflect the recommendations of the Amended Water Cycle Management Strategy prepared by Martens Consulting Engineers and dated December 2009 for the proposed residential development at Fern Bay, including the following treatment devices to ensure pollutants leaving the site are minimised: • runoff from all catchments would be directed through bio-retention swales that have been designed to treat flows up to and including those with a three month Average recurrence Interval (ARI); • flows up to and greater than three months ARI would overtop the biorention swales and pass through vegetated filter zones prior to being discharged into natural drainage lines.	Aspen Group Pty Ltd	Ongoing.
28		Pumping stations will be located to minimise clearing of vegetation in the Community Conservation Lands. In particular pumping stations P3, P5, P6 and P7 will be located in the field to avoid clearance of mature and/or hollow bearing trees. Following construction, the sites will be revegetated and	Aspen Group Pty Ltd	Ongoing

Item Number	Item	Commitment	Responsibility	Timing
		ongoing maintenance of the areas will be undertaken consistent with the CLEMP.		
29	Erosion and Sediment Control	The following management approaches will be taken to limit potential for wind and soil erosion: • construction activities shall be phased to minimise erosion and minimise impacts on stormwater management measures that rely on infiltration processes; • clearing of vegetation shall be minimised; • sediment basins, silt fences and perimeter banks shall be used during construction to minimise erosion and sediment transport to receiving waters; • sediment traps and GPTs shall be installed in stormwater drainage systems; and • vegetated ground cover shall be maintained or restored.	Aspen Group Pty Ltd	For the duration of the construction of the subdivision.
30	Traffic Management and Access	The design of the internal roads will be generally in accordance with Port Stephens Council Subdivision Development Control Plan. Pedestrian laneways will be included in relevant stages to ensure compliance with Port Stephens Council DCP 2007 B1.C11 that a new block in a residential zone must be no more than 80m deep and 160m long.	Aspen Group Pty Ltd	For the duration of the construction of the subdivision.
31		The design and upgrade of the northern intersection with Nelson Bay Road will be undertaken at the developer's expense and will be constructed in accordance with RTA requirements and approvals.	Aspen Group Pty Ltd	During Stage 14

Item Number	Item	Commitment	Responsibility	Timing
32		Footpaths will be provided consistent with Port Stephens Council Policy requirements.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
33		Shared Footpath/Cycleway from existing roundabout at the intersection of Nelson Bay Road and Fullerton Cove Road to the bus shelter at Bay Way Village to the south will be constructed during Stage 4 of the Fern Bay Seaside Village.	Aspen Group Pty Ltd	During Stage 4
34		Interim bus stop locations will be discussed with Port Stephens Council on a stage by stage basis with the final bus route outlined in Figure 4.1 of the Traffic Impact Assessment (Annex M of the EA)	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
35		Access to existing Four- Wheel- Drive Track from Seaside Boulevard will be formalised through an easement.	Aspen Group Pty Ltd	Prior to release of the Subdivision Certificate for Stage 4.
36	Infrastructure Provision	Each residential lot will be provided with reticulated water supply, sewerage and underground electricity.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
37		The subdivision will make satisfactory arrangements with Telstra for the provision of telecommunication facilities to each residential lot.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.
38	Developer Contributions	Section 94 contributions will be paid consistent with Port Stephens S94A Development Contributions Plan 2006 as modified September 5 2009.	Aspen Group Pty Ltd	Prior to the release of the Subdivision Certificate for each stage.

Item Number	Item	Commitment	Responsibility	Timing
39	Landscaping	A Landscape Plan will be submitted to Port Stephens Council detailing the proposed landscaping works (including species, location and establishment procedures).	Aspen Group Pty Ltd	Prior to the release of the Construction Certificate for each stage.
40	Community Facilities	Details regarding the proposed children's play equipment will be submitted to Port Stephens Council.	Aspen Group Pty Ltd	Prior to the release of the Construction Certificate for the relevant stage.
41	Commercial facilities	An action plan to facilitate the establishment of commercial facilities on lots identified as commercial development, including staging information, will be developed and implemented. Staging of Commercial lots will be as per the Staging plan included in the Submissions Report.	Aspen Group Pty Ltd	Prior to the release of the Construction Certificate for the relevant stage.

5 *CONCLUSION*

All responses received and issues raised have been considered and the submissions report represents a response to all concerns or issues raised. A number of modifications have been made to the project proposal and they are detailed in the above report and further explained in the attached annexure. These changes have resulted from consideration of the issues raised by various Government agencies, Port Stephens Council and the local community. The proposed amendments will assist in mitigating any adverse environmental impacts associated with the proposed development and enhance the achievement of sustainable urban outcomes on the site.

As a result of amendments to the project plan it is considered that the development as proposed through the preferred project plan represents an improved outcome which is able to be supported by the Department of Planning.

Annex A

Response to Submissions

Table A.1 Fern Bay Seaside Village Response to Submissions

Authority	Issue Raised	Ref	Submission	Response
DoP	Subdivision Layout and Urban Design	1(a)	The Department has previously advised the proponent that the subdivision plan would need to be amended to depict a number of 'superlots' which are anticipated to contain proposed lots that are less than 500sqm and where it was not intended to lodge an 'integrated housing' application (in accordance with Clause 17 of the Port Stephens LEP 2000). The proposed subdivision plan as submitted as part of the EA is inconsistent with this advice. The Department requires an amended subdivision plan to consolidate all lots less than 500sqm into a number of superlots. Draft Statement of Commitments should be prepared which indicates the intention to pursue small lots (less than 500sqm) as 'integrated housing' development with Council following a Project Approval'.	The subdivision plans and Project Plan have been adjusted to identify super lots. A density plan has been developed by ERM/DMS to identify density of proposed development within the super lots – similar to the density plan in the Master Plan.
		1(b)	*Table 4.1* of the EA states that the 'majority of residential buildings are proposed to be one or two storeys in height'. Confirm that the maximum building height for the development will be 2 storeys.	There are no buildings proposed as part of this Project Plan. Any future buildings will need to conform to Port Stephens Council Guidelines.

Authority	Issue Raised	Ref	Submission	Response
		1(c)	The Department raises concerns with the future built form anticipated for the lots within the proposed subdivision which are proposed to be less than 500sqm. The Design Guidelines provided in *Annex G* are general and are not specific to particular built form types (such as villas, courtyards, conventional lots etc). Further, *Figure 4.1* of the EA titled 'Built Form Control' is insufficient in detail to determine the future built form anticipated on lots less then 500sqm.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments in the submission report to that effect.
		1(d)	Reference is made to the proposed design guidelines (Vol 1, *Annex G*). It is noted that these guidelines already apply to the existing Stages 1 and 2 of the development. Section 2.5 of the EA states the 'Community Management Statement / Plan 'will contain design guidelines for future urban development'. Clarify whether these guidelines are anticipated to apply to future development in Stages 4 -20 or will a new set of guidelines be developed for Stages 4 - 20? Any new design guidelines will need to cover the full spectrum of the proposed dwelling types to be included in the Fern Bay Development (eg villas, courtyard, duplex). A Statement of Commitment should also be made which commits the developer to preparing design guidelines for future stages.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments in the submission report to that effect.

Authority	Issue Raised	Ref	Submission	Response
		1(e)	Indicate the maximum number of dwellings anticipated on the 'integrated housing lots' (which will include any new superlots) and the proposed dwelling types envisaged to be constructed on the integrated lots. Provide the proposed net residential density (dwellings/hectare) to be achieved on the lots which are depicted as 'integrated housing' (*Figure 2.3* Staging Plan).	*Figure 2.3* identifies integrated housing lots have a potential yield of 111 lots in accordance with Port Stephens LEP. This is at a density of one dwelling per 300m^2. The approved master plan identifies the intent to realise 102 dwellings in the integrated housing lot. A further breakdown of the development density is provided in *Annex G* of the Submissions report. 36 super lots have also been created from the need to remove laneways and consolidate lots under 500m^2. These lots have a maximum yield of 389 in accordance with the Port Stephens LEP. This is at a density of one dwelling per 300m^2. The approved master plan identifies the intent to realise 294 dwellings in the areas now identified as super lots.
	Management regime under Community Title and Dedication of Lands to Council.	1(f)	Clarify whether the Community Management Plan (*Section 2.5*) is equivalent to the Community Management Statement (Vol 1, *Annex E*).	The Community Management Plan referred to in *Section 2.5* is actually the Community Management Statement (CMS) which was registered at the LPI with the Stage 1 Community Subdivision Plan. This CMS will apply to the entire development, being Stages 1 to 20. An amended CMS incorporating Stages 1 to 20 is to be provided in the Submissions Report.

Authority	Issue Raised	Ref	Submission	Response
		1(g)	Provide confirmation that all community property (including 'community conservation lands', parks and associated infrastructure (excluding roads) will be owned and managed by the Community Association.	Roads, road reserves and any drainage infrastructure within the road reserve will be dedicated to PSC. All other community property, including drainage structures (outside road reserves), parks, reserves and conservation lands and associated infrastructure will be owned by the Community Association. Drainage basins catering for runoff from road reserves will be owned by the Community Association but will be managed by Port Stephens Council.
		1(h)	Clarification is also sought as to the stage of the development (eg Stage 4?) when Aspen Group Ltd will transfer ownership of the community property (such as main parks, cultural heritage reserves and community conservation lands) to the Community Association. The CMS also refers to Winten (No 20) Pty Ltd being the original proprietor of lands. Clarify whether it will be Winten or Aspen who will own and manage community property prior to transfer to the Community Association.	The ownership of community property developed at each stage of the development will be transferred to the Community Association at the completion of the construction of each asset within the respective stage. Prior to transfer to the Community Association, the land will remain under the ownership and management of Winten Fern Bay No 2 Pty Ltd. Aspen will manage the land on behalf of Winten as per an existing legal agreement.
		1(i)	There are inconsistencies throughout the EA document on the responsibilities of the Community Association. It is unclear which components of the development will be managed by the Community Association and which components will be dedicated to Council. Provide clarification and a plan which clearly shows areas to be managed under the Community Association and areas to be dedicated to Council. The CMS should be amended to provide details on the	The land in the estate will be in one of three types of ownership: • lots which will be owned and maintained by the lot owner; • Community Association property will be owned and maintained by the Community Association; and • public roads and road reserves will be owned and

Authority	Issue Raised	Ref	Submission	Response
			special requirements for the use or maintenance of the Association property.	maintained by Port Stephens Council. For information on the drainage system see 1(k) below. Clauses 2 and 4 of Schedule 1 of the *Community Land Management Act 1989* stipulate that the Community Association must maintain all of the Association property. The Community Management Statement has been amended to refer to the special maintenance/management requirements for this estate.
		1(j)	The conservation of the "Community Conservation Lands' is a key component of the development. *Section 2.5* of the EA states that the CLEMP will form part of the CMS. However, the CMS makes no reference to the Community Conservation Lands or the CLEMP. The Department requests that the CMS is amended to make reference to the Community Conservation lands and the CLEMP.	As mentioned in 1(f) the Community Management Statement has been amended to refer to the Community Lands Environmental Management Plan in By-Law 35B.
		1(k)	ERM have previously advised that the drainage features located in road reserves will be dedicated to Council. However, all other drainage features will be under the management of the Community Association. According to the 'Trunk Drainage Conceptual Plan' (Sheet 10 of 18, *Annex B*) and cross referencing against the Project Plan (*Figure 2.2* of the EA), it appears that one detention basin is located in an area depicted as 'Managed Community Reserves', two detention basins are located in the Community Conservation Lands and	The stormwater treatment facilities which are within the Community Association property will be maintained and managed by Port Stephens Council as these facilities cater for the stormwater from the public road system. The existing stormwater treatment facilities are covered by an easement in favour of Port Stephens Council which gives council the right to access the Association property for maintenance purposes. The Community Management Statement has been amended to specify that Council

Authority	Issue Raised	Ref	Submission	Response
			all three dispersion areas will be located in the Community Conservation Lands. The Community Association will be required to manage all three detention basins and three dispersion areas, including ongoing monitoring and maintenance. The Department requests that the Community Management Statement is amended to specify that the Community association is responsible for the management, maintenance and monitoring of the drainage features.	has the responsibility to maintain the drainage facilities.
		1(l)	The Department recommends a re-design of the development such that APZ's do not occur on the Community Conservation Lands. Where this cannot be done, reference should be made to the management of the APZ via the Community Management Statement.	The Project Plan has been amended to incorporate all APZs for Stages 4 to 20 within the development footprint (refer to *Annex A*). No APZs for Stages 4 to 20 occur within the Community Conservation Lands. The Project Plan has been updated to ensure that the APZ for the integrated housing lots are incorporated fully into the lot and not within the Community Conservation Lands. This plan currently identifies the differing widths of the APZs. APZs for Stages 1 to 3 are also shown on the plan. These APZs are already approved as part of the development consent for Stages 1 to 3 and do not form part of the current project application.

Authority	Issue Raised	Ref	Submission	Response
		1(m)	The CMS should refer to the obligations of the Community Association to the ongoing maintenance of the Aboriginal Cultural Heritage Reserve in accordance with the Fern Bay Estate Aboriginal Heritage Reserve - Cultural Heritage Management Plan.	The Community Management Statement has been amended to refer to the maintenance obligations for the Aboriginal Cultural Heritage Reserve as contained in the Cultural Heritage Management Plan.
		1(n)	The CMS should incorporate or reference detailed plans for fuel management in the APZs, water quality/groundwater monitoring, maintenance requirements for drainage structures, maintenance requirements of community open space (inclusive of all buildings, equipment and pedestrian pathways) and bushland regeneration/maintenance requirements in the buffer lands. At this stage, an outline of the contents of such plans should be provided.	The Community Management Statement has been amended to refer to maintenance and management of the asset protection zones, groundwater monitoring, open space areas, bushland and buffer lands.
		1(o)	The CMS makes no reference to the funding regime required for the future monitoring and maintenance of community property and associated infrastructure. Further clarification on funding arrangements is required. This should include consideration for any initial funding by the developer (Aspen/Winten) to the Community Association upon transferring ownership of the Community Property.	Clause 13 of Schedule 1 of the *Community Land Management Act 1989* stipulates that the Community Association is to raise money to be paid into the administrative fund and sinking fund to meet all of its management and maintenance requirements. The funding for each year is decided at the annual general meeting of the Community Association thereby providing a budget for the coming year with each land owner to contribute.

Authority	Issue Raised	Ref	Submission	Response
		1(p)	It is understood Winten (No 2) Pty Ltd are the landowners for the development. Confirm whether Aspen or Winten will have responsibility for the management of the Community Conservation Lands prior to handover to the Community Association.	Prior to transfer to the Community Association, the land will remain under the ownership and management of Winten Fern Bay No 2 Pty Ltd. Aspen will manage the land on behalf of Winten as per an existing legal agreement, whereby the obligations of Winten Fern Bay No 2 Pty Ltd are passed on to Aspen.
	Social and Community	1(q)	*Section 7.3* provides an analysis of the existing community profile based on 2001 census data. Analysis of 2006 census data should be provided and any impacts on the changing demographics should be discussed.	*Section 7.3* (Social and Community) has been updated to include 2006 census data. This is provided in *Annex C* of the Submissions Report.
	Traffic and Access	1(r)	The RTA will need to approve the future design and construction of the northern site intersection with Nelson Bay Road. It is also noted that the RTA requires the intersection works to be undertaken at full cost to the developer. As such, the proponent will need to provide a commitment to undertake these works in the draft Statement of Commitments.	The draft Statement of Commitments have been amended identifying that the developer will undertake intersection upgrade works, with the design and construction to be approved by the RTA and at full cost to the developer.

Authority	Issue Raised	Ref	Submission	Response
		1(s)	*Section 4.3.5* states that concrete footpaths will be provided adjacent to roads. A plan needs to be provided which depicts the location of the footpaths proposed within the development.	Footpaths adjacent to roads will be provided in accordance with the current policy requirements of Port Stephens Council. The specific locations and design of the footpaths will be provided to Council at the construction certificate stage. This is usual Council practice. The engineering design to date has reflected the existing stages which were designed to Council requirements and approved by Council's engineers. A commitment has been added to the draft Statement of Commitments identifying that footpaths will be provided consistent with Council policy requirements.
		1(t)	Pedestrian pathways are indicated on *Figure 1.2* of the Traffic Report (Vol 3, *Annex N*) and on the 'Project Plan' (*Figure 2.2*). Provide an indication of how the paths will be constructed and the requirement for clearing, particularly where paths are proposed to be constructed in the Community Conservation lands. Provide a plan showing the types of boardwalks to be used for the pedestrian pathways, including a typical section.	Pathways throughout the development will be a combination of concrete footpaths, boardwalks (in environmentally sensitive areas) and pedestrian trails where practical consisting of natural surfaces. The pathways will be located and constructed to avoid clearing of vegetation (ie meander around vegetation). The specific design and construction details of the pathways will be detailed during the construction certificate stage. The Landscape Plan provides additional information regarding paths and trails throughout the development.

Authority	Issue Raised	Ref	Submission	Response
		1(u)	Concern is raised with the location of the pedestrian pathway which runs through proposed detention basin no. 3. Demonstrate that the proposed pathway will not undermine the treatment and retention of stormwater in this location.	The location of this pathway has been amended to be located adjacent to detention basin 3 within the road reserve of Stage 3 and is no longer shown on the Plan.
		1(v)	The Community Management Statement and Community Lands Environmental Management Plan will need to be updated to make reference to the maintenance of pedestrian pathways.	As mentioned in Response 1(i) the Community Association is responsible for the maintenance of all of the Community Property. The Community Management Statement has been amended to make reference to Public Access Management in Section 35B.2. The CLEMP has been updated to specifically reference maintenance of pedestrian pathways by the Community Association. The CLEMP is subject to regular review in consultation with PSC and DECC. The draft Statement of Commitments has been amended to identify that the CLEMP will be reviewed and updated prior to the construction of Stage 4 to incorporate maintenance of pedestrian footpaths.

Authority	Issue Raised	Ref	Submission	Response
		1(w)	*Table 4.1* (should be *Table 5.2*) of the EA specifies that there are some variations proposed to the standard road widths required by the Port Stephens DCP 2007. *Figure 4.1* of the Traffic Study (Vol 3, *Annex M*) is not detailed enough to determine where the variations actually occur. Provide a detailed plan for the variations and a justification for these variations.	Road design in EA report is consistent with existing Council approved streets. Council confirmed that continuation of approved and constructed streets is acceptable. Variation in standard streets was identified as some access streets are shown as having 15 metre road reserves. There is no conflict with PSC DCP 2007 as *Figure B1.3* now shows minimum road reserves for access streets as 13.5 metres as opposed to the 17.5 metre included in the EA. Detail plans included in *Annex B* of the Submission Report shows the widths of road reserves.
		1(x)	The Project Plan (*Figure 2.2*) depicts a future road connection to the proposed 4WD track in the Worimi Regional Park. However, the subdivision plan (sheet 2 of 18, Vol 2, *Annex B*) does not show a proposed connection, provide clarification if approval is sought for this road extension.	Approval is sought for this road to be constructed up to the property boundary. Sheet 9 of 22 included in *Annex B* of the Submission Report has been updated to identify this.

Authority	Issue Raised	Ref	Submission	Response
	Infrastructure Provision	1(y)	Reference is made to the 'Indicative Sewer Layout' (Sheet 7 of 18, *Annex B*). The locations of the proposed pumping stations (P3, P4, P5, P6 and P7) vary from the locations as shown on the 'Conventional Sewer layout' (Fig 4, Sewer and Water Servicing Strategy Report, November 2004), *Annex O*). Provide a justification for the relocation of the pumping stations.	The original assessment by GHD (*Annex O* of the EA) was based on the previous conceptual plan and layout of the Fern Bay Seaside Village subdivision. Since that time, modifications were made to the subdivision plan, resulting in the need to modify the sewer design and pump station locations. The proposed locations are shown in Plan 11 of 22 *Annex B* of the Submission Report. Pumping stations P3, P5, P6 and P7 are proposed for Community Conservation Lands. P3 is proposed for an existing cleared easement and will be located in the field to avoid clearing swamp sclerophyll forest. A statement has been added to the Amended Statement of Commitments that pumping stations will be located to minimise clearing of vegetation. In particular pumping stations P3, P5, P6 and P7 will be located in the field to avoid clearance of mature and/or hollow bearing trees. Following construction, the sites will be revegetated and ongoing maintenance of the areas will be undertaken consistent with the CLEMP.

Authority	Issue Raised	Ref	Submission	Response
		1(z)	Particular concern is raised with the location of proposed pumping stations in areas to be managed as 'Community Conservation Lands' on the Project Plan (*Figure 2.2*). Minimal vegetation removal should occur on the lands. As such, all proposed pumping stations located on these lands should be relocated into the development footprint. This is consistent with the development as described in the Master Plan approval (MP-20-4-2005).	The proposed locations are shown in Plan 11 of 22 *Annex B* of the Submission Report. Pumping stations require an area of approximately six metres by 15 metres and will need to be located at the detailed design stage. A commitment has been added to the Draft Statement of Commitments that pumping stations will be located so as to avoid clearing vegetation and in particular avoid clearing mature and/or hollow-bearing trees. Following construction, the sites will be revegetated and ongoing maintenance of the areas will be undertaken consistent with the CLEMP.
	Water Cycle Management	1(aa)	Refer to the Cardno Lawson Treloar Report (dated 2 July 2009) prepared on behalf of the Department which provides detailed comments on stormwater, groundwater, flooding and coastal hazards.	The Cardno report has been taken into account in the Water Cycle Management Strategy prepared by Dr Daniel Martin.
	Bushfire Protection	1(bb)	Proposed widths of APZs vary from 20 to 25 m, but appear to be the same size as depicted on Project Plan – Detail Plan No. 1-5 in *Annex B* and it would appear that the APZ in some locations may impinge on proposed lots. Provide a plan to a legible scale and size which clearly depicts the proposed APZ widths.	*Figure 2.2* Project Plan has been amended to identify that all APZs associated with Stages 4 to 20 are located within the development footprint and will not be located within the Community Conservation Lands. *Figure 2.2* currently identifies the differing widths of the APZs. A Bushfire report will be prepared for each stage of the development as recommended in the Bushfire Assessment Report.

Authority	Issue Raised	Ref	Submission	Response
		1(cc)	APZs impinge on Lots 91 to 106 and Lot 1144. Provide a plan to a legible scale and size which clearly depicts the exact extent to which the APZs impinge onto the residential lots. A Section 88B covenant will be required on lands where the APZ impinges on lots. This should be incorporated as a draft Statement of Commitment.	Lots 91 to 106 are located within Stage 1 of the Fern Bay Seaside Village and are not subject to this application. APZs within Stages 1 to 3 have been previously approved. These are not subject to the current project application. The Project Plan (*Figure 2.2*) has been amended to identify that APZs will occur within Lots 289 and 410 (integrated housing lots). Future design of the integrated housing lots will take into consideration the location and requirements of the APZs. The draft Statement of Commitments has been amended to identify that a restriction will be placed on lots which have APZ's. Lots containing 5 metres of APZ include lots 44, 45, 52, 53, 54, 55, 66, 67, 68, 69, 70, 84, 85, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363 and 364. This will be included in compulsory lot set backs from the road. Integrated Housing Lots 410 and 289 require a 20 metre APZ, comprising 6 metre lane and 14 metres of managed land within the lot footprint.
		1(dd)	APZs are currently shown to impinge on land earmarked as 'Community Conservation Lands' (in the vicinity of Lots 459 and 1144). The development proposed must be amended to ensure all APZs are contained within the development areas.	*Figure 2.2* Project Plan has been amended to identify that all APZs associated with Stages 4 to 20 will be located within the development footprint and will not be located within the Community Conservation Lands.
	Flora and Fauna	1(ee)	Concern is raised that there is no mention of the CLEMP within the CMS. Therefore, demonstrate what mechanism is available to ensure that ongoing maintenance of the Community Conservation Lands will be undertaken.	As mentioned in Response 1(j) the CMS has been amended to refer to the CLEMP in By-Law 35B.

Authority	Issue Raised	Ref	Submission	Response
		1(ff)	*Figure 7.2* of the EA depicts proposed areas of the site where vegetation will be retained, removed or modified. Concern is raised with the proposed clearing to occur in the areas to be modified, which appear to coincide with proposed detention basins and dispersion areas. In addition, *Figure 7.2* does not appear to include the clearing required for the construction of pumping stations which are proposed to be located in the Community Conservation Lands. Minimal, vegetation clearing should occur in the Community Conservation Lands. Provide a map and calculated areas which shows the extent of each vegetation community to be removed and retained. This figure should include any proposed clearing in the Community Conservations Lands for infrastructure including pumping stations, pedestrian paths or stormwater features.	The location of drainage infrastructure has been re-assessed by Dr Daniel Martens. An assessment of the vegetation to be impacted by the proposed development and drainage infrastructure has been undertaken and is provided in *Annex J* of the Submission Report. As indicated previously vegetation will be modified for construction of drainage swales. The area of disturbance and regeneration for the swales has been recalculated given the modifications to the drainage infrastructure as modelled by Dr Daniel Martens.

Authority	Issue Raised	Ref	Submission	Response
	Aboriginal Cultural Heritage	1(gg)	*Section 4.3* of the EA states vegetation and soils in Cultural Heritage Reserve will not be removed and destroyed. However, the Aboriginal Cultural Heritage Management Plan (dated June 2006) refers to the provision of pathways. Confirm whether pathways will be appropriate and whether the construction of pathways will impact on any buried items.	During previous consultation with the local Aboriginal community, the provision of a pathway through the Aboriginal Heritage Reserve was suggested by the local Aboriginal community. The pathway would be of the same form of the pathways proposed within the Community Conservations Lands to minimise environmental impact, in consultation with the local Aboriginal community. The pathway will provide a designated walking area through the reserve, thereby ensuring that areas containing buried items will be protected from pedestrian activity. Any excavation works required for the construction of the pathway will be undertaken in consultation with the local Aboriginal community.
		1(hh)	Figure 7.5 of the EA depicts an additional Aboriginal Cultural Heritage Reserve on the eastern portion of the site. More detail is needed on the justification and need for this additional reserve.	The draft Aboriginal Heritage Reserve – Cultural Heritage Management Plan was prepared in consultation with the local Aboriginal community in 2006. Ongoing liaison with the local Aboriginal community has occurred since that time. During further consultation in 2008, the local Aboriginal Community identified that due to the size of the total development and location of the existing reserve within the western portion of the site, a second reserve is desirable. The proponent has no objection to the provision of a second Aboriginal heritage reserve within one of the two identified areas detailed in *Figure 7.5* of the EA.

Authority	Issue Raised	Ref	Submission	Response
	Draft Statement of Commitments	1(ii)	Please ensure that all commitments clearly indicate: the party to be responsible for carrying out the commitment, the timing of the commitment, and the requirement for monitoring and maintenance measures (and required funding arrangements).	The draft Statement of Commitments has been modified as requested. Monitoring and maintenance measures and funding arrangements are detailed in the Community Management Statement.
		1(jj)	The draft Statement of Commitments needs to incorporate all commitments that are specifically referenced in relevant specialist reports, as well as: • VPA; • Community Lands Environmental Management Plan; • Asset Protection Zones; • intersection upgrade works; • bus shelters; • management of Aboriginal Heritage Cultural Reserve; • commercial facilities; and • recreational/community facilities.	The draft Statement of Commitments have been modified as requested.
	Confirmation of Project Application Extent	1(kk)	Many of the plans provided with the EA indicate that approval is sought for the subdivision of Stage 3 of the development. However, it is understood that a Section 96 modification was approved by Port Stephens Council on 12 December 2008 to allow for 33 lots in Stage 3. As such, all relevant subdivision plans (eg Sheet 2 of 18, *Annex B*), will need to be amended to clearly exclude Stage 3 (including lots and roads) from	The final subdivision plans, included in *Annex B*, have been amended to clearly identify that Stage 3 is not subject to the current application.

Authority	Issue Raised	Ref	Submission	Response
			the Project Plan.	
	Subdivision Lots	1(ll)	The EA documentation is inconsistent with the proposed number of residential lots to be provided (varying from 683 to 713 lots). Provide confirmation on the number of lots where approval is sought in the current project application (including superlots).	The number of lots to be sought is detailed in *Annex G* of the Submissions report. *Tables G.1* and *G.2* outline the potential yield based on the Port Stephens LEP and approved Master Plan for integrated housing lots and super lots.
		1(mm)	Provide a breakdown of the proposed allotment types and numbers (eg number of conventional lots, courtyard lots, villas etc). An accompanying plan should also be provided which clearly shows the variation in allotment types. The plan should be similar to the 'Concept Plan of proposed Subdivision' prepared by Winten Property Group for the Master Plan Application.	An allotment breakdown plan is provided in *Annex G*. This provides a breakdown of allotment types and numbers and compares it to the approved Master Plan allotment breakdown and acceptable densities in the Port Stephens LEP 2000.
		1(nn)	Confirm whether Lot 796 (on the Project Plan) is to be a residential lot or will it be a pocket park. The lot would be more appropriate to be used as a common community space, as opposed to a residential development.	This lot has been incorporated into a 'superlot'.
	Indicative Earthworks Plan	1(oo)	Provide the proposed volume of cut and fill anticipated for the site to grade the development to the proposed 2.8m AHD.	Proposed volume of cut and fill is provided in the Bulk Earthworks (Cut and Fill) Plan 22 of 22 in *Annex B*.

Authority	Issue Raised	Ref	Submission	Response
	Community Land	1(pp)	Confirm why the Community Land is shown as Part Lot 5 on *Figure 2.2*. Should this be part Lot 1 (ie the community lot?). A precinct and community plan should be provided showing the community lot as part of Lot 1.	All community land will become part of Lot 1 (community lot). Land dedicated to the Community Association is clearly indicated in Plan 13 of 22 in *Annex B*.
		1(qq)	Reference is made to the plan titled 'Council Community Land' (Sheet 13 of 18, *Annex B*). The purpose of the drawing is unclear and no legend has been provided. Confirm the purpose of the drawing.	Land dedicated to the Community Association is clearly indicated in Plan 13 of 22 in *Annex B* of the Submission Report.
	Landscaping	1(rr)	Reference is made to the Landscape Plan (Vol 2, *Annex G*). Details of the proposed detention basins and dispersion areas (Sheet 10 of 18, *Annex B*), are not currently included in the Landscape Plan and should be amended.	The Landscape Plan is currently being updated to provide further detail regarding revegetation and landscaping throughout the subdivision. This Plan will incorporate the modified Project Plan (inclusive of super lots and drainage infrastructure).
	Proposed Commercial Space	1(ss)	Two commercial areas are proposed on the site. There appears to be a discrepancy in the size of the proposed commercial areas in the south west portion of the site between Fig 2.2 of the EA and Sheet 2 of 18, *Annex B*. Please provide confirmation on the size of the two commercial areas.	Figure 2.2 Project Plan has been amended to clearly define the commercial areas consistent with that identified in Sheet 2 and Sheet 9 of *Annex B*.
	Provision of Bus Route	1(tt)	Provide a map which shows the existing bus routes along Nelson Bay Road.	Figure 4.1 of the Traffic Assessment (*Annex M* of the EA) identifies proposed bus within the vicinity of the proposed development. The existing bus route is along Nelson Bay Road with the nearest existing bus stop in front of the Bayway Caravan Village (see *Figure 1* Locality Plan).
	Subdivision Plan	1(uu)	A single scaled drawing should be provided which shows the entire subdivision and proposed access	A plan will be provided which depicts the whole subdivision on one A1 plan. The level of detail able to

Authority	Issue Raised	Ref	Submission	Response
			roads (to the level of detail provided in the Project Plan – Detail Plan drawings in *Annex B*).	be provided on one plan will be dependant on scale and readability.
DECC	Draft Statement of Commitments	2(a)	The Statement of Commitments detailed in Section 9.2.9 of the EA is very brief and does not include all of the commitments made by the proponent in the Community Lands Environmental Management Plan (CLEMP) or during ongoing negotiations with DECC. The draft Statement of Commitments states that the CLEMP will form part of the Community Association Management Plan, however there are numerous management requirements detailed within the CLEMP which need to be adhered to by the developer during construction and / or prior to the formulation of the Community Association. DECC therefore requires that the draft Statement of Commitments be updated to include the management requirements (detailed in Chapters 6, 7 and *Annex D* of the CLEMP) as well as further commitments made during negotiations with DECC.	An amended Community Management Statement (CMS) incorporating Stages 1 to 20 is provided in the Submissions Report. The CMS has been amended to refer to the CLEMP in By-Law 35B. A commitment is included in the draft statement of commitments to implement the CLEMP. The construction requirements detailed within the CLEMP will be incorporated into a Construction Environmental Management Plan that will be prepared, as identified in the draft Statement of Commitments.
		2(b)	The draft Statement of Commitments should include a commitment that all vegetation within 100m of the owl roost tree will be retained.	The draft Statement of Commitments have been amended identifying that all vegetation within 100m of the owl roost tree will be retained.
		2(c)	Section 9.2.4 states that all mature trees will be retained where possible. This is considered a broad statement with no commitment reflected within the draft Statement of Commitments. If all mature trees will be retained where possible, the mature trees to be retained and to be removed should be accurately surveyed and depicted on a plan and submitted to	The majority of vegetation within the development footprint is likely to be removed through construction. Whilst mature habitat trees will be retained in asset protection zones where possible, it is likely that the majority will be removed. The ecological assessment has been based on the removal of all vegetation within

Authority	Issue Raised	Ref	Submission	Response
			DECC for approval prior to Project Approval. The draft Statement of Commitments should also be amended to include a commitment stating that all trees identified for retention in the plan are to be adequately identified on site with appropriate measures taken by the developer to protect those trees throughout the construction period. The Community Title Scheme should also be amended to include a by law which protect these trees in perpetuity (subject to a Safe Useful Life Expectancy assessment). An application for the future removal of retained trees should be made to the Community Association / Council for consideration.	the development footprint. Sections 6.4, 6.5 and 7.1 of the CLEMP have been amended to state "that clear identification of individual habitat trees that are to be retained within asset protection zones where possible" will be identified prior to clearing. A detailed survey of vegetation to be retained within the development is therefore not considered required.

Authority	Issue Raised	Ref	Submission	Response
		2(d)	The Statement of Commitments are confirmed sufficient, with the inclusion of: • a clause relating to the amendment of the Cultural Heritage Management Plan, in consultation with the Aboriginal Community, to include specific reference to the additional cultural heritage reserves; • a commitment confirming that management of the above areas by the Community Association will be approved by the Aboriginal Community; • inclusion of a clause relating to the education and induction of construction workers in relation to cultural heritage; and • removal of reference to Part 6 approvals under the NPW Act as these are not relevant to Part 3A approvals by DoP.	The draft Statement of Commitments have been amended, incorporating the following additional commitment: • The draft Aboriginal Reserve Cultural Heritage Management Plan (ERM, 2006) will be updated and finalised in consultation with the local Aboriginal community. The plan will identify the management requirements of the existing Aboriginal Cultural Heritage Reserve, as well as the additional Aboriginal Reserve as requested by the Aboriginal community. The Management Plan will form part of the Community Management Statement and will be implemented by the Community Association in consultation with the Aboriginal Community. Reference to Part 6 approvals (Section 90 consent) has been removed from the Statement of Commitments.

Authority	Issue Raised	Ref	Submission	Response
	Zoning of Community Conservation Lands	2(e)	Despite DECC consistently asking for the zoning plan to reflect the actual land use proposed for the site, the proposed conservations lands on the subject site are not yet zoned for conservation. The EA indicates that the bulk of the retained vegetated areas will be maintained under 1(a) Rural, 2(a) Residential and 7(a) Environment Protection under the Port Stephens LEP 2000. These zonings to not afford long term conservation in perpetuity. In our negotiations with the proponent, DECC has sought to find a mechanism, such as a VPA or 88B/E covenant on the Community Title, to ensure that the conservation lands are managed for conservation in perpetuity. The proponent has not been willing to use any of these options. To progress this matter, DECC agreed on 5 December 2008 that we would accept conservation in perpetuity via appropriate zonings and the CLEMP forming part of the Articles of the Community Association. Our December 2008 letter noted that the proposed conservation areas were still not zoned for conservation and our agreement on the use of the CLEMP was premised on the basis that the rezoning would be altered to reflect the new proposed landuses. We remain of the view that the rezoning should be implemented at the approval stage.	The overall Fern Bay Seaside Village land is the subject of a Master Plan Approval pursuant to State Environmental Planning Policy No 71. This approval has made clear the development footprint of the residential subdivision and the associated offsets required through the Vegetation Management Plan applying to the adjoining Worimi Conservation Lands. The applicant has previously advised DECCW that it is supportive of the rezoning of the Community Conservation Lands to an Environment Protection zone and notes that such rezoning would be undertaken by Port Stephens Council. The submission by PSC has identified that the lands should be rezoned to environmental protection. An amended Community Management Statement incorporating stages 1 to 20 is provided in the Submissions Report. The CMS has been amended to refer to the CLEMP in By-Law 35B.

Authority	Issue Raised	Ref	Submission	Response
	Infrastructure impacting on conservation lands	2(f)	DECC opposes the placement of the stormwater detention/treatment devises within the conservation lands set aside for conservation. Placement of these structures within the conservation lands is inconsistent with the Master Plan approved by the Minister in 2006. The placement of these structures in conservations lands will require the removal of vegetation outside the development area, will reduce buffers, may impact on the adequate functioning of the wildlife corridors and will require ongoing management and maintenance access further increasing the environmental impact of the proposal. It is unclear whether this vegetation loss has been previously included in the calculations of vegetation retention and loss.	An Amended Water Cycle Management Strategy in particular stormwater detention/treatment devices for Stages 4 to 20 has been prepared by Dr Daniel Martens. The location and size of proposed detention basins and proposed conveyance swales are provided in Plan 15 of 22 in *Annex B* of the Submissions Report. Calculation of the extent of disturbance of each vegetation community by the proposed development and drainage infrastructure has been reviewed and is provided in *Annex J* of the Submission Report. Vegetation will be cleared for construction of the drainage swales, basin 6 and the batters. The batters will be rehabilitated on completion of construction.
	Asset Protection Zones	2(g)	Despite numerous requests and agreements by ERM that the APZ's are to remain outside of the community conservation lands, it appears that some of the APZ's still intrude into this area. The plans should be amended to include all APZ's are contained with the development area. Assurances should be made within the Statement of Commitments that no intrusion into the Community Lands by asset protection zones will occur.	Lots 91 to 106 are located within Stage 1 of the Fern Bay Seaside Village and are not subject to this application. APZs within Stages 1 to 3 have been previously approved by Port Stephens Council and NSW Rural Fire Service. Lots 289 and 410 (integrated housing lots) and lots 44, 45, 52, 53, 54, 55, 66, 67, 68, 69, 70, 84, 85, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363 and 364 contain APZ's within the proposed allotments. Future design of the integrated housing lots will take into consideration the location and requirements of the APZ while residential lots require a 5 metre set back which will account for 5 metre intrusion of APZ. The

Authority	Issue Raised	Ref	Submission	Response
				draft Statement of Commitments has been amended to identify that a restriction will be placed on lots containing APZ's.
	Community Title Scheme - Community Association responsibilities	2(h)	*Annex E* Community Title Scheme lacks detail on how the conservation lands will be managed in perpetuity, or what financial mechanism will be employed to ensure appropriate management of these lands. This document does not refer to the CLEMP or the draft Statement of Commitments and therefore does not bind the Community Association into the ongoing management responsibilities of the CLEMP. The Community Title Scheme by-laws need to be amended to include reference to both the CLEMP and finalised Statement of Commitments to ensure that the environmental objectives of these two documents are adhered to by the Community Association.	Refer to 1(o) and 1(ee).
	Community Title Scheme - Developer Access Rights	2(i)	By-Law 12.1 refers to the access rights of the original proprietor (Winten (No 20) Pty Ltd) over community property whilst carrying out development on land adjacent to the conservation lands. DECC requests that the Community Title Scheme be amended to exclude the rights provided to the original Proprietor by By-Lay 12 to the conservation lands.	By Law 12 is within Part 2 – Restricted Community Property section of the Community Management Statement. In accordance with Section 54 (5) of the *Community Land Management Act 1989* this By Law cannot be amended or revoked during the initial period of the Community scheme. As the Fern Bay Seaside Village Community Scheme is within its initial period this By Law cannot be amended or revoked. The initial period will not expire until a significant proportion of the estate is developed.

Authority	Issue Raised	Ref	Submission	Response
	Community Title Scheme – Original Proprietor	2(j)	By-Law 36 of the Community Title Scheme refers to the 'Original Proprietor' as Winten (No 20) Pty Ltd. The Community Scheme does not identify Aspen Group, who DECC understands is the developer for the purposes of the project.	The CMS defines the original proprietor as Winten (No. 20) Pty Ltd. By Law 12.1 of the CMS gives the Original Proprietor and all persons authorised by it the right to complete the development of the community parcel and complete development on land adjacent to the community parcel. Aspen are afforded these rights via agreement with Winten (No. 20) Pty Ltd.
	Aboriginal heritage Issues	2(k)	It is recommended that the Cultural Heritage Management Plan be amended post consent to include reference to the additional reserve areas and specific management measures in consultation with the Aboriginal community.	As detailed in 2(d) above, the Aboriginal Reserve Cultural Heritage Management Plan will be updated and finalised in consultation with the local Aboriginal community. A commitment has been inserted into the draft Statement of Commitments.
		2(l)	The CHMP states that the management of the cultural heritage reserves will be the responsibility of the Community Association, however there is no indication of whether this meets the approval of the Aboriginal community, or whether the Community Association will contain members of the Aboriginal community.	The Community Association will be comprised of land owners within the Fern Bay Seaside Village. The Aboriginal Reserve Cultural Heritage Management Plan will be updated and finalised in consultation with the local Aboriginal community. The implementation of the plan will be subject to ongoing consultation and liaison with the local Aboriginal community, thereby ensuring that the Aboriginal community is involved in the ongoing management of the reserve.
		2(m)	There is no discussion about the relevance of native title and land rights under the *NSW Native Title Act 1994* and the *Aboriginal Land Rights Act 1983*.	Fern Bay Seaside Village is located on freehold land and therefore native title is extinguished.

Authority	Issue Raised	Ref	Submission	Response
DWE	Water	3(a)	There is a need to ensure that any detention basins are constructed so as not to intercept the water table which includes accounting for the variation in the water table. DWE requires that any excavations for development must maintain a minimum of a one metre buffer above the highest predicted groundwater table. Any infiltration / detention basins that are located within this one metre buffer need to have impermeable liners to prevent direct infiltration to the groundwater, and therefore cannot operate to infiltrate into the groundwater aquifer. As a result of the requirement for the buffer, proposed development areas may require the filling of land to maintain a one metre buffer.	Infiltration basins are to be constructed in accordance with Amended Water Cycle Management Strategy included in Annex D of the Submissions Report. Amended Water Cycle Management Strategy takes into account variations in the water table. No infiltration or detention basins will be located within the one metre buffer above the highest predicted groundwater table.
		3(b)	DWE in principle supports the subdivision proposal provided that there are no structures (excavations) resulting in the permanent connection with the groundwater aquifer. Consideration should be given to the approval of treatment devices that incorporate satisfactory infiltration design strategies.	The subdivision will be developed in accordance with the Amended Water Cycle Management Strategy based on the Ground Water Assessment undertaken by Dr Daniel Martins included in *Annex D*.

Authority	Issue Raised	Ref	Submission	Response
		3(c)	Matters for consideration for the project approval need to address: • activities that pose a pollution risk to groundwater aquifers should be avoided / prohibited; • necessary on site stormwater treatment devices are installed to ensure removal of potential pollutants before stormwater ensure the groundwater; • the quality of any water entering the groundwater aquifer shall be equal to or netter than the quality of the receiving groundwater; • the preparation and implementation of satisfactory management plans for stormwater management, groundwater monitoring and contingency strategies; • contingency plans include trigger mechanisms, remediation actions and communication strategies for events that have the potential to contaminate the aquifer and establish a groundwater monitoring network / reporting program (for construction and operational stages) linked to the contingency plan; and • plan preparation and associated responsibilities must be clearly identified for monitoring, assessment and implementation of contingency arrangements, water quality restoration work and maintenance of the monitoring network.	The Amended Water Cycle Management Strategy included in *Annex D* addresses all issues raised in this submission. A Construction Environmental Management Plan (CEMP) will be prepared prior to construction, which will identity environmental risks associated with construction and management / mitigation measures to be implemented to manage and minimise the risks including ground water pollution risks. The preparation of the CEMP is identified in the draft Statement of Commitments

Authority	Issue Raised	Ref	Submission	Response
Hunter New England Health	Health Services	4(a)	The submission states that the development will provide housing opportunities for mainly older people. The projected population increase will have a significant impact on demand for and access to public health services and this impact needs to be considered by Council when land is released for such large developments.	The proposed development will provide a range of housing types, including integrated housing, residential villas, residential courtyard, conventional lots and duplexes, thus providing a choice of housing for the population. As detailed in *Sections 5.7* and *7.4* of the EA, the development will result in an increased demand for services, including health care. A range of existing services are currently available in Stockton. In addition, the proposed development incorporates commercial and community facilities. The proposed development is consistent with the Lower Hunter Regional Strategy, which clearly identifies the site as a future site for residential growth and development.

Authority	Issue Raised	Ref	Submission	Response
		4(b)	We also understand that a 'seniors living' development of 250 units has been approved and commenced construction. The Bayview Village (relocatable home park) is close to the development and provides 400 mobile home to a predominately older population. In addition, a mobile home park of 300 homes has been approved on the western side of Nelson Bay Road. It is expected that this development will attract an older population. Given the increasing numbers of older people living in this area, consideration needs to be given to the availability and access to health services, including aged care, health related transport, after hours emergency medical services and healthcare providers such as GP's, dentists and allied health services.	As detailed above.
		4(c)	Consideration should be given to the provision of appropriately situated suites in the commercial complex for the establishment of a general practice and other health providers to set up services that would be required by an ageing population. The proposed Community Centre should also be multifunctional in design to allow for exercise programs and social activities targeting older persons.	No specific tenancies are proposed at this stage, however the preference is noted. Detailed design of the commercial and community complexes is yet to be undertaken and will be subject to separate development approval by Port Stephens Council, however the suggestion of multifunctional design is noted and land allocated could potentially accommodate such development.

Authority	Issue Raised	Ref	Submission	Response
		4(d)	Another important issue for older people is appropriate public transport to access health and other services. The nearest bus stop is outside the proposed development and residents will have to cross a busy road to reach the bus stop. Consideration should be given to increasing public transport in and to this area.	Public bus services will be able to access Fern Bay Seaside Village. The proposed location of bus stops throughout the development and the bus route are detailed in *Figure 4.1* of the Traffic Impact Assessment Report within *Annex M* (Volume 3). The closest existing bus stop is in front of Bayway Caravan Village to the south of the development on Nelson Bay Road, shown on *Figure 1* Locality Plan. Refer also to Response 4(m).
	Environmental Health	4(e)	The inclusion of best practice design principles is supported in this development and includes energy, water saving strategies and grey water reuse with appropriate approval and monitoring processes in place.	An Urban Water Cycle Management Strategy has been prepared which encompasses all aspects of Water Sensitive Urban Design throughout the development, including the onsite treatment of rainwater incorporating treatment of urban runoff through WSUD devices and biorention trenches, on-site storage and slow infiltration into the aquifer. Subject to review and response to the Cardno report.
		4(f)	The provision of reticulated water and sewerage is supported. The requirements of Hunter Water Corporation should be adhered to alleviate any environmental or public health concerns.	The proposed development incorporates connection to reticulated sewer and water. Consultation regarding requirements has been undertaken with Hunter Water Corporation and the implementation of the necessary infrastructure works will be undertaken in accordance with the requirements of HWC.

Authority	Issue Raised	Ref	Submission	Response
		4(g)	The reticulated water supply must be of a suitable quality and quantity for the population size and meet water quality standards in the Australian Drinking Water Guidelines.	Reticulated water will be provided in accordance with HWC requirements and relevant water quality standards.
		4(h)	It is noted that air quality and noise generation are considerations in the construction management plans. It is strongly urged that the development activities comply with the relevant guidelines for both these issues. The proponent should consult with DECC and processes should be in place so that the community can seek remedial action from the proponent in a timely fashion should air quality and noise generation become problematic.	A Construction Environmental Management Plan (CEMP) will be prepared prior to the commencement of construction, detailing the environmental controls to be implemented during construction, including air quality and noise management requirements. The preparation of the CEMP is identified in the draft Statement of Commitments.
		4(i)	A reduction in the reliance of solid fuel heaters for heating in the development will greatly enhance air quality and reduce use of solid fuels.	The proposed development seeks approval for the subdivision of land for residential development. Heating and cooling of residential premises will be subject to BASIX compliance requirements during the development application stage for each dwelling. The Community Association will provide guidance to landholders about woodsmoke reduction programs currently being undertaken by the Hunter Central Coast Regional Environmental Management Strategy and DECC as required.

Authority	Issue Raised	Ref	Submission	Response
		4(j)	Consideration should be given to existing adjacent use practices on the proposed development. The proposed development may be impacted by these uses and they could lead to an increase in noise and odour complaints to the local authority. Adequate buffer zones for differing landuses should be established.	An assessment of adjacent land uses has been undertaken (refer to *Section 7.8* of the EA), including the adjacent Worimi Regional Park to the south, Worimi State Conservation Area to the east, the 200m metre vegetated buffer between the development and Nelson Bay Road and sand extraction operations to the north. The assessment identified that extraction operations are in excess of one kilometre from the nearest residential property. The EIS for the Boral windblown sand operations (ERM, 2005) concluded that the Boral operation would unlikely impact on ambient air quality; set back distances of 900m were recommended for noise (setbacks in the order of one to 1.5km will be realised), and Boral's operation will not be visible from Fern Bay Seaside Village. Adequate buffer distances between Boral's operation and Nelson Bay Road have been incorporated into the design of the subdivision.

Authority	Issue Raised	Ref	Submission	Response
		4(k)	A mosquito risk assessment should be included to ensure any potential mosquito breeding sites are identified. A mosquito management plan should also be developed if constructed wetlands are proposed in the residential development with consideration of best practice design. It is highly recommended that information be sought from Port Stephens Council's Environment and Planning Department on previous mosquito assessment and surveillance undertaken.	A Mosquito Risk Assessment has been prepared for Fern Bay Seaside Village and is attached to the Submission report in *Annex E*. An addendum to the risk assessment is included and takes into account PSC DCP2007 requirements on mosquito risk assessments and the Living with Mosquitoes in the Lower Hunter and Mid North Coast of NSW. Correspondence with Port Stephens Council Senior Weed/Pest Management Officer confirmed that the Living with Mosquitoes in the Lower Hunter and Mid North Coast of NSW document reflect Councils current mosquito management requirements.
		4(l)	Consideration should be given to the installation of rainwater tanks on dwellings within the proposed township.	In accordance with the requirements the NSW Government's BASIX program, all new residential dwellings in NSW are required to meet energy and water targets, thereby ensuring homes are more energy and water efficient. At the development application stage for each dwelling (ie not subject to this current application), the applicant will be required to obtain a BASIX certificate, certifying that the house design meets the energy and water targets set by the NSW government. This may include the installation of a rainwater tank for the collection and reuse of water.

Authority	Issue Raised	Ref	Submission	Response
	Connectivity, public transport and walkability	4(m)	It is essential that the proposed development is serviced by public transport in order to provide access to employment, education and childcare facilities, health services and supermarkets. Provision of public transport will also enable connectivity between the proposed development and existing communities of Fern Bay and Stockton, allows for ageing in place and a reduction in car dependency.	The Traffic Impact Assessment (*Annex M* of the EA) identifies public transport, cycling and pedestrian facilities servicing the development. The report also identifies that the existing bus service along Nelson Bay Road can service the proposed development, with the proposed bus route and bus stop locations within the development identified in *Figure 4.1* of the report. Sheet 1 of 22 in the Subdivision Plans details the proposed staging of the development. Interim bus stop locations will be discussed with Port Stephens Council on a stage by stage basis with the final bus route outlined in *Figure 4.1* of the Traffic Impact Assessment (Annex M of the EA), with a statement to this affect included in the draft Statement of Commitments. The proposed development also includes a shared foot/cycle path from the existing roundabout on Nelson Bay Road (at Fullerton Cove Road) to the bus stop at Bayway Village to the south, thereby providing an essential link to existing pedestrian and cycle facilities to the south (refer to Sheet 19 of 22 of the Subdivision Plans).
		4(n)	A bus route through the proposed development should be accessible by all residents (within 400 metres) with bus stops that comply with Crime Prevention through Environmental Design Principles and provide shelter / shading for passengers.	*Figure 4.1* in the Traffic Impact Assessment (refer to *Annex M* of the EA), identifies the proposed location of bus stops within the development. This figure has been amended to demonstrate that all residents will have access (within 400 metres) to bus stops.

Authority	Issue Raised	Ref	Submission	Response
	Crime Prevention	4(o)	The Crime Prevention through Environmental Design Principles should also be applied throughout the subdivision to create a safe environment for pedestrian thoroughfare, encouraging walking for recreation and active transport, particularly where bushland tracks abut houses, and in threes cases, design for natural surveillance.	An assessment of the Crime Prevention through Environmental Design Principles has been undertaken and is included in *Annex F* of the Submission Report. The assessment identifies that subdivision design is generally consistent with the principles of crime prevention through environmental design.
	Housing affordability and ageing in place	4(p)	Mixed housing affordability should be a goal of all developments. HNEH recommends placement of affordable housing options in positions where access to public transport and community services is maximised. Housing appropriate for ageing in place, such as accessible, low maintenance dwellings should comply with the same positioning principles.	The proposed development seeks to incorporate a range of housing types to provide affordable housing options. Such options include residential integrated housing, residential villas, residential courtyard, conventional lots and duplexes (refer to 4a above).
	Open space and public facilities	4(q)	For open space and public facilities to be equally accessible by all residents, they should be available for the whole community to use, have flexible / mixed use, and be positioned so that residential access is maximised (400 to 800 metres from all residential lots). It is recommended that footpaths and cycleways be provided on both sides of the street and be shaded by appropriate street trees.	All areas of open space will be available to the general public and residents alike. Footpaths will be provided in accordance with Council policy requirements.
	Healthy food access	4(r)	It is recommended that consideration be given to the availability of affordable / health food within the Fern Bay Seaside Village and measures taken to encourage this availability.	No specific tenancies are proposed at this stage however the preference is noted.

Authority	Issue Raised	Ref	Submission	Response
	Community cohesion and consultation	4(s)	Community consultation throughout all stages of the development process encourages improved community cohesion and builds social capital. This consultation should include Aboriginal and Torres Strait Islander people within the area. Ongoing consultation with the Worimi Local Aboriginal Land Council is particularly important given identified potential negative socio-economic impacts associated with disturbance of Aboriginal archaeological sites.	Consultation with the community, including the Worimi Local Aboriginal Land Council has been ongoing during the development of the Master Plan, and subsequent preparation of the Project Plan application (refer to *Annex I* of the EA). Ongoing consultation will be undertaken with the local Aboriginal community during construction and the management of the Aboriginal Cultural Heritage Reserve.
RTA	Traffic	5(a)	The RTA raises no objections to or any further requirements for the proposed development of the estate. All matters raised in the RTA's letters dated 20 January 2006 and 30 January 2006 still apply, being: • new vehicular access (left in/left out) shall be designed/constructed in accordance with the RTA's Road Design Guide; • a shared foot/cycle way shall be provided on Nelson Bay Road from the roundabout at Fullerton Cove to the bus shelter at Bayway Village to the south; and • all of the above shall be provided at RTA/Council requirements at full cost to the developer.	The proposed development will be undertaken consistent with the requirements of the RTA.

Authority	Issue Raised	Ref	Submission	Response
Ministry of Transport	Public Transport	6(a)	It is noted that the Traffic Impact Assessment proposes to run a public bus service through the subdivision and connecting to Stockton ferry wharf. The isolated location and gated, circuitous subdivision design will make servicing of the proposal by bus difficult and costly to Government, resulting in limited public bus service provision.	As detailed in *Annex M* of the EA, existing bus services operate in the locality, including those by Port Stephens Coaches and Blue Ribbon Bus Company. The Fern Bay Seaside Village is proposed to be serviced by a public bus service, and these bus companies have expressed an interest in providing this service.
		6(b)	The proposed residential subdivision's density of 7.5 dwellings per hectare is significantly less than the recommended 12 dwellings per hectare as identified in the Lower Hunter Regional Strategy. This will further limit the subdivisions ability to support a viable public transport service.	The density of the development has been re-calculated and further density estimates are provided in *Annex G* of the Submission Report.
		6(c)	The proposed higher density residential integrated housing lots should be located as close as possible to bus stops in order to improve the viability of services to the proposed subdivision.	Refer to Response 4(n).

Authority	Issue Raised	Ref	Submission	Response
	Footpaths and pathways	6(d)	The Ministry supports the proposed inclusion of footpaths and pathway connections between precincts, however, such pathways should be designed to allow shared access with cyclists. The DoP's Guidelines for Walking and Cycling (2004) is recommended for review. The applicant should address the following matters: • provision of footpaths along both frontages of residential streets; • provision of safe and direct pedestrian cyclists links to major trip generating facilities and bus stops; • provision of adequate and secure bicycle storage facilities as well as cyclist amenities at all commercial, retail and open space developments; and • the need for separated cycleway along designated bus routes.	Footpaths and cycleways will be provided in accordance with Port Stephens Council policy requirements.
	Pedestrian path linking to Fern Bay	6(e)	It is noted that the Department has identified a requirement for the inclusion of a dedicated pedestrian path and cycleway linking the subdivision with the township of Fern Bay, however this has not been addressed in the EA or Traffic Impact Assessment.	As detailed in Plan 19 of 22 in *Annex B* of the Submissions Report, the development incorporates the provision of a shared footpath/cycleway which the applicant proposes to construct from the existing roundabout at the intersection of Nelson Bay Road and Fullerton Cove Road to the bus shelter at Bayway Village to the south. This shared footpath/cycleway provides the link between the proposed development and the township of Fern Bay.

Authority	Issue Raised	Ref	Submission	Response
	Car dependence	6(f)	The isolated location of the proposal coupled with the lack of a dedicated shopping centre or school within the proposed subdivision means that residents will be required to drive to nearby centres for the majority of their daily requirements, further increasing car dependence.	The Department of Education and Training has confirmed that a school site is not required within the development site. The previously identified school site approved in Stages 1 to 3 has been subsequently modified under a separate development application (ie not part of the project application) for residential development (within Stage 3) as a result of the Department of education and Training's previous advice. The proposed development will incorporate commercial lots for the provision of services to the local community. Additional services are provided in Fern Bay and Stockton. These areas will accessible by pedestrian and public transport.
	Recreational Oval	6(g)	The location of the active recreational facility on the western edge of the precinct significantly reduces the accessibility by active transport for residents located in the eastern side of the precinct. The Ministry recommends that the oval be located in a more centralised location.	Cabbage Tree Park, located on the western edge of Fern Bay Seaside Village has been constructed as part of the Stages 1 to 3. Additional reserve areas for active and passive recreation are proposed throughout the development as detailed in the Project Plan (*Figure 2.2*).

Authority	Issue Raised	Ref	Submission	Response
NSW Rural Fire Service	Bushfire Fire Protection	7(a)	The following conditions are recommended: • a restriction to the land use pursuant to Section 88B of the Conveyancing Act 1919 shall be placed on all lots within the subdivision requiring the provision of asset protection zones as identified in the drawing prepared by ERM numbered 0063154hv_planning_Annex L_01 dated 10 February 2009. APZ shall be managed as outlined within section 4.1.3 and Appendix 5 of 'Planning for Bushfire Protection 2006 and the NSW Rural Fire Service's document 'Standards for asset protection zones'; • water, electricity and gas are to comply worth section 4.1.3 of Planning for Bushfire Protection 2006; and • public road access shall comply with section 4.1.3 of Planning for Bushfire Protection 2006. These requirements are for the subdivision of land only. Any further development applications for class 1, 2 and 3 buildings as identified by the 'Building Code of Australia' must be subject to separate application under Section 79BA of the EP&A Act and address the requirements of Planning for Bushfire Protection 2006.	*Figure 2.2* Project Plan has been amended to identify that all APZs associated with Stages 4 to 20 will be located within the development footprint and will not be located within the Community Conservation Lands. A Bushfire Report will be prepared for each stage of the development. The draft Statement of Commitments has been amended to identify a restriction placed on lots with APZ's.

Authority	Issue Raised	Ref	Submission	Response
Department of Defence	Aircraft Noise Impacts	8(a)	Defence reiterates its advice that the land will be overflown by military aircraft in the source of normal operations. In previous requests, defence requested a 'memorial' be placed on the certificates of title to inform prospective landowners that their land will be exposed to aircraft noise form time to time. Defence considers that this could be best be achieved via a Section 149(5) notation advising that the land is affected by aircraft noise. Suggested wording is: 'This land may be subject to aircraft noise associated with the operation of RAAF Base Williamtown and Salt Ash Air Weapons Range'. Overall, Defence does not object to the proposal provided that future residents and potential landowners are made aware that they may be exposed to aircraft noise from time to time.	The applicant is supportive of the placement of a notation on Section 149(5) certificates stating: 'This land may be subject to aircraft noise associated with the operation of RAAF Base Williamtown and Salt Ash Air Weapons Range'
NSW Department of Education and Training	Education	9(a)	The Department of Education and Training does not require a primary school site in the Fern Bay development.	Noted.

Authority	Issue Raised	Ref	Submission	Response
NSW Department of Housing	Future housing demand	10(a)	The EA neglects the implications the development will have on surrounding services and facilities. It has not provided adequate evidence to support the claim (of households over the next 10 years), which has been used to determine the mix of allotments proposed within the Fern Bay Seaside Village.	The proposed development seeks to incorporate a range of housing types to provide affordable housing options. Such options include residential integrated housing, residential villas, residential courtyard, conventional lots and duplexes. Additional detail of housing types and densities is provided through the density plan in *Annex G*. This land has been zoned for residential development for 15 years and is planned for within Council's Community Services strategy. The proposed development will comply with the requirements of Council's contributions plan.
	Section 94 contributions	10(b)	The proponent has only briefly touched on the social and economic impact assessment in their EA, detailing Section 94 contributions will be paid towards the provision of services and facilities and existing services and facilities have the capacity to support the development once completed, however, Housing NSW is concerned the proponent has presented no evidence to support this claim with no thorough investigation undertaken.	Section 94 contributions will be made consistent with Port Stephens Council's DCP requirements. The draft Statement of Commitments has been amended to identify this commitment.

Authority	Issue Raised	Ref	Submission	Response
		10(c)	Housing NSW's view is that the proponent should provide a more detailed social and economic impact assessment in response to the DGR's, including details of specific public transportation services operating in Fern Bay and linkage of services and facilities and identification of the implications of an increased population on existing services and facilities such as hospital, schools and child care.	This has been dealt with through the Master Plan approval and it is not considered that additional social impact assessment is required.
		10(d)	The proposal provides an opportunity to: • incorporate some affordable housing in response to local demand; • ensure a range of housing types and configurations, including one and two bedroom dwellings; and • ensure that some of the housing needs of older people and people with disabilities are met by requiring a proportion of adaptable housing on site.	The proposed development seeks to incorporate a range of housing types to provide affordable housing options. Such options include residential integrated housing, residential villas, residential courtyard, conventional lots and duplexes.

Authority	Issue Raised	Ref	Submission	Response
		10(e)	Housing NSW's recommendations to DoP are: • consideration be given to requiring a minimum proportion of one (10%) and two bedroom (30%) stock and adaptable housing to ensure a housing diversity which meets the needs of the community; • consideration be given to requiring a minimum of 15% of all new housing on site as adaptable housing to enable residents tp age in place and to cater for the needs opf people with disabilities; and • consideration be given to negotiating a voluntary planning agreement between the proponent and DoP in order to achieve more affordable housing on this site in response to the needs of the community of Port Stephens.	The proposal is for subdivision only and does not intend to construct dwellings. Lot sizes will vary to ensure a range of dwelling/housing types are encouraged however these will be pursued in accordance with Council policy. DoH should be encouraged to take up issues of housing stock/bedroom numbers with PSC as a wider policy issue.
Hunter Water Corporation	Water and Wastewater Servicing	11(a)	The 300mm watermain outstanding is to be constructed prior to any of the proposed 683 lots connecting to the water supply system.	The timing of construction of the water main will be as required by Hunter Water as each stage will require a separate Section 50 application to Hunter Water.

Authority	Issue Raised	Ref	Submission	Response
Port Stephens Council	Strategic Planning	12(a)	Section 5.6.1 of the EA acknowledges that the proposed project approval is inconsistent with the Port Stephens LEP 2000 in so far as Clause 19 of the LEP requires a residential dwelling to have a minimum lot size of 500sqm. Clause 17(2) of LEP 2000 requires that subdivision of land for residential purposes less than 500sqm may only be granted if consent has been granted for a dwelling house on that allotment or is granted at the same time as the proposed subdivision. As such the project approval should not approved under LEP 2000 as there are no dwelling approvals on the subject lots nor is consent being requested for dwellings as part of the project approval. Council contends that the solution to the inconsistency put forward by the EA is unworkable and cannot be applied in practice. Notwithstanding that the Minister may have the power to approve the development contrary to Council's LEP, it is requested that the Minister take into account the provisions of LEP 2000 and the fact that approval is being sought for the creation of allotments to which the local consent authority is unable to approve dwellings to be erected thereon.	Refer to Response 1(a).

Authority	Issue Raised	Ref	Submission	Response
		12(b)	It is further noted that the project approval seeks consent under Part 3A based on the Minister's approval of a 'Master Plan'. For the purposes of Section 75P(2) (cl), no 'concept plan' has been approved which may prevent the Minister from directing Council that the provisions of the LEP have no effect in relation to this matter.	Not considered relevant as the Project Plan is consistent with the LEP.
		12(c)	The proposal indicates that a significant portion of land which has been zones for residential purposes will be retained as managed bushland for ecological reasons. These areas will be considered as part of Council's comprehensive review of Port Stephens LEP 2000. It is possible these areas identified would be zoned to reflect their environmental values.	The proponent is supportive of the rezoning of the managed bushland areas to environmental protection by Port Stephens Council. This is also consistent with the requests of DECCW.
	Traffic	12(d)	Provision of local area traffic management (LATM) measures should be incorporated into the entire road network. It is sufficient to provide a plan view of proposed locations (spacing ideally <150m apart) along with a typical section and plan view of the type (s) of LATM device proposed. For bus routes and major traffic routes it is preferred that devices such as lane narrowing, kerb extensions at intersections and alternate intersection are preferable to vertical deflection devices.	Local area traffic management measures will be identified during detailed design and will be incorporated in consultation with Council's traffic engineers.

Authority	Issue Raised	Ref	Submission	Response
		12(e)	Council has concerns about the number of roundabouts proposed within the subdivision which are not pedestrian friendly. Four way intersections can be satisfactorily controlled by signage and line marking.	The provision of roundabouts or four way intersections will be discussed with Council and addressed during the detailed design stage when seeking the construction certificate.
		12(f)	It is noted that a bus stop is proposed directly outside the commercial area, equating to a loss of on street parking spaces directly in front of the shops. Council is not against this is strong pedestrian and cycling connections are designed. How will parking be managed around the commercial area and public areas such as reserves? There is a concern that uncontrolled parking will destroy the verge and swales in these areas.	The provision of parking for the commercial areas will be discussed with Council and addressed during the detailed design stage when seeking the construction certificate.
		12(g)	There is insufficient detail provided to allow a full understanding of how the drainage, traffic and pedestrian linkages will occur on Seaside Boulevard and near Lot 649 and the commercial space through to the northern end of Seaside Boulevard (eg how does stormwater from the central median swale flow along Seaside Boulevard through two roundabouts? How is pedestrian connectivity across the central median catered for?	Pedestrian linkages (eg through small bridges over stormwater drainage swales etc) along Seaside Boulevard and near Lot 649 and the commercial space through to the northern end of Seaside Boulevard will be addressed during the detailed design stage when seeking the construction certificate.
		12(h)	The Port Stephens DCP 2007 requires a maximum street block length of 160m. There are a number of proposed streets that do not comply and require re-design to achieve adequate choice and connectivity.	DoP will be discussing with PSC given the plans consistency with the Master Plan approval.

Authority	Issue Raised	Ref	Submission	Response
		12(i)	The T intersections within the laneways appear to be impractical for turning movements. Some of the laneways could be eliminated by re-designing. Port Stephens DCP 2007 does not encourage laneways is residential areas. Council requests that the laneways be deleted.	Laneways have been removed as requested. The subdivision plans and Project Plan have been adjusted to identify super lots.
		12(j)	The creation of lot 796 provides no amenity and poor laneway configuration. The laneway should be deleted and the street block designed.	This lot has been incorporated into a 'superlot'.
		12(k)	Seaside Boulevard should be provided with a 1.2m footpath on one side of the road, and a 2.4m cycleway on the other.	Council previously approved Seaside Boulevard with shared cycleway/footpath facility. The project plan seeks to continue what Council has already endorsed.
		12(l)	The traffic report fails to identify at what stage infrastructure items should be constructed (eg opening of the northern connection to Nelson Bay Road.	The proposed northern intersection will be constructed no later than Stage 11 of the development. All other roads, associated drainage infrastructure and reserves etc will be constructed during the respective stages of development as per the Staging Plan (refer to Sheet 1 of 22, *Annex B* of the Submissions Report).
		12(m)	Council will accept the dedication of the proposed roads and drainage structures within the road reserve as per the previous stages of the development. Council also notes that all drainage basins will remain as community property and will not be dedicated to Council.	All roads, road reserves and drainage structures located with road reserves will be dedicated to Council. All other drainage structures, parks, community lands etc will be owned and managed by the Community Association.

Authority	Issue Raised	Ref	Submission	Response
		12(n)	The proposed cycleway on Nelson Bay Road shall be constructed in conjunction with the first stage of the proposed development.	The proposed project includes the construction of a shared footpath/cycleway form the existing roundabout at the intersection of Nelson Bay Road and Fullerton Cove Road to the bus shelter at Bayway Village to the south. This will be constructed during Stage 4 of the Fern Bay Seaside Village (ie the first stage of the subject Project Plan application as Stages 1 to 3 have been previously approved). A commitment has been added to the Statement of Commitments to this effect.
	Dedication of Land	12(o)	The constructed oval at Seaside Boulevard was not dedicated to Council and the local parks and playgrounds are to be managed under Community Title.	Cabbage Tree Park, constructed as part of Stages 1 to 2 of the Fern Bay Seaside Village is owned and managed by the Community Association.
	Stormwater Management	12(p)	Council concurs with the view of the Department in that the location of a detention basin within the 1(a) Rural zone is prohibited.	Based on the Amended Water Cycle Management Strategy (*Annex D*) a constructed detention basin is no longer required in the area zoned 1(a).
		12(q)	Council raised a number of concerns with the stormwater management for the proposed development, including: • the report does not address the problems with existing low lying areas; • there is no groundwater level monitoring data available for Basin 3, 5, and 6 to decide the basins invert level and believes that the average groundwater and predicted maximum groundwater is much higher than the design	Stormwater management for the proposed development has been reviewed as part of the Amended Water Cycle Management Strategy (*Annex D* of the Submission Report)..

Authority	Issue Raised	Ref	Submission	Response
			invert level of the infiltration basins; • the report does not include any assessment on groundwater flow and the natural surface flow at the low laying areas; • the report does not address the predevelopment scenarios; • the report only considered the proposed development areas as a catchment area; • excessive cutting and filling may later the entire hydrological and hydrogeological regime; and • Basins 1, 2 and 4 are designed as infiltration basins. The EA indicates that all water from the development area will be dispersed into the existing low lying areas during prolonged rainfall periods. Basin 1 – it is believed that this should not be designed as an infiltration basin as infiltration in this area would be minimal. This area requires more investigation on stage-storage, inflow, outflow, groundwater flow, groundwater level etc and a suitable drainage system should be designed for this catchment based on these investigations. Basins 2 and 4 have similar problems as Basin 1.	

Authority	Issue Raised	Ref	Submission	Response
		12(r)	The following factors need to be addressed: • infiltration rates for each sub-catchment; • use of a suitable factor of safety (clogging factor); • consider large scale pilot infiltration pit tests to find out infiltration rates; • a groundwater study should be carried out for the whole catchment to assess the impact of infiltration system,, variation on the water table, variation of the hydraulic gradient, groundwater flow and changes of flow pattern as a result of construction of roads, houses and other infrastructure; and • effect of urban soil compaction on infiltrations rates should be determined and considered in the design infiltration rate used for the modelling.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.
		12(s)	The report does not give any detail on the management of overland flows along the roads and contain the flows within the proposed roads without overflowing onto the private properties.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.
		12(t)	The report does not provide any catchment parameters used in the model to see whether these parameters are appropriate or not for this catchment.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.
		12(u)	It is important to consider the water sensitivity and flooding in one model so that the designer can accurately predict the overflow along the road.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.

Authority	Issue Raised	Ref	Submission	Response
		12(v)	Pre-developed groundwater levels should be determined for the location of the infiltration basins and used as tail water conditions for hydraulic design of the street drainage system.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.
		12(w)	Future sea level rise and future increases in the rainfall intensities (10-30%) need to be considered in the design to determine the size of the drainage infrastructure.	An Amended Water Cycle Management Strategy has been developed for the proposed development and is included in *Annex D*.
	Ecological Assessment	12(x)	There appears to be no documentation proving that the works outlined in the VMP will adequately offset the loss of vegetation from the development site. It is also concerning that the documentation refers to the VMP as being the offset for the loss of wet heath and hollow bearing trees however is silent on the other vegetation communities that are being cleared.	The offset package negotiated with DECC for the proposed development has been ongoing since the preparation and approval of the Master Plan in 2006 and throughout the preparation and subsequent adequacy assessment of the Environmental Assessment for the Project Plan application. The offset package not only provides for a VPA to be entered into for works and monetary contributions within the adjacent Worimi Regional Park, but also the conservation of a large parcel of land within the site to be retained as a conservation area. This offset has been subject to significant discussion and liaison with DECCW and DoP over a number of years, culminating in the Master Plan approval and the VPA recently publicly exhibited. The offset as negotiated is considered adequate and has been subject to government agency review and agreement. As assessment of the development against the biodiversity offset principles is provided in full in *Annex J* of the Submission Report.

Authority	Issue Raised	Ref	Submission	Response
		12(y)	Since 2006, there have been significant changes to the manner in which offsets are calculated and the legislation to which this offset package does not comply. The offset package may be commensurate with the vegetation loss, however there has be no effort to prove this. The appropriateness of the offset package should be assessed by preparing a biodiversity offset assessment report, demonstrating that the development proposal and its offsets meet the 'improve or maintain' test for biodiversity values.	As above.
		12(z)	There did not appear to be any justification given as to why the *Eucalyptus parramattensis* subsp. *decadens* was seen to be *E. robusta* hybrid and Council has been informed that the appropriate scientific on this new species has yet to be undertaken. Regardless of the taxonomy, given the small population size the clearing of 7 individuals is seen as a significant impact that has not been considered. There appears to be no data to prove that the offset is adequate. The layout of the subdivision should be reviewed to assess the potential to retain the 7 individuals currently being removed.	Targeted surveys undertaken by ERM and Bell in 2006 identified clumps of *Eucalyptus parramattensis* subsp. *decadens* in Worimi Regional Park and within the Fern Bay Seaside Village. Ongoing consultations with DECCW occurred throughout 2008 regarding this species, resulting in further taxonomic investigation being undertaken by DECCW. DECCW latest advice is that the species is *Eucalyptus parramattensis* subsp. *decadens* x *E. robusta*. This species is not listed as threatened under State or Commonwealth legislation, however it is considered to have a very high conservation value. The proposed offset package has been negotiated with DECC, which incorporates the protection and management of the species within the Worimi Regional Park.

Authority	Issue Raised	Ref	Submission	Response
		12(aa)	There is also a discrepancy between the EA which states that 7 individuals are within the development footprint and the SIS which states that there are only 4.	The SIS was prepared to support the Master Plan application in 2006. At that time, four individuals had been identified on site. Since the Master Plan approval in 2006, further investigations have been undertaken in consultation with DECCW regarding this species, resulting in the identification of additional individuals, bringing the total number of individuals recorded within the Fern Bay Seaside Village development area to seven as identified in the EA.
	Port Stephens Comprehensive Koala Plan of Management	12(bb)	Environmental Services of PSC disagrees that there is not a resident population on site as Council staff have recorded them within this location.	The Ecological Assessment Report within the EA (*Annex P*) details the previous assessment of Koala habitat undertaken on site, including a Koala habitat assessment undertaken in accordance with Appendix 6 of the CKPoM and Koala spot assessment conducted in the study area to assess the level of current Koala activity. The Ecological Assessment identified preferred and supplementary Koala habitat across the site. The assessment concluded that the two vegetation communities (wet heath and swamp forest) do not support core Koala habitat as defined in SEPP 44. The conclusion is supported by the lack of recent records in the study area and no evidence of Koala usage having been recorded in the study area during previous assessments by Gunninah Consultants and ERM. Council has advised that Council officers have recorded Koalas near the Newcastle Golf Course and

Authority	Issue Raised	Ref	Submission	Response
				within the electricity easement. These sightings are not recorded with DECC's Wildlife Atlas. The project will provide for the protection of large areas of preferred Koala habitat and habitat buffers within the wildlife corridor, thereby minimising impact on Koala habitat but also minimising impact through providing a buffer to the swamp forest habitat. DECCW have been consulted throughout the Master Plan approval process and ongoing discussions and negotiations have occurred with DECCW since that time regarding the ecological impacts of the proposed development, including impacts to the Koala. The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments. The guidelines will consider environmental requirements, including bushfire and ecological issues, including Koala management measures.
		12(cc)	Although 42ha of preferred Koala habitat and buffers will be retained, any loss of preferred Koala habitat within Port Stephens is significant. This does not seem to have been addressed within the offset provisions.	The offset package negotiated with DECCW for the proposed development has been ongoing since the preparation and approval of the Master Plan in 2006 and throughout the preparation and subsequent adequacy assessment of the Environmental Assessment for the Project Plan application. The offset package not only provides for a VPA to be entered into for works and monetary contributions within the adjacent Worimi Regional Park, but also

Authority	Issue Raised	Ref	Submission	Response
				the conservation of a large parcel of land within the site to be retained as a conservation area. This offset has been subject to significant discussion and liaison with DECC and DoP over a number of years, culminating in the Master Plan approval and the VPA recently publicly exhibited. The offset as negotiated is considered adequate and has been subject to government agency review and agreement.
		12(dd)	The documentation lists several recommendations in relation to fencing however there appears to be no reference to these recommendations within the design guidelines. There has been no effort to dictate what fencing will be within the design guidelines and there should be provisions such as ropes in pools to minimise the potential for drowning.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments. The guidelines will consider environmental requirements, including bushfire and ecological issues.
		12(ee)	The design guidelines should be amended to include requirements for koala friendly fencing as per Council's advice.	As above.
	Design Guidelines	12(ff)	In line with best practice in relation to energy efficiency and climate change mitigation, light colours for roofing should not be excluded and should be encouraged.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments. The guidelines will consider environmental requirements, including bushfire and ecological issues.

Authority	Issue Raised	Ref	Submission	Response
		12(gg)	Also of concern is that solar panels and water tanks are not permitted to be visible from the street. Some houses will have to be built facing a northern or western direction and this clause effectively means that any solar panels will have to be located on the southern or eastern facing rooves. This clause should be amended to encourage solar panel to be installed where they are most effective.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments. The guidelines will consider environmental requirements, including bushfire and ecological issues.
		12(hh)	Water tanks should also be allowed to be placed where they can get the best amount of water from gutters.	The Design Guidelines will be updated for Stages 4 to 20. A commitment has been added to the draft Statement of Commitments. The guidelines will consider environmental requirements, including bushfire and ecological issues.
	Residual 2a land	12(ii)	The report acknowledges the possibility of rezoning the residual 2a land to 7a, however it would be beneficial to protect these areas via a 88B covenant or similar mechanisms.	The proponent has previously indicated support to the rezoning of the conservation lands to an environment protection zone by Port Stephens Council. It is considered that the rezoning by PSC will provide an effective means for ensuring the protection of the conservation lands into the future.

Authority	Issue Raised	Ref	Submission	Response
	Mosquitoes	12(jj)	The CLEMP suggests the use of adulticides for mosquito controls. This method is outdated and potentially highly damaging to the ecology of surrounding ecosystems. The control method should be removed from the CLEMP and more emphasis put on the controls such as screens etc as outlined in the Port Stephens DCP 2007.	The mosquito management measures identified in the CLEMP have been amended to take into account PSC DCP 2007 requirements and to include the guidelines provided in Living with Mosquitoes in the Lower Hunter and Mid North Coast of NSW document that reflect Council's current mosquito management requirements. As stated in Section 10.4 of the CLEMP, the plan will be subject to regular review in consultation with PSC and DECC. Modifications to the control measures will be assessed at that time on consultation with Council.
	Maintenance of community land	12(kk)	Environmental services is concerned that weed infestations are rapidly spreading through out the community lands. Landholders have requirements under the Noxious Weeds Act and these weeds should be treated as soon as possible to avoid the infestations becoming more established.	The EA and CLEMP identify the management requirements for weeds by the Community Association. Current weed management is the responsibility of the landowner and is a separate issue to the current application for project approval.
	Section 94 Contributions	12(ll)	There is a need to provide the following in association with the development: • active and passive open space; • community facilities; and • rural fire service station. The outcome of a meeting on 1 February 2008 between DoP, PSC, DECC and a representative of the proponent was "….it is recognised that there is a need	Section 94 contributions will be made consistent with Port Stephens Council's DCP requirements. The draft Statement of Commitments has been amended to identify this commitment.

Authority	Issue Raised	Ref	Submission	Response
			to incorporate further community / social and commercial facilities on the site to service existing populations (both on the Fern Bay site as well as adjoining developments) and future population growth in the area. Additional facilities should be incorporated within the improved development footprint as established in the Master plan approval (MP 20-4-2006)." The provision of these service centre facilities essentially remains unresolved and more recently has been subject of discussions with Newcastle City Council. A revised Section 94 plan has now been finalised in draft form between Council and Newcastle City Council, and is recommended to Council for public exhibition throughout top late July / early August. Council considers is as essential that provisions are established for the proponent's responsibilities for contributions to and / or provisions of the public services and facilities as explained above.	
Newcastle City Council	Section 94 Contributions	13(a)	*Section 7.4.4* and *Table 7.2* of the EA outlines the community and recreational facilities to be provided within the Fern Bay Estate by the proponent under Community Title. The EA does not provide any clarification as to whether the completed facilities will be dedicated to PSC or will remain in the ownership of the Community Association. Section 7.4.4 also states that the proponent is proposing to provide the nominated works as in-kind works or as a material	Section 94 contributions will be made consistent with Port Stephens Council's DCP requirements. The draft Statement of Commitments has been amended to identify this commitment. The local parks and playgrounds will be available for public use, without any maintenance or depreciation costs to Council.

Authority	Issue Raised	Ref	Submission	Response
			public benefit rather then through the payment of monetary contributions. NCC has not objection to local parks and playground being provided as works in kind, but only where these become Council owned pubic spaces which can be utilised by the wider community and not only the residents of Fern Bay Seaside Village. While 'works in kind' are adequate for local parks and playgrounds, all other contributions should be provided in the form of monetary contributions to ensure cross boundary issues can be adequately addressed and funded. As there is only limited existing and proposed public amenities and public services within Fern Bay, NCC is seeking appropriate apportionment of contributions from PSC towards the embellishment and upgrade of existing facilities and provision of new facilities within Stockton.	
		13(b)	As the current PSC Development Contributions Plan 2007 does not address the cross boundary issues between Stockton and Fern Bay, NCC is seeking the Minister for Planning to impose a condition under Section 94C of the EP&A Act for the Fern Bay Seaside Village and any subsequent approvals within Fern Bay.	Section 94 contributions will be made consistent with Port Stephens Council's DCP requirements. The draft Statement of Commitments has been amended to identify this commitment.

Authority	Issue Raised	Ref	Submission	Response
DPI		14(a)	DPI notes that the nearest residence within the proposed Fern Bay Seaside Village development will be in excess of 1km from Boral Resources sand extraction site and that with control measures in place, the operation should have no impacts on the proposed village in relation to noise, dust and visual amenity.	Noted.
Community Submission	Other residential development opportunities	15(a)	We strongly protest and are against further development at former Winten Estate unless we are afforded same rights. We asked Frank Sartor in December 200? to include our property in future housing zoning. He did not help us. What's more, he put our property in green corridor so it cannot be rezoned. Thus preventing further housing competition to Winten's Estate.	The proposed development is located within the 2(a) residential zone. A road and associated infrastructure are proposed within part of the site zoned 1(a) Rural Agriculture and a small section of roadway and pedestrian trails are proposed within the 7(a) Environment Protection areas of the site. The proposed development area is identified in the Lower Hunter Regional Strategy as existing urban land and the proposed development is consistent with the strategy.
Community Submission	Water Management	16(a)	Question regarding runoff of water during extreme weather conditions. Having looked at the flows, I cannot tell if the excess flood water will run to the Pacific Ocean, Fullerton Cove or Fullerton Cove drainage system. As a landholder in the Fullerton Cove drainage system, I would object if the excess flood water was diverted to the system. It is already overloaded due to the development in the area. Should the flood water be directed to the drainage system, the developer should have to upgrade the existing drains.	Water management is detailed in Section 7.9 of the EA. Water management on the site is based on water sensitive urban design philosophies and incorporates a number of stormwater treatment and detention basins. For each of the urban areas and individual catchments, water will be treated, conveyed and stored wholly within the subject site and treated accordingly to water sensitive Urban design principles. Due to the sizing of the detention basins and the full containment of the 1 to 100 year rainfall event, no impact on adjoining areas is expected.

Authority	Issue Raised	Ref	Submission	Response
Community Submission	Impacts on Flora and fauna	17(a)	I am concerned that human invasion and destruction of trees, bush and habitat will be a tragedy for all wildlife. Despite efforts to preserve some areas for conservation, it will be in vain and the bush and wildlife will pay the price for greedy landowners who are only interesting in profiting from this. We need to protect and preserve our flora and fauna for future generations	Ecological assessments have been undertaken and are contained with *Section 7.7* of the EA, and within *Annex P* - Ecological Assessment Report, *Annex Q* – Response to Koala Plan of Management and *Annex R* – Species Impact Statement. The assessment considered the ecological impact of the proposed development. A number of measures have been incorporated into the design of the residential subdivision footprint to either avoid or mitigate ecological impacts and species specific impact, including retaining a minimum 200 metre ecological corridor along the boundary with Nelson Bay Road, protection of large areas of preferred Koala habitat and habitat buffers, retaining an ecological corridor along the eastern boundary of the site to provide a movement corridor, establishment of a 100 metre buffer around the known Powerful Owl roost tree, design and planting in bioswales to trap runoff and provide a buffer to neighbouring vegetation and retaining the majority of vegetation within the land zoned 7(a) Environment Protection and 1(a) Rural Agriculture.

Authority	Issue Raised	Ref	Submission	Response
	Traffic	17(b)	The roads will not manage with the increased traffic volume.	A traffic impact assessment was undertaken (refer to *Annex M* of the EA). The assessment considered the existing road network, road volume data, increase traffic volumes, impacts on intersections and the proposed road network. The assessment demonstrates that the existing and proposed road is adequate to cater for the proposed development. The RTA has not raised concerns regarding the proposed development's impacts on traffic. The northern intersection will be designed and constructed in accordance with RTA requirements.
	Pollution	17(c)	An increase in population comes with increased pollution.	The EA identifies potential environmental impacts associated with the proposed development, including socio-economic, traffic, ecological, heritage, water, flooding, climate change, bushfire impacts amongst others. A Construction Environmental Management Plan will be prepared to manage and mitigate potential environmental impacts during construction. The Community Association will be responsible for the ongoing management and monitoring of the community lands following construction. The Community Lands Environmental Management Plan (CLEMP) identifies the requirements for monitoring and management of the conservation lands. In addition, a Community Management Plan will be prepared identifying the maintenance requirements for stormwater and drainage structures and the like to ensure such infrastructure is appropriately maintained and managed by the Community Association.

Authority	Issue Raised	Ref	Submission	Response
	Social impacts	17(d)	Quite low key lifestyle and atmosphere of Fern Bay (1 shop, 1 motel, 1 golf course). We don't want supermarkets or McDonalds to feed the thousands of people you plan to house in this area.	The Fern Bay Seaside Village development provides for commercial and community facilities within the subdivisions (refer to *Figure 2.2* Project Plan). The Project Plan application does not seek approval for a supermarket or MacDonald's within the development.
	Other residential development opportunities	17(e)	Surely it would be wise to use up the existing vacant land around the area first instead of bulldozing the bush.	The development of the land for residential purposes has been identified by both local and state governments. The majority of the Fern Bay Seaside Village site is zoned 2(a) Residential. The proposed development area is identified in the Lower Hunter Regional Strategy as existing urban land.
Community Submission	Flora and Fauna Impacts	18(a)	Further destruction of unique and natural habitats / ecosystems.	Ecological assessments have been undertaken and are contained with *Section 7.7* of the EA, and within *Annex P* - Ecological Assessment Report, *Annex Q* – Response to Koala Plan of Management and *Annex R* – Species Impact Statement. The assessment considered the ecological impact of the proposed development. A number of measures have been incorporated into the design of the residential subdivision footprint to either avoid or mitigate ecological impacts and species specific impact, including retaining a minimum 200 metre ecological corridor along the western boundary of the site, protection of large areas of preferred Koala habitat and habitat buffers, retaining an ecological corridor along the eastern boundary of the site to provide a movement corridor, establishment of a 100 metre buffer around the known Powerful Owl roost tree, design and planting in bioswales to trap runoff and provide a buffer to neighbouring vegetation and retaining the majority of vegetation within the land zoned 7(a) Environment Protection and 1(a) Rural Agriculture.

Authority	Issue Raised	Ref	Submission	Response
	Water Quality	18(b)	Contamination of pristine water reserves under the sand dunes.	A groundwater report was included in *Annex J* of the EA which assesses groundwater impacts as a result of the proposed development. The assessment recommended that groundwater monitoring be carried out and concluded that with the application of Water Sensitive Urban Design, there should be no significant impact on the groundwater beneath the site. An Amended Water Cycle Management Strategy has also been developed and is included in *Annex D* of the Submissions Report.
	Sand dune stabilisation	18(c)	Removal of vegetation resulting in destabilised sand dunes.	The proposed development will result in the clearance of vegetation to facilitate the construction of the subdivision, however infrastructure associated with the construction and post construction rehabilitation will ensure stabilisation of the site. A Coastal Hazards and Dune Stability Assessment has been undertaken (refer to *Annex K* of the EA). The assessment concluded that dune stabilisation was not required for the dunes adjacent to the Fern Bay Seaside Village site.

Authority	Issue Raised	Ref	Submission	Response
	Traffic impacts	18(d)	Additional traffic movements on already congested and over used roads.	A traffic impact assessment was undertaken (refer to *Annex M* of the EA). The assessment considered the existing road network, road volume data, increase traffic volumes, impacts on intersections and the proposed road network. The assessment demonstrates that the existing and proposed road is adequate to cater for the proposed development. The RTA has not raised concerns regarding the proposed development's impacts on traffic. The northern intersection will be designed and constructed in accordance with RTA requirements.
	Economic viability	18(e)	Uncertainty of future sales as a result of the economic downturn. Why destroy large tracts of land for only the possibility of future sales?	The Lower Hunter Regional Strategy identifies that over the next 25 years, there will be a need to provide for 115 000 new homes to cater for a projected population growth of 160 000 people. The proposed development area is identified in the Lower Hunter Regional Strategy as existing urban land. The development of the land for residential purposes has been identified by both local and state governments. The development will be construction in accordance with the staging plan (refer to Plan 1 of 22 in Annex B of the Submission Report) in consideration of market demand.
	Pedestrian / cycle paths and safety.	18(f)	Danger of a shared footpath / cycleway on any part of Nelson Bay Road because of insufficient space.	The provision of a shared foot/cycle path along Nelson Bay Road is a requirement of the NSW RTA. The design and construction of the pathway will be subject to the approval of the RTA.

Authority	Issue Raised	Ref	Submission	Response
Community Submission	Vegetation removal	19(a)	The present subdivision has caused terrible destruction of the environment including semi rainforest which is irreplaceable. Also this must impact heavily on the native wildlife.	Ecological assessments have been undertaken and are contained with *Section 7.7* of the EA, and within *Annex P* - Ecological Assessment Report, *Annex Q* – Response to Koala Plan of Management and *Annex R* – Species Impact Statement. The assessment considered the ecological impact of the proposed development. A number of measures have been incorporated into the design of the residential subdivision footprint to either avoid or mitigate ecological impacts and species specific impact, including retaining a minimum 200 metre ecological corridor along the western boundary of the site, protection of large areas of preferred koala habitat and habitat buffers, retaining an ecological corridor along the eastern boundary of the site to provide a movement corridor, establishment of a 100 metre buffer around the known Powerful Owl roost tree, design and planting in bioswales to trap runoff and provide a buffer to neighbouring vegetation and retaining the majority of vegetation within the land zoned 7(a) Environment Protection and 1(a) Rural Agriculture.

Authority	Issue Raised	Ref	Submission	Response
Community Submission	Flora and Fauna	20(a)	The development will destroy a significant part of the environment on the site (more than 70 hectares of existing natural vegetation) thus causing a drastic reduction in the value of the site to the detriment of all Australians. In the broad (national and NSW) context the area represents an outstanding example of remnant coastal habitats that forms a critical corridor for the survival of regionally significant and nationally significant species. The development due to its size and nature will fragment and devalue the remaining habitats. The site is located in a fragile environment bound by the Pacific Ocean and the Hunter River, where the geography and habitats provide a unique environment to the NSW Coast. The site includes an extremely varied biodiversity and rare habitat types which will be further threatened by natural and anthropogenic processes. There has not been an assessment on development adjacent to coastal swamp forests. Issues not addressed include the effect of climate change and increasing spread of mosquito borne diseases. The severe ecological impacts of the site including massive loss of habitat, loss of wet heath habitat and fragmentation of habitats in the local and regional context – not adequately addressed. It is unacceptable that more than 37 threatened species and one endangered ecological community will be impacted buy the development. More than seven fauna species will be severely impacted by the proposal. The development will result in weed problems and	Ecological assessments have been undertaken and are contained with *Section 7.7* of the EA, and within *Annex P* - Ecological Assessment Report, *Annex Q* – Response to Koala Plan of Management and *Annex R* – Species Impact Statement. The assessment considered the ecological impact of the proposed development. A number of measures have been incorporated into the design of the residential subdivision footprint to either avoid or mitigate ecological impacts and species specific impact, including retaining a minimum 200 metre ecological corridor along the western boundary of the site, protection of large areas of preferred Koala habitat and habitat buffers, retaining an ecological corridor along the eastern boundary of the site to provide a movement corridor, establishment of a 100 metre buffer around the known Powerful Owl roost tree, design and planting in bioswales to trap runoff and provide a buffer to neighbouring vegetation and retaining the majority of vegetation within the land zoned 7(a) Environment Protection and 1(a) Rural Agriculture.

Authority	Issue Raised	Ref	Submission	Response
			rubbish dumping which will have significant detrimental effects on the existing ecosystems within the site and the adjacent Worimi Regional Park and Conservation Area.	
	Locality	20(b)	The site is situated adjacent to a State Conservation Area (Worimi) and Regional Park and is not in keeping with the nature of the locality or region. A development of this size and magnitude belongs in an area adjoining or within the large towns or cities of NSW and does not belong at Fern Bay.	The development of the land for residential purposes has been identified by both local and state governments. The majority of the Fern Bay Seaside Village site is zoned 2(a) Residential. The proposed development area is identified in the Lower Hunter Regional Strategy as existing urban land. The biodiversity offset package negotiated with DECCW includes the developer entering into a Voluntary Planning Agreement with DECCW for the provision of funds and works within the adjacent Worimi Regional Park over a period of 20 years, which will result in environmental and habitat improvements within the park.
	Bush Fire	20(c)	The site constitutes a severe risk in terms of hazards from bushfires. The hazard zones are completely inadequate between the remaining vegetation and buildings. The addition of adequate hazard zones will result in further stress to and loss of unique habitat of the site. The development itself will disturb the natural fire regime of the area as the natural fire regime will not be allowed to talk place. This will result in biodiversity and habitat changes and loss.	A bush fire hazard assessment has been undertaken for the proposed development (refer to *Annex L* of the EA) consistent with the requirements of the Rural Fire Services' Planning for Bush Fire Protection guidelines. Asset protection zones are identified across the development. The draft Statement of Commitments have been amended to identify that a Section 88B covenant will be prepared for the lots identifying the restriction imposed by the APZ.

Authority	Issue Raised	Ref	Submission	Response
	Groundwater	20(d)	The issues regarding potential groundwater contamination are not comprehensively addressed.	A groundwater report was included in *Annex J* of the EA which assesses groundwater impacts as a result of the proposed development. The assessment recommended that groundwater monitoring be carried out and concluded that with the application of Water Sensitive Urban Design, there should be no significant impact on the groundwater beneath the site.
	Vehicle movements and Stockton Beach	20(e)	There are environmental issues regarding effects in Stockton Beach due to the massive increase in vehicle movements and visitation by the access provided by the development.	As detailed in Section 7.4.2, the development of the subdivision is likely to increase the demand for public access to Stockton Beach, which may result in further disturbance of dunes and coastal vegetation. Access to the beach for vehicles and pedestrians is currently via informal trails. A formal 4WD track is proposed to be constructed adjacent to the fern bay Seaside Village within the Worimi Regional Park to provide formalised access to the beach. The track is to be constructed in accordance with agreement with DECC and the Voluntary Planning Agreement. By limiting beach access to this 4WD track, as opposed to many informal tracks, the impact on the dunes and coastal vegetation will be minimised.

Authority	Issue Raised	Ref	Submission	Response
	Sea Level Rise	20(f)	There has been inadequate assessment of the risks of further sea level rise.	Section 7.11 considers climate change in accordance with DECC's Floodplain Risk Management Guidelines titled Practical Consideration of Climate Change, including low, medium and high scenarios for sea level rise. The assessment concluded that when expected increase in sea levels are combined in association with the Hunter River flood modelling done to date, there would be a safety margin for the proposed dwellings in Fern Bay Seaside Village.
	Coastal Erosion	20(g)	There has been inadequate assessment of the long term coastal erosion.	A Coastal Hazards and Dune Stability Assessment has been undertaken (refer to *Annex K* of the EA). The assessment concluded that dune stabilisation was not required for the dunes adjacent to the Fern bay Seaside Village site.

Authority	Issue Raised	Ref	Submission	Response
	Overall impacts	20(h)	The severe human impacts associated with residential development including impacts from road traffic, increased runoff associated with impervious surfaces, rubbish dumping, predation by domestic and feral animals, weed dispersal, changes in fire frequency – not adequately addressed. The EA conclusions assume that no development (with the exception of access roads) will occur within the ecological corridor – however it does not take into consideration affects of traffic, noise, air pollution etc.	The EA identifies potential environmental impacts associated with the proposed development, including socio-economic, traffic, ecological, heritage, water, flooding, climate change, bushfire impacts amongst others. A Construction Environmental Management Plan will be prepared to manage and mitigate potential environmental impacts during construction. The Community Association will be responsible for the ongoing management and monitoring of the community lands following construction. The Community Lands Environmental Management Plan (CLEMP) identifies the requirements for monitoring and management of the conservation lands. In addition, a Community Management Plan will be prepared identifying the maintenance requirements for stormwater and drainage structures and the like to ensure such infrastructure is appropriately maintained and managed by the Community Association.
	Traffic	20(i)	The isolation of the development will have large traffic impacts and is not amenable to widespread integration of public transport.	A traffic impact assessment was undertaken (refer to *Annex M* of the EA). The assessment considered the existing road network, road volume data, increase traffic volumes, impacts on intersections and the proposed road network. The assessment demonstrates that the existing and proposed road is adequate to cater for the proposed development. The RTA has not raised concerns regarding the proposed development's impacts on traffic. The northern intersection will be designed and constructed in accordance with RTA requirements.

Authority	Issue Raised	Ref	Submission	Response
	Urban Expansion	20(j)	The development represents increased urban expansion which increases traffic, travelling time, reduced amenity to workplace etc.	A traffic impact assessment was undertaken (refer to *Annex M* of the EA). The assessment considered the existing road network, road volume data, increase traffic volumes, impacts on intersections and the proposed road network. The assessment demonstrates that the existing and proposed road is adequate to cater for the proposed development. The RTA has not raised concerns regarding the proposed development's impacts on traffic. The socio-economic assessment within *Section 7.4* of the EA identifies both beneficial and potential negative impacts associated with the proposed development on the community. Benefits include the provision of a variety of housing stock, meeting increasing demand for housing, provision of additional service infrastructure and community facilities, approximately 2470 jobs to be created through construction, generating over $35 million per annum of additional expenditure in the local economy. Potential negative socio-economic impacts include the increased need for public facilities and beach access, potential disturbance of the neighbouring dunes and coastal vegetation, an increase in local traffic and disturbance of Aboriginal archaeological sites. These impacts are however not likely to be significant and can be adequately mitigated. Overall, the socio-economic benefits of the proposed subdivision are considered to outweigh the potential negative socio-economic impacts.

Table A.2 Fern Bay Seaside Village Response to Submissions - Additional issues:

Issue	Response
Provision of existing development consents for Stages 1 – 3 and surrendering of consent.	For discussion with DoP
Commercial and Recreational Buildings – draft Statement of Commitments should be provided which addressed the mechanisms required to facilitate the establishment of commercial and recreational buildings proposed within the development (requested by DoP following meeting dated 28 July 09).	For discussion between Aspen and ERM
Staging of works – provide a summary of works to be provided in each stage of the development (Stage 4 – 20).	Summary of works for each stage is provided in *Table 3.1* of the main Submission Report.

Annex B

Subdivision Plans

GN

Sheet List Table	
Sheet Number	Sheet Title
0	SHEET LIST
1	SITE & STAGING PLAN
2	STAGE 4 - 6 DETAIL PLAN
3	STAGE 7 DETAIL PLAN
4	STAGES 8 & 9 DETAIL PLAN
5	STAGES 10 - 12 DETAIL SHEET
6	STAGES 13 & 14 DETAIL PLAN
7	STAGES 15 & 16 DETAIL PLAN
8	STAGE 17 DETAIL PLAN
9	STAGE 18 & 19 DETAIL PLAN
10	STAGE 20 DETAIL PLAN
11	INDICATIVE SEWER LAYOUT
12	INDICATIVE WATERMAIN LAYOUT
13	LAND TENURE PLAN
14	SUBJECT & ADJOINING TITLE DETAILS
15	CONCEPT SITE CRAINAGE PLAN - PROPOSED SWALES AND BASINS
16	FLOOD PRONE & LOW LYING AREAS
17	TYPICAL DRAINAGE TREATMENTS DETAIL1
18	TYPICAL DRAINAGE TREATMENTS DETAIL 2
19	FOOTPATH & CYCLEWAY
20	TYPICAL ROAD DETAIL
21	AERIAL VIEW
22	BULK EARTHWORKS (CUT-FILL) PLAN

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SCALE 1: 1000
REVISION DATE ----
PLOT DATE 22/12/2009
DRAWN/CHKD BY GJS / AED
DA NUMBER
CC NUMBER

DRAWING TITLE SHEET LIST
DEVELOPMENT PROJECT PLAN ----
FERN BAY SEASIDE VILLAGE
NELSON BAY ROAD, FERN BAY

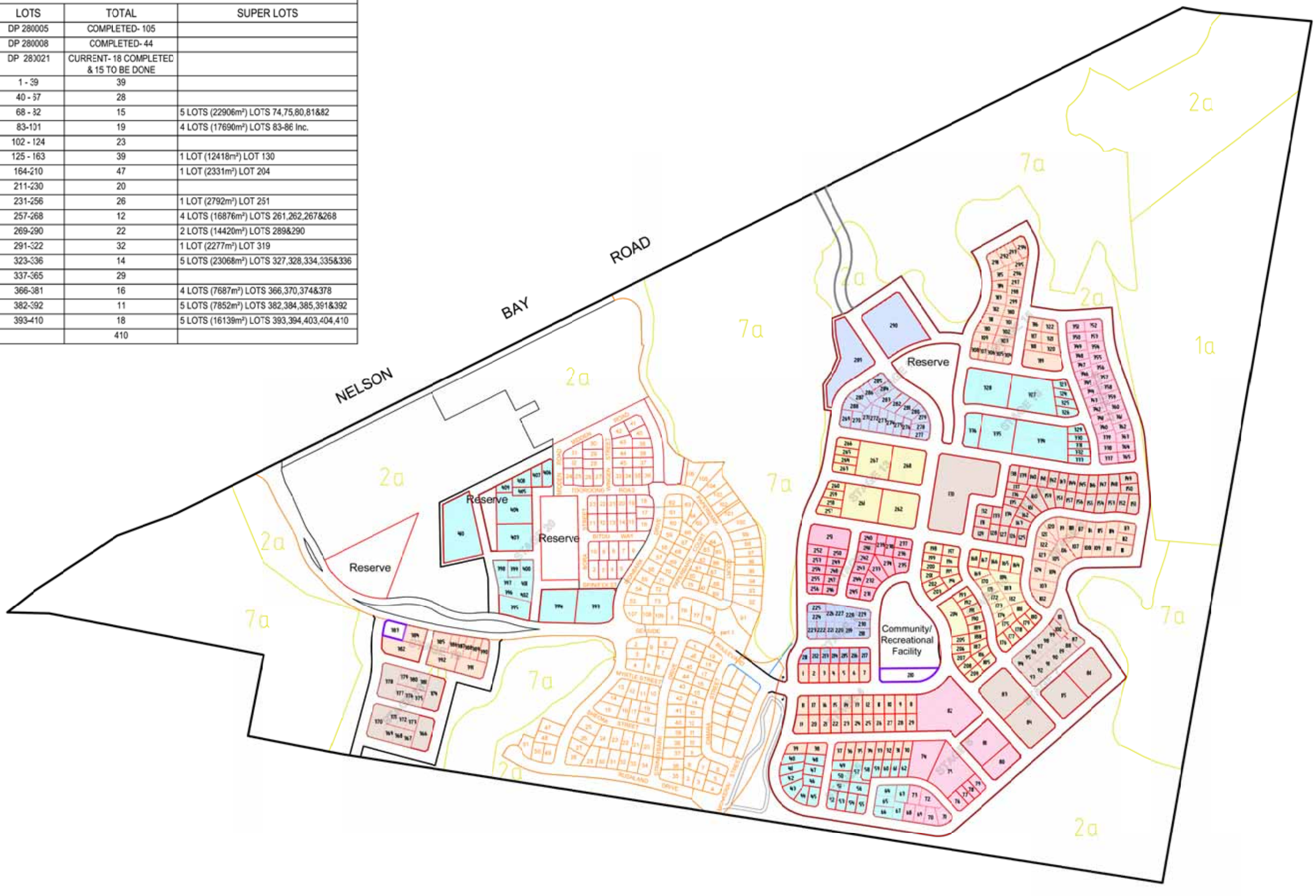
CLIENT ASPEN GROUP LIMITED

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29850 ----

0 OF 22

STAGING & LOT TABLE			
STAGE	LOTS	TOTAL	SUPER LOTS
1	DP 280005	COMPLETED- 105	
2	DP 280008	COMPLETED- 44	
3	DP 280021	CURRENT- 18 COMPLETED & 15 TO BE DONE	
4	1 - 39	39	
5	40 - 67	28	
6	68 - 82	15	5 LOTS (22906m²) LOTS 74,75,80,81&82
7	83-101	19	4 LOTS (17690m²) LOTS 83-86 Inc.
8	102 - 124	23	
9	125 - 163	39	1 LOT (12418m²) LOT 130
10	164-210	47	1 LOT (2331m²) LOT 204
11	211-230	20	
12	231-256	26	1 LOT (2792m²) LOT 251
13	257-268	12	4 LOTS (16876m²) LOTS 261,262,267&268
14	269-290	22	2 LOTS (14420m²) LOTS 289&290
15	291-322	32	1 LOT (2277m²) LOT 319
16	323-336	14	5 LOTS (23068m²) LOTS 327,328,334,335&336
17	337-365	29	
18	366-381	16	4 LOTS (7687m²) LOTS 366,370,374&378
19	382-392	11	5 LOTS (7852m²) LOTS 382,384,385,391&392
20	393-410	18	5 LOTS (16139m²) LOTS 393,394,403,404,410
TOTAL		410	



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SCALE 1: 5000	DATUM AHD	DRAWING TITLE	SITE & STAGING PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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29850 ----

GN

1 715 m² | 2 647 m² | 3 647 m² | 4 647 m² | 5 647 m² | 6 647 m² | 7 719 m²

COMMERCIAL
210
2418 m²

208 615 m² | 209 610 m² | 185 616 m²

94 652 m² | 91 594 m² | 92 594 m² | 93 652 m²

ROAD 17.5 WIDE

23.5 WIDE

18 728 m² | 17 700 m² | 16 700 m² | 15 700 m² | 14 700 m² | 13 700 m² | 12 700 m² | 11 700 m² | 10 700 m² | 9 700 m² | 8 700 m²

19 924 m² | 20 692 m² | 21 688 m² | 22 684 m² | 23 680 m² | 24 676 m² | 25 672 m² | 26 667 m² | 27 663 m² | 28 659 m² | 29 655 m²

82
8428 m²

ROAD 20 WIDE

ROAD 15 WIDE

83
4729 m²

84
4729 m²

ROAD 17.5 WIDE

81
3875 m²

80
2357 m²

ROAD 20 WIDE

ROAD 17.5 WIDE

39 728 m² | 38 767 m²

40 739 m² | 48 713 m²

41 800 m² | 47 713 m²

42 753 m² | 46 700 m²

43 804 m² | 44 677 m² | 45 712 m²

ROAD 20 WIDE

ROAD 15 WIDE

37 634 m² | 36 610 m² | 35 617 m² | 34 644 m² | 33 567 m² | 32 569 m² | 31 570 m² | 30 575 m²

49 710 m² | 50 705 m² | 51 706 m² | 52 650 m² | 53 630 m² | 54 630 m² | 55 665 m²

57 887 m² | 58 698 m² | 59 545 m² | 60 547 m² | 61 549 m² | 62 552 m²

74
3465 m²

75
4681 m²

64 891 m² | 65 670 m² | 66 696 m²

63 768 m² | 67 648 m²

73 749 m² | 68 648 m² | 69 648 m²

72 924 m² | 70 704 m² | 71 731 m²

79 613 m² | 78 500 m² | 77 500 m² | 76 768 m²

ROAD 20 WIDE

ROAD 20 WIDE

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SCALE	DATUM	DRAWING TITLE
1: ####	AHD	STAGE 4 - 6 DETAIL PLAN
REVISION DATE	CONTOURS	DEVELOPMENT
----	X m	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE	DRAWN/CHKD BY	
22/12/2009	GJS / AED	
DA NUMBER	CC NUMBER	CLIENT
		ASPEN GROUP LIMITED

DALY . SMITH Pty Ltd
Design Management Surveying
OFFICES AT: PORT STEPHENS | CENTRAL COAST & HUNTER
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29850 ----

GN

ROAD 23.8 WIDE

ROAD 17.5 WIDE

ROAD 20 WIDE

ROAD 15 WIDE

5 WIDE

Community/
Recreational
Facility

COMMERCIAL
210
2418 m²

203 629 m²
204 2331 m²
205 545 m²
206 548 m²
207 558 m²
208 615 m²
209 610 m²
171 551 m²
172 536 m²
173 602 m²
174 674 m²
175 757 m²
176 616 m²
177 564 m²
178 589 m²
179 556 m²
180 507 m²
181 720 m²
182 629 m²
183 752 m²
184 611 m²
185 616 m²
186 577 m²
187 600 m²
188 545 m²
189 561 m²
190 557 m²
191 557 m²
192 557 m²
193 557 m²
101 639 m²
100 575 m²
99 530 m²
98 506 m²
97 503 m²
96 503 m²
95 503 m²
94 652 m²
93 652 m²
92 594 m²
91 594 m²
90 594 m²
89 530 m²
88 536 m²
87 553 m²
102 872 m²
103 984 m²
86 4222 m²
85 4010 m²
84 4729 m²
83 4729 m²
82 8428 m²
81 3975 m²
80 2357 m²
75
74 3465 m²
10 700 m²
9 700 m²
8 700 m²
27 663 m²
28 659 m²
29 655 m²
32 569 m²
31 570 m²
30 575 m²
60 47 m²
61 549 m²
62 552 m²

A2

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	STAGE 7 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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GN

SEASIDE BOULDEVARD 23.8 WIDE

ROAD 20 WIDE

ROAD 17.5 WIDE

ROAD 20 WIDE

ROAD 20 WIDE

ROAD 17.5 WIDE

ROAD 20 WIDE

ROAD

ROAD 17.5 WIDE

ROAD 23.8

330 514 m²
331 511 m²
332 517 m²
333 606 m²
334 6440 m²
337 649 m²
338 627 m²
364 577 m²
365 652 m²
638 m²
681 m²
130 12418 m²
131 600 m²
132 652 m²
133 560 m²
134 893 m²
135 503 m²
136 512 m²
137 572 m²
138 581 m²
139 589 m²
140 589 m²
141 589 m²
142 589 m²
143 589 m²
144 600 m²
145 627 m²
146 675 m²
147 674 m²
148 735 m²
149 652 m²
150 603 m²
151 745 m²
152 706 m²
153 700 m²
154 688 m²
155 689 m²
156 589 m²
157 589 m²
158 661 m²
159 816 m²
160 1060 m²
161 651 m²
162 577 m²
163 632 m²
125 562 m²
126 560 m²
127 560 m²
128 560 m²
129 652 m²
112 640 m²
113 631 m²
114 717 m²
115 601 m²
116 568 m²
117 580 m²
118 552 m²
119 765 m²
120 621 m²
121 646 m²
122 641 m²
123 576 m²
124 896 m²
103 984 m²
102 872 m²
104 926 m²
105 709 m²
106 908 m²
107 939 m²
108 619 m²
109 640 m²
110 724 m²
111 722 m²
197 636 m²
198 636 m²
199 528 m²
200 539 m²
201 576 m²
202 611 m²
203 629 m²
196 628 m²
195 624 m²
194 608 m²
204 2331 m²
168 631 m²
167 608 m²
166 608 m²
165 672 m²
164 664 m²
169 703 m²
170 542 m²
171 551 m²
172 536 m²
173 602 m²
174 674 m²
184 1008 m²
183 752 m²
182 629 m²
181 720 m²
180 507 m²
179
193 557 m²
192 557 m²
191 557 m²
190 557 m²
101 639 m²

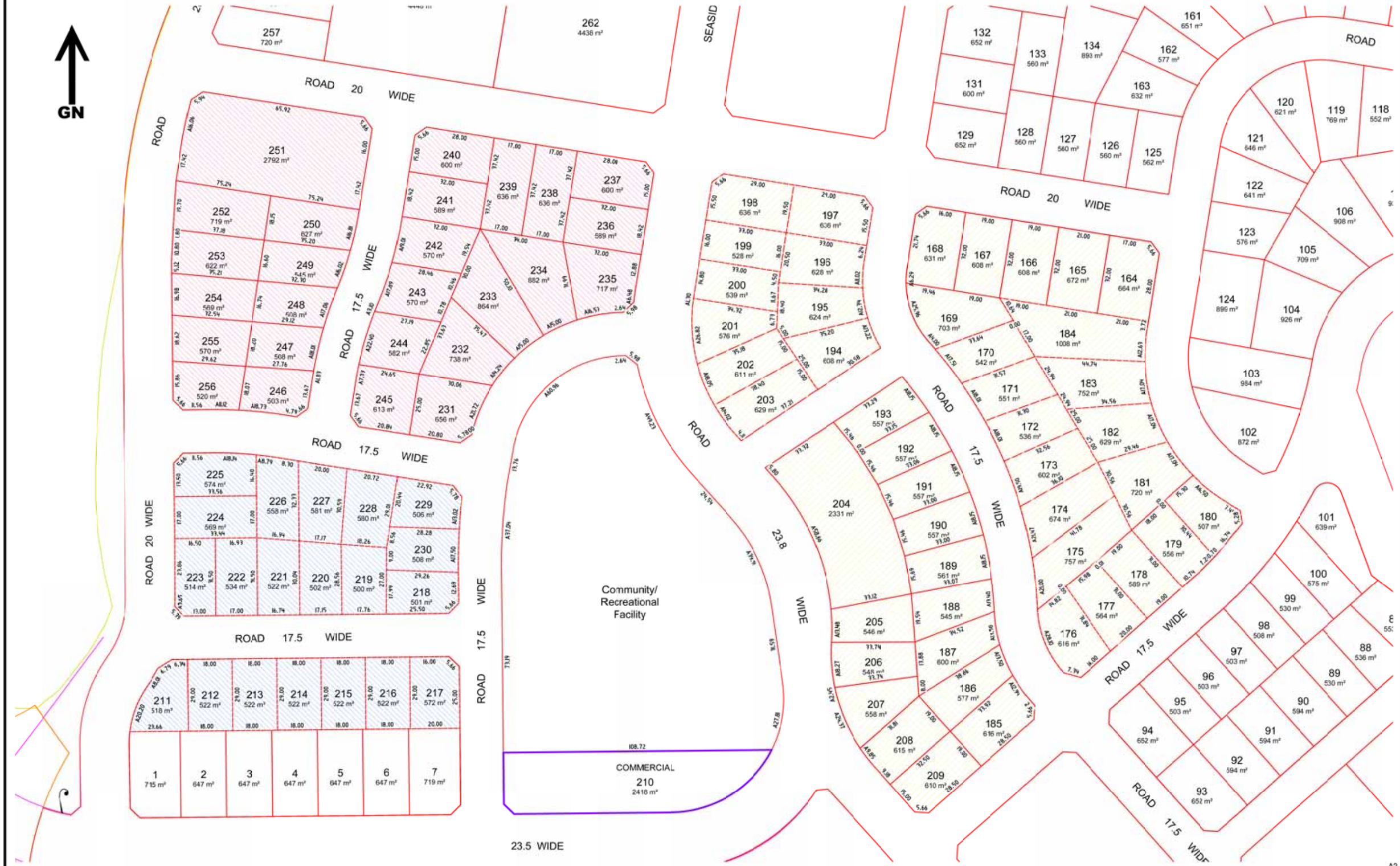
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SCALE 1: 1000	DATUM AHD	DRAWING TITLE STAGES 8 & 9 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED	
DA NUMBER	CC NUMBER	CLIENT ASPEN GROUP LIMITED

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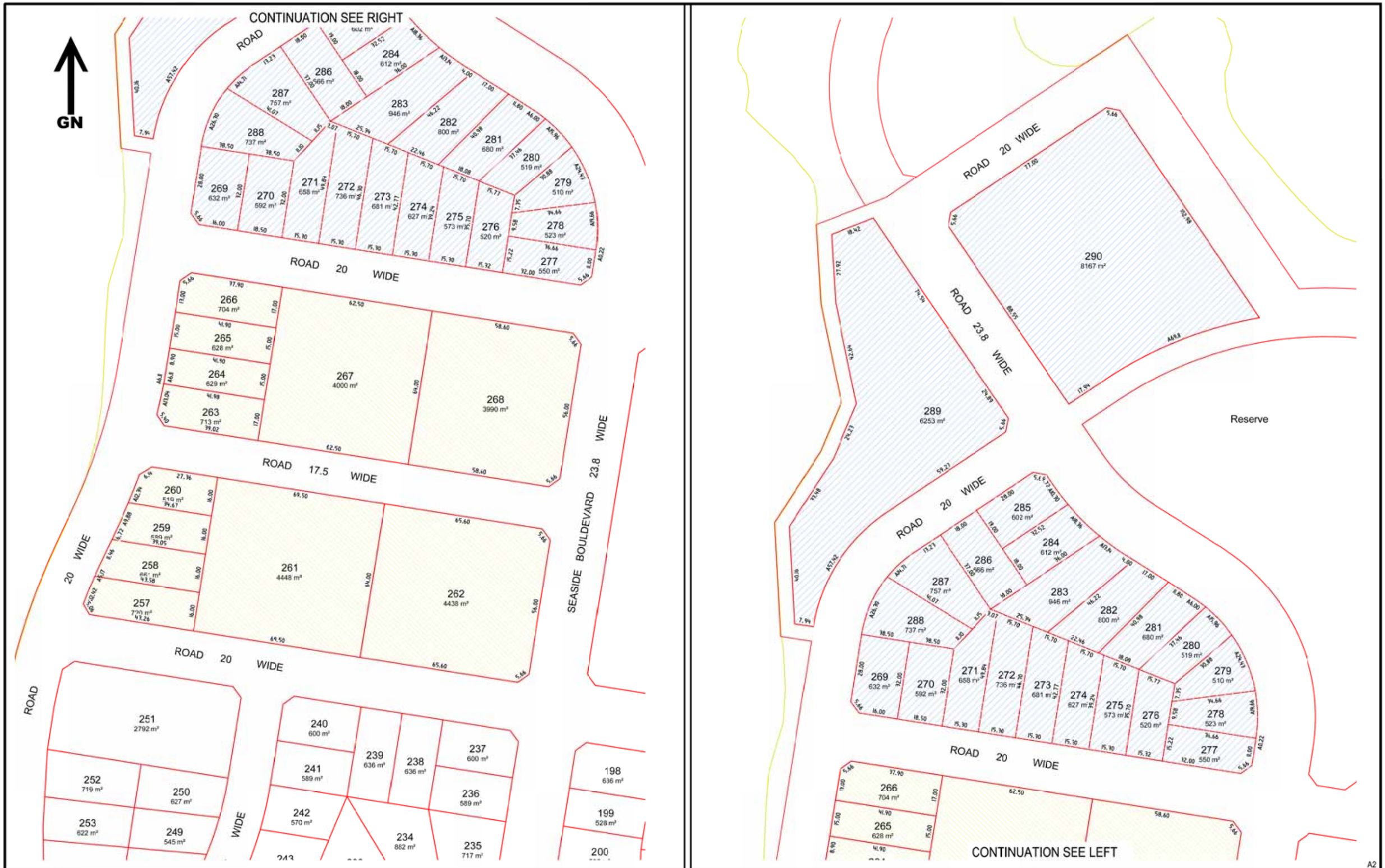
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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	STAGES 10 - 12 DETAIL SHEET
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE STAGES 13 & 14 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED	
DA NUMBER	CC NUMBER	CLIENT ASPEN GROUP LIMITED

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE STAGES 15 & 16 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED	
DA NUMBER	CC NUMBER	CLIENT ASPEN GROUP LIMITED

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	STAGE 17 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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GN

SEASIDE BOULEVARD

COMMERCIAL 383 1166 m²
384 1174 m²
382 2262 m²
385 1081 m²
386 514 m²
387 520 m²
388 543 m²
389 566 m²
390 586 m²
392 1668 m²
391 1667 m²
395 2056 m²
402 569 m²
394 4186 m²
393 4344 m²

ROAD 17.5 WIDE
ROAD 20 WIDE

378 1969 m²
379 558 m²
380 558 m²
381 558 m²
374 1906 m²
377 558 m²
376 558 m²
375 558 m²

ROAD 14.5 WIDE

370 1906 m²
371 558 m²
372 558 m²
373 558 m²
366 1906 m²
369 558 m²
368 558 m²
367 558 m²

ROAD 20 WIDE
ROAD 20 WIDE

ROAD TO CONNECT TO 4WD TRACK

A2

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	STAGE 18 & 19 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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GN

ROAD 20 WIDE

Reserve

ROAD 16 WIDE

410
6979 m²

409
573 m²

408
900 m²

407
782 m²

406
903 m²

405
552 m²

404
3612 m²

403
3300 m²

ROAD 17.5 WIDE

CULTURAL HERITAGE RESERVE

Reserve

ROAD 17.5 WIDE

398
743 m²

399
746 m²

400
748 m²

397
598 m²

401
750 m²

396
599 m²

402
569 m²

395
2056 m²

394
4186 m²

393
4344 m²

Reserve

SEASIDE BOULEVARD

SEASIDE BOULEVARD

COMMERCIAL
383
1166 m²

384
1174 m²

385

A2

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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	STAGE 20 DETAIL PLAN
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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LEGEND

- ~ CATCHMENT 1
- ~ CATCHMENT 2
- ~ CATCHMENT 3
- ~ CATCHMENT 4
- ~ CATCHMENT 5
- ~ CATCHMENT 6
- ~ CATCHMENT 7
- ~ EASEMENT FOR SEWAGE PUMPING STATION
- ~ PROPOSED PUMP STATION (WITH NUMBER)
- ~ EXISTING PUMP STATION (WITH NUMBER)

NOTE:
- E1 & E2 ARE EXISTING PUMP STATIONS

- P3 - P7 ARE PROPOSED PUMP STATIONS

- P3 ,P4 & P7 PROPOSED PUMP STATIONS TO BE LOCATED IN EXISTING CLEARED AREA

- P5 & P6 PROPOSED PUMP STATIONS TO MINIMISE VEGETATION REMOVAL

GN

NELSON BAY ROAD

Reserve

Reserve

Reserve

Reserve

Community/ Recreational Facility

A2

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SCALE 1: 4000	DATUM	DRAWING TITLE INDICATIVE SEWER LAYOUT
REVISION DATE ----		DEVELOPMENT PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED	
DA NUMBER	CC NUMBER	CLIENT ASPEN GROUP LIMITED

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LEGEND

~ EXISTING 100mm WATERMAIN
~ EXISTING 200mm WATERMAIN
~ EXISTING 250mm WATERMAIN
~ EXISTING 300mm WATERMAIN
~ PROPOSED 100mm WATERMAIN
~ PROPOSED 150mm WATERMAIN
~ PROPOSED 200mm WATERMAIN

GN

NELSON BAY ROAD

Reserve
Reserve
Reserve
Reserve
Ccmmunity/ Recreational Facility

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SCALE	1: 4000
DATUM	AHD
REVISION DATE	----
CONTOURS	X m
PLOT DATE	22/12/2009
DRAWN/CHKD BY	GJS / AED
DA NUMBER	
CC NUMBER	

DRAWING TITLE: INDICATIVE WATERMAIN LAYOUT

DEVELOPMENT: PROJECT PLAN ----
FERN BAY SEASIDE VILLAGE
NELSON BAY ROAD, FERN BAY

CLIENT: ASPEN GROUP LIMITED

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RESERVE TABLE

Shading	Area/Section	Ownership	Maintenance Responsibility	Exist/Prop
	Existing Roads	Port Stephens Council	Port Stephens Council	E
	Proposed Roads	Port Stephens Council	Port Stephens Council	P
	Completed Development			E
	R1	Community Association	Community Association (DP270466)	E
	R2	Precinct Associaton	Precinct Association	P
	R3	Community/Precinct Ass	Community /Precinct Association	P
	R4 & R5	Community/Precinct Ass	Community/Precinct Association	P
	Detention Basins	Community/Precinct Ass	Port Stephens Council	E
	Conveyance Swales (see note)	Community/Precinct Ass	Port Stephens Council	P
	Detention basins	Aspen Land	Port Stephens Council	E
	Precinct Property	Precinct DP 280005 Property	Precinct DP 280005 Association	E
	Precinct Property	Precinct DP 280008 Property	Precinct DP 280008 Association	E

Note: Conveyance swales are 2 metres wide, with associated batters as required
(drawn not to scale for clarity)

RESERVE TABLE

No.	TITLE	AREA	COMMENTS
R1	CABBAGE TREE PARK	1.302 Ha	ACTIVE RECREATION
R2	UNNAMED	2500 m²	-
R3	UNNAMED	1.0 Ha	CULTURAL HERITAGE RESERVE
R4	BANKSIA PARK	1.38 Ha	PROPOSED RECREATIONAL FACILITY/COMMUNITY CENTRE
R5	CORYMBIA PARK	1.09 Ha	-



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SCALE	1: 5000
REVISION DATE	----
PLOT DATE	22/12/2009
DRAWN/CHKD BY	GJS / AED
DA NUMBER	
CC NUMBER	
DRAWING TITLE	LAND TENURE PLAN
DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ---
CLIENT	ASPEN GROUP LIMITED

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GN

3
DP 242093

20
DP 606361

1
DP 1006399

19
DP 606361

19
DP 606361

14
DP 258848

FULLERTON COVE ROAD

NELSON BAY ROAD

LOT 46
DP 280008

18
DP 1108060

LOT 1
COMMUNITY PROPERTY

PT LOT 7
DP 270466

PT LOT 7

LOT 1
DP 270466

PT LOT 7
DP 270466

DP 280008

DP 280005

DP 280021

TO STOCKTON

PT LOT 7

PT LOT 7
DP 270466

21
DP 593626

2
DP 881206

4
DP 233358

20
DP 828848

0 100 200 300 400

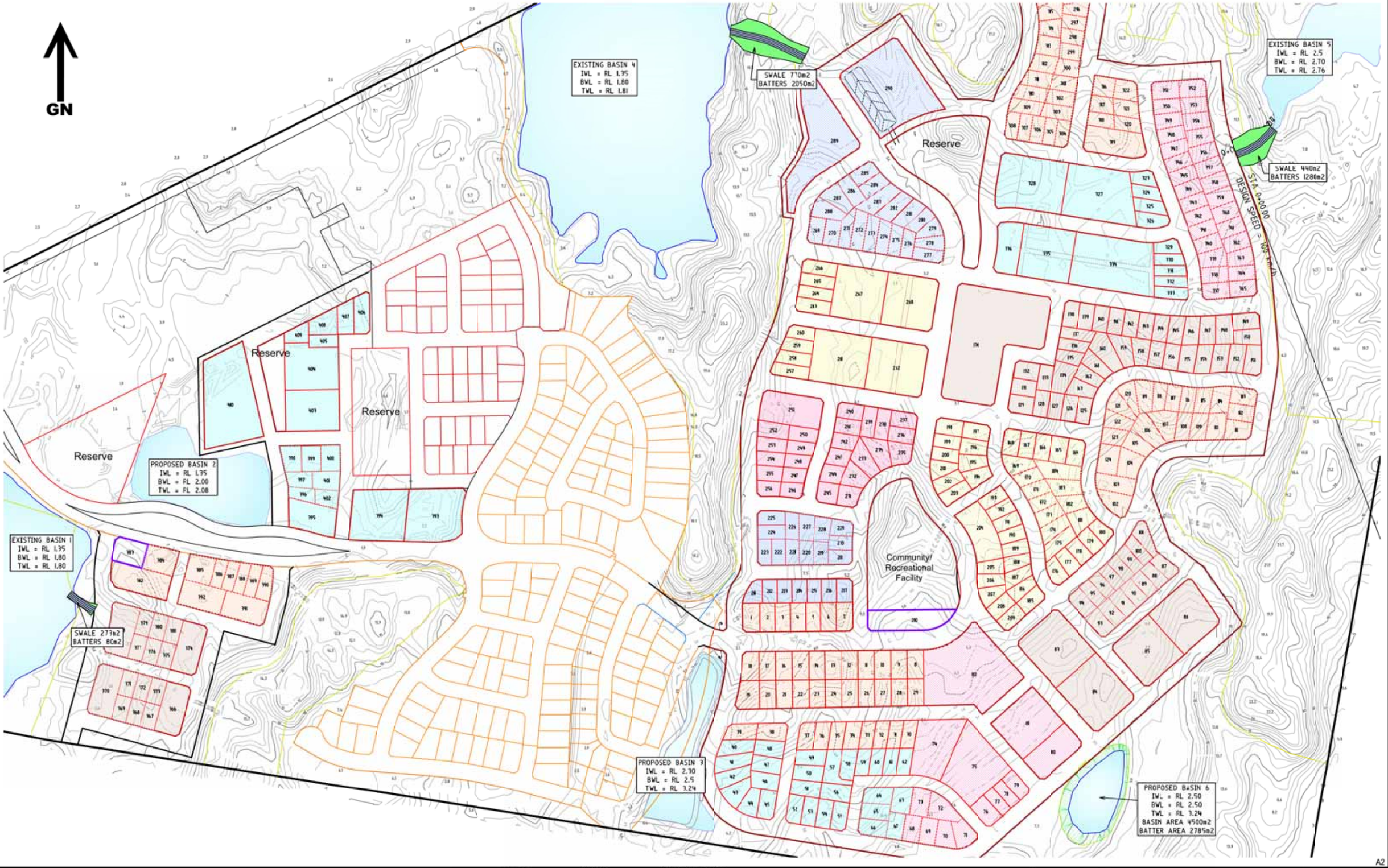
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SCALE 1: 5000	DATUM AHD	DRAWING TITLE	SUBJECT & ADJOINING TITLE DETAILS
REVISION DATE -----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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SCALE	1: 3000
DATUM	AHD
REVISION DATE	----
CONTOURS	2 m
PLOT DATE	22/12/2009
DRAWN/CHKD BY	GJS / AED
DA NUMBER	
CC NUMBER	

DRAWING TITLE
CONCEPT SITE DRAINAGE PLAN - PROPOSED SWALES AND BASINS

DEVELOPMENT
CIVIL DESIGN PLANS ----
FERN BAY SEASIDE VILLAGE
NELSON BAY ROAD, FERN BAY

CLIENT
ASPEN GROUP LIMITED

DALY . SMITH Pty Ltd
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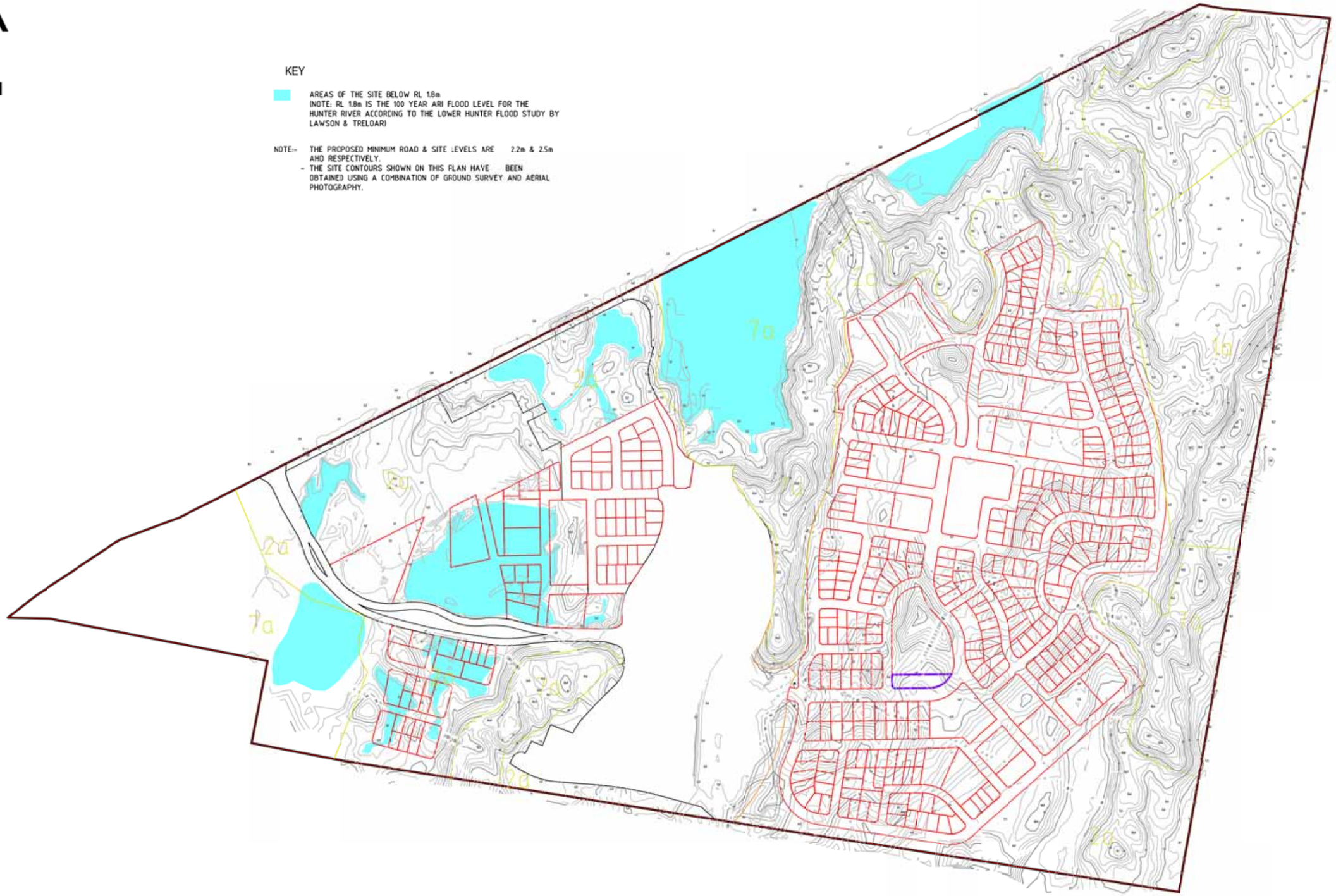
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GN

KEY

AREAS OF THE SITE BELOW RL 1.8m
(NOTE: RL 1.8m IS THE 100 YEAR ARI FLOOD LEVEL FOR THE HUNTER RIVER ACCORDING TO THE LOWER HUNTER FLOOD STUDY BY LAWSON & TRELOAR)

NOTE:- THE PROPOSED MINIMUM ROAD & SITE LEVELS ARE 2.2m & 2.5m AHD RESPECTIVELY.
- THE SITE CONTOURS SHOWN ON THIS PLAN HAVE BEEN OBTAINED USING A COMBINATION OF GROUND SURVEY AND AERIAL PHOTOGRAPHY.



A2

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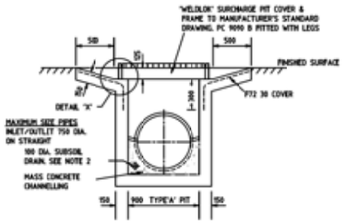
SCALE 1: 5000	DATUM AHD	DRAWING TITLE	FLOOD PRONE & LOW LYING AREAS
REVISION DATE -----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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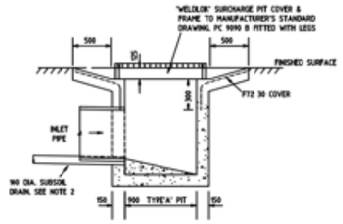
29850 ----

GN

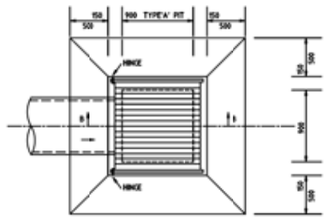
SURCHARGE PIT - RM11(TYPE A)



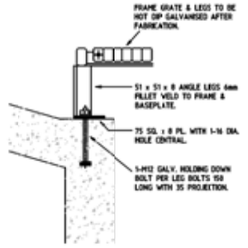
SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE



PLAN
NOT TO SCALE



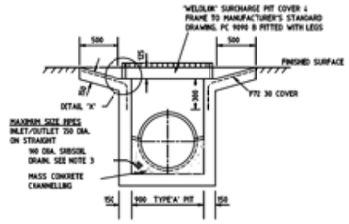
DETAIL 'X'
NOT TO SCALE

NOT TO SCALE
DENOTED [P]

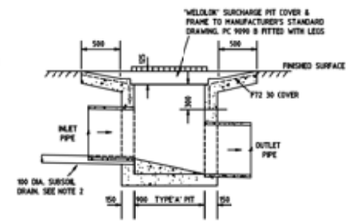
NOTES

1. COMPRESSIVE STRENGTH OF CONCRETE Fc AT 28 DAYS TO BE 20 MPa.
2. 100 DIA. SUBSOIL DRAINAGE 3000 LONG WRAPPED IN FABRIC COSK TO BE PROVIDED IN PIPE TRENCHES ADJACENT TO INLET PIPES.
3. PROVIDE CLIMB IRONS TO R.M.3 WHERE PIT IS DEEPER THAN 1200.

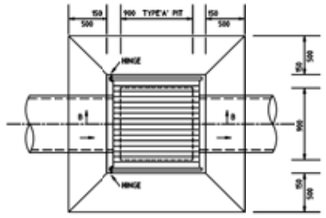
SURFACE INLET PIT - RM11(TYPE A)



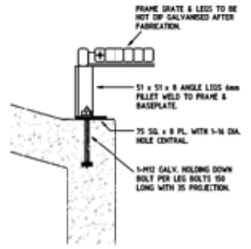
SECTION A-A
NOT TO SCALE



SECTION B-B
NOT TO SCALE



PLAN
NOT TO SCALE



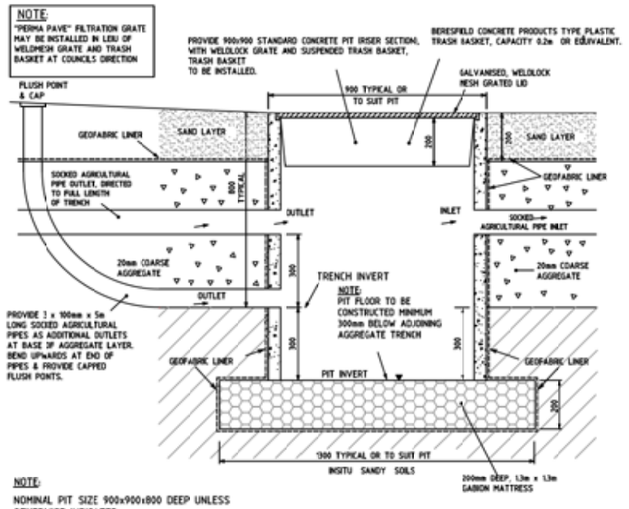
DETAIL 'X'
NOT TO SCALE

NOT TO SCALE
DENOTED [I]

NOTES

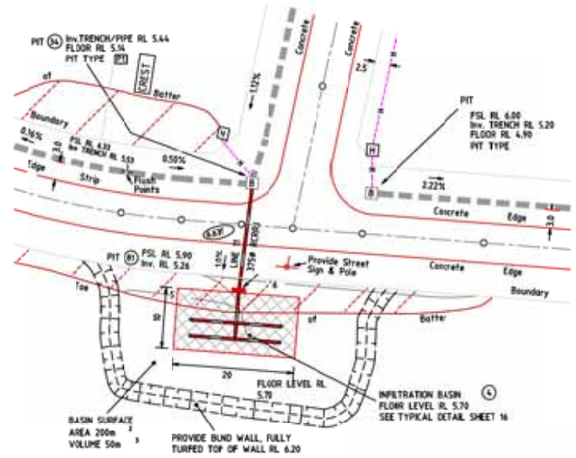
1. COMPRESSIVE STRENGTH OF CONCRETE Fc AT 28 DAYS TO BE 20 MPa.
2. TOP OF BENCHING TO BE 1/2 OF OUTLET PIPE DIAMETER.
3. 100 DIA. SUBSOIL DRAINAGE 3000 LONG WRAPPED IN FABRIC COSK TO BE PROVIDED IN PIPE TRENCHES ADJACENT TO INLET PIPES.
4. PROVIDE CLIMB IRONS TO R.M.3 WHERE PIT IS DEEPER THAN 1200.

NOTE:
"PERMA PAVE" FILTRATION GRATE MAY BE INSTALLED IN LIEU OF WELDMESH GRATE AND TRASH BASKET AT COUNCILS DIRECTION



NOTE:
NOMINAL PIT SIZE 900x900x800 DEEP UNLESS OTHERWISE INDICATED.
PIT TYPE [P1] SIZE 1100x1100x800 DEEP (CAPACITY 1.0m³)
PIT TYPE [P2] SIZE 1600x1600x800 DEEP (CAPACITY 2.0m³)

BIO RETENTION SURFACE INLET PIT
NOT TO SCALE



TYPICAL INFILTRATION BASIN
NOT TO SCALE

A2

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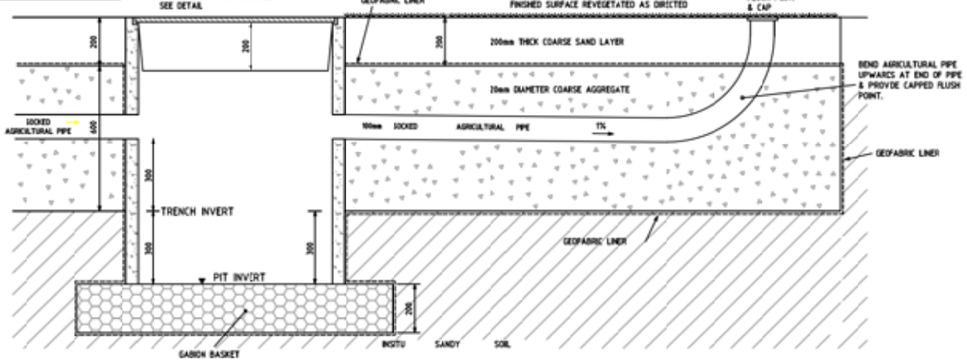
SCALE	DATUM	DRAWING TITLE
1: 1000	AHD	TYPICAL DRAINAGE TREATMENTS DETAIL1
REVISION DATE	CONTOURS	DEVELOPMENT
-----	X m	PROJECT PLAN FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY
PLOT DATE	DRAWN/CHKD BY	
22/12/2009	GJS / AED	
DA NUMBER	CC NUMBER	CLIENT
		ASPEN GROUP LIMITED

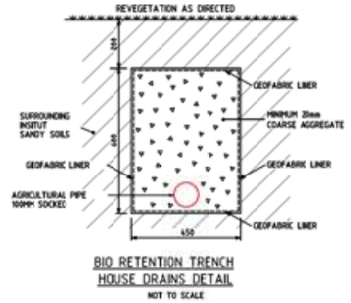
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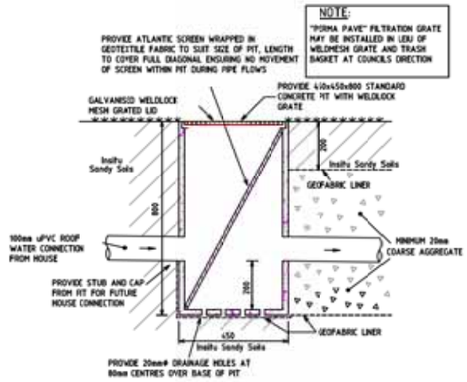
NOTE:
"PERMA PAVE" FILTRATION GRATE MAY BE INSTALLED IN LIEU OF WELDMESH GRATE AND "RASH BASKET AT COUNCILS DIRECTION



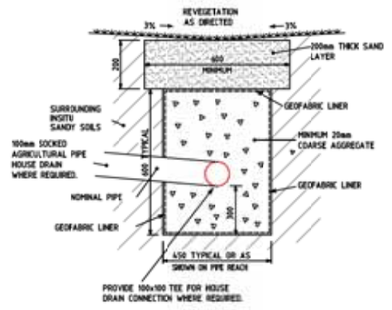


BIO RETENTION TRENCH
HOUSE DRAINS DETAIL
NOT TO SCALE

NOTE:
"PERMA PAVE" FILTRATION GRATE MAY BE INSTALLED IN LIEU OF WELDMESH GRATE AND TRASH BASKET AT COUNCILS DIRECTION



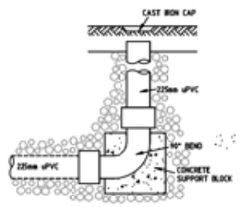
HOUSE DRAINAGE PIT DETAIL
NOT TO SCALE



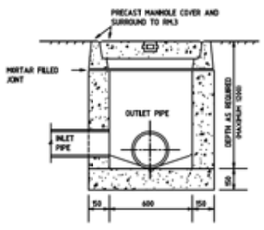
BIO RETENTION SWALE AND TRENCH
NOT TO SCALE

NOTES:

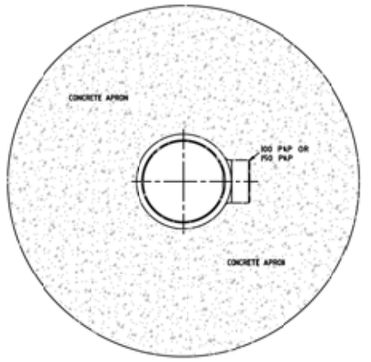
1. PITS CONSTRUCTED IN CRESTS TO BE USED FOR FLUSHING 100mm SOCKED AGRICULTURAL PIPE. 100mm AGRICULTURAL PIPE TO BE CLEARLY ACCESSIBLE.
2. OUTLET OF BIO RETENTION SURFAZE PITS TO BE ABLE TO TAKE 100mm SOCKED AGRICULTURAL PIPE OUTLET OR 375mm RCRRJ CONCRETE PIPE.
3. DRAINAGE INSTALLATION AS DIRECTED AND SPECIFICATION TO BE WITH "STORMWATER MANAGEMENT AT THE PROPOSED STOCKTON BEACH DEVELOPMENT STAGE 2" BY URBAN WATER CYCLE SOLUTIONS, JANUARY, 2005.

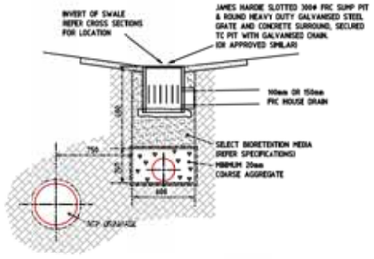


TYPICAL SLOTTED PIPE
& FLUSHING POINT
N.T.S.

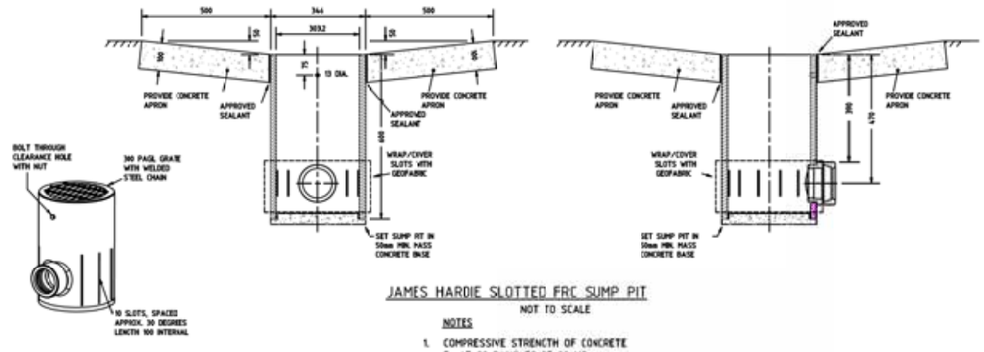


JUNCTION PIT RM8
NOT TO SCALE





TYPICAL ARRANGEMENT
300mm FRC SUMP PIT BIORETENTION SWALE
AND STORMWATER DRAINAGE LINE
NOT TO SCALE



JAMES HARDIE SLOTTED FRC SUMP PIT
NOT TO SCALE

NOTES

1. COMPRESSIVE STRENGTH OF CONCRETE Fc AT 28 DAYS TO BE 20 MPa.

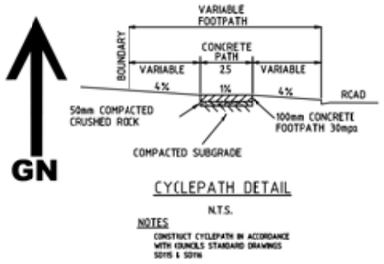
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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	TYPICAL DRAINAGE TREATMENTS DETAIL 2
REVISION DATE -----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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CYCLEPATH DETAIL

N.T.S.

NOTES

CONSTRUCT CYCLEPATH IN ACCORDANCE WITH COUNCILS STANDARD DRAWINGS SD115 & SD116

GN

LEGEND

HYDRANT
HYDRANT CAP
STOP VALVE
PP POWER POLE
LP LIGHT POLE
EB EDGE BITUMEN
NIP NORFOLK ISLAND PINE
KIP KERB INLET PIT
SHRUB
PALM

SSM SEWER RISING MAIN
W WATER PIPE
G GAS PIPE
T TELSTRA CABLE
O OPTIC FIBRE
OVERHEAD POWER LINE
UNDERGROUND POWER CABLE

EXISTING ROUNDABOUT

EXISTING BITUMEN ROAD

EXISTING FOOTPATH

TO FERN BAY SEASIDE VILLAGE

PROPOSED CYCLEWAY

LOT 5
DP 270466

LOT 18
DP 1108060

PROPOSED CYCLEWAY

LOT 17
DP 1108060

LOT 1
DP 881206

BITUMEN ROAD

EXISTING

LOT 802
DP 789845

PROPOSED CYCLEWAY

CMRS SHELTER

TRAFFIC ISLANDS

LOT 2
DP 881206
"BAYWAY VILLAGE CARAVAN PARK"

EXISTING FOOTPATH

EXISTING BUS SHELTER

NOTE: DETAILED DESIGN & APPROPRIATE APPROVAL FOR THE CONCRETE FOOTPATH/CYCLEWAY WILL BE REQUIRED PRIOR TO CONSTRUCTION.

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SCALE 1: 1500	DATUM AHD	DRAWING TITLE	FOOTPATH & CYCLEWAY
REVISION DATE ----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY ----
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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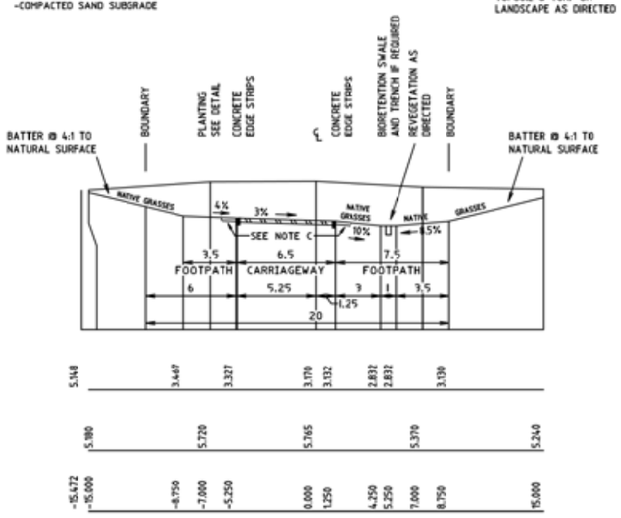
SUBGRADE NOTES

- REFER TO GEOTECHNICAL REPORT FOR PAVEMENT DETAILS AND GEOTECHNICAL ADVICE.
- SUBGRADE TO BE OF CLEAN SAND TO DEPTH OF 500mm. WHERE EXISTING MATERIAL IS CONSIDERED UNSUITABLE, REFER TO SUBGRADE PREPARATION ADVICE IN GEOTECHNICAL REPORT
- IF WET CLAY MATERIAL IS ENCOUNTERED IN SUBGRADE THEN SUBGRADE SUITABILITY IS TO BE ASSESSED BY CONSULTANT GEOTECHNICAL ENGINEERS.
- IN AREAS OF GRADE OF GREATER THAN 10%, CONSULTANT GEOTECHNICAL ENGINEER IS TO ASSESS SUITABILITY OF MATERIAL AND VERIFY SUBBASE THICKNESS.

PAVEMENT DETAILS

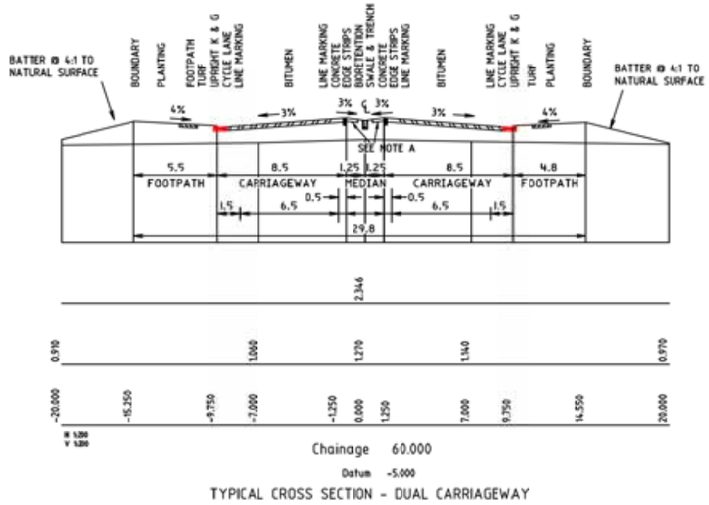
ROAD No.1
-PRIME 7mm COAT & 25mm AC RESIDENTIAL MIX
-100mm COMPACTED BASECOURSE
-200mm COMPACTED SUBBASE
-COMPACTED SAND SUBGRADE

NOTE C
PROVIDE 1.0m WIDE 100mm THICK CRUSHER DUST LAYER, AT 60mm BELOW FSL, COVER WITH TOPSOIL & TURF OR LANDSCAPE AS DIRECTED



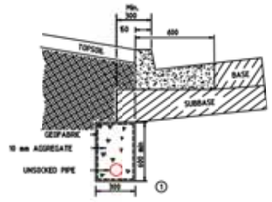
Chainage 87.290
Datum -4.000

TYPICAL CROSS SECTION - SINGLE CARRIAGEWAY



Chainage 60.000
Datum -5.000

TYPICAL CROSS SECTION - DUAL CARRIAGEWAY



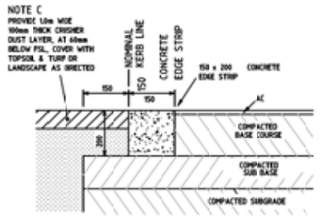
TYPICAL SUBSOIL DRAINAGE DETAIL

NOTE: -GEOFABRIX IN ALL SUBSOIL DRAINS TO BE PLACED ON TOP AND BOTH SIDES AS DETAILED.

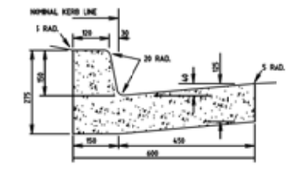
-SUBSOIL DRAINS TO BE CONSTRUCTED IN ACCORDANCE WITH PORT STEPHENS COUNCIL'S STANDARD DRAWING D4, SEE PORT STEPHENS COUNCIL'S SUBDIVISION CODE - PART 2.



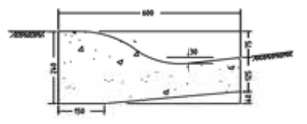
TYPICAL INTERSECTION DETAIL
SCALE 1:200



TYPICAL CONCRETE EDGE STRIP DETAIL
N.T.S.



TYPICAL 150mm KERB & GUTTER
N.T.S.



TYPICAL ROLL KERB & GUTTER
N.T.S.

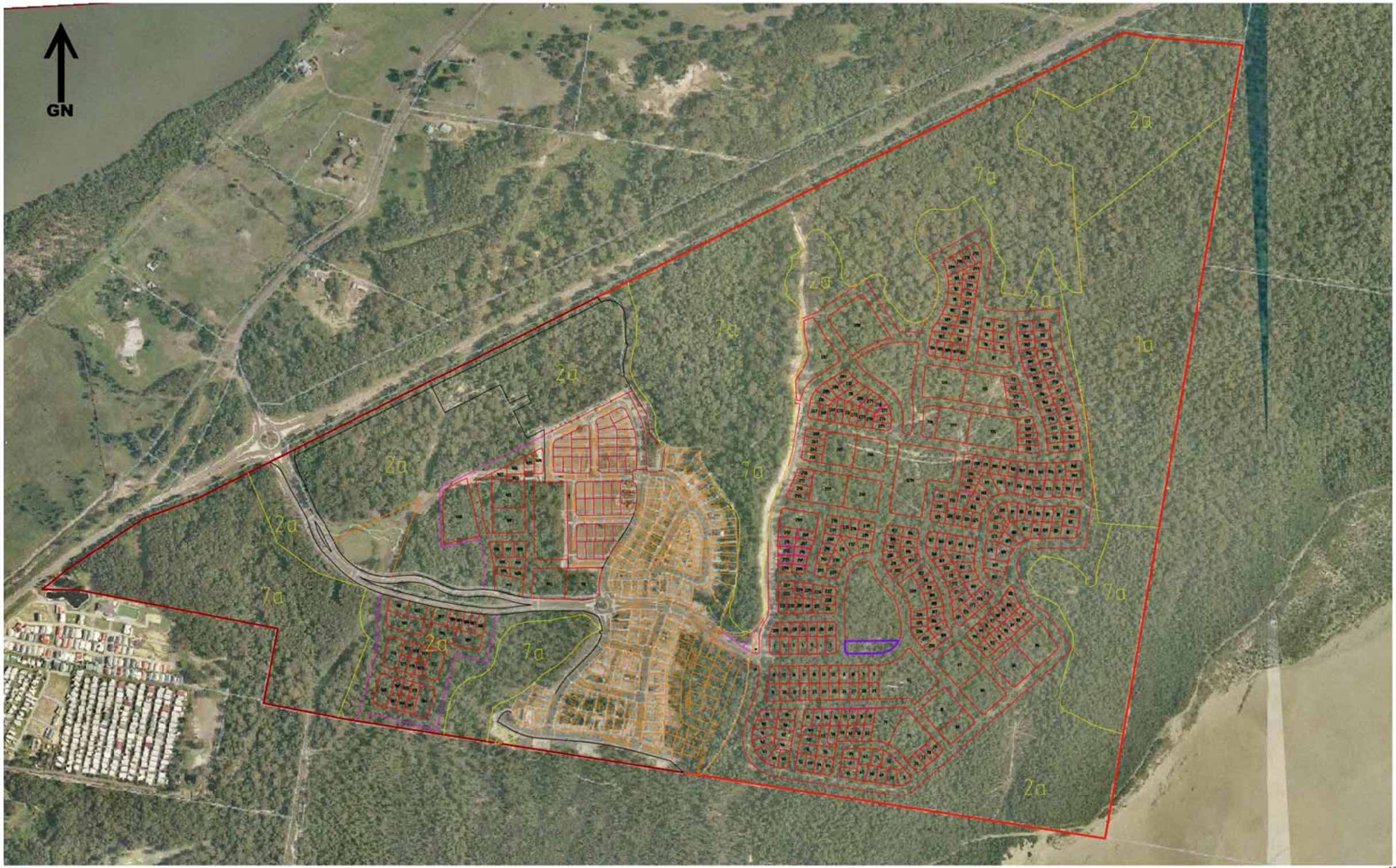
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SCALE 1: 1000	DATUM AHD	DRAWING TITLE	TYPICAL ROAD DETAIL
REVISION DATE -----	CONTOURS X m	DEVELOPMENT	PROJECT PLAN FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
DA NUMBER	CC NUMBER	CLIENT	ASPEN GROUP LIMITED

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SCALE	1: 5000
DATUM	AHD
REVISION DATE	----
CONTOURS	X m
PLOT DATE	22/12/2009
DRAWN/CHKD BY	GJS / AED
DA NUMBER	
CC NUMBER	

DRAWING TITLE: AERIAL VIEW

DEVELOPMENT: PROJECT PLAN ----
FERN BAY SEASIDE VILLAGE
NELSON BAY ROAD, FERN BAY

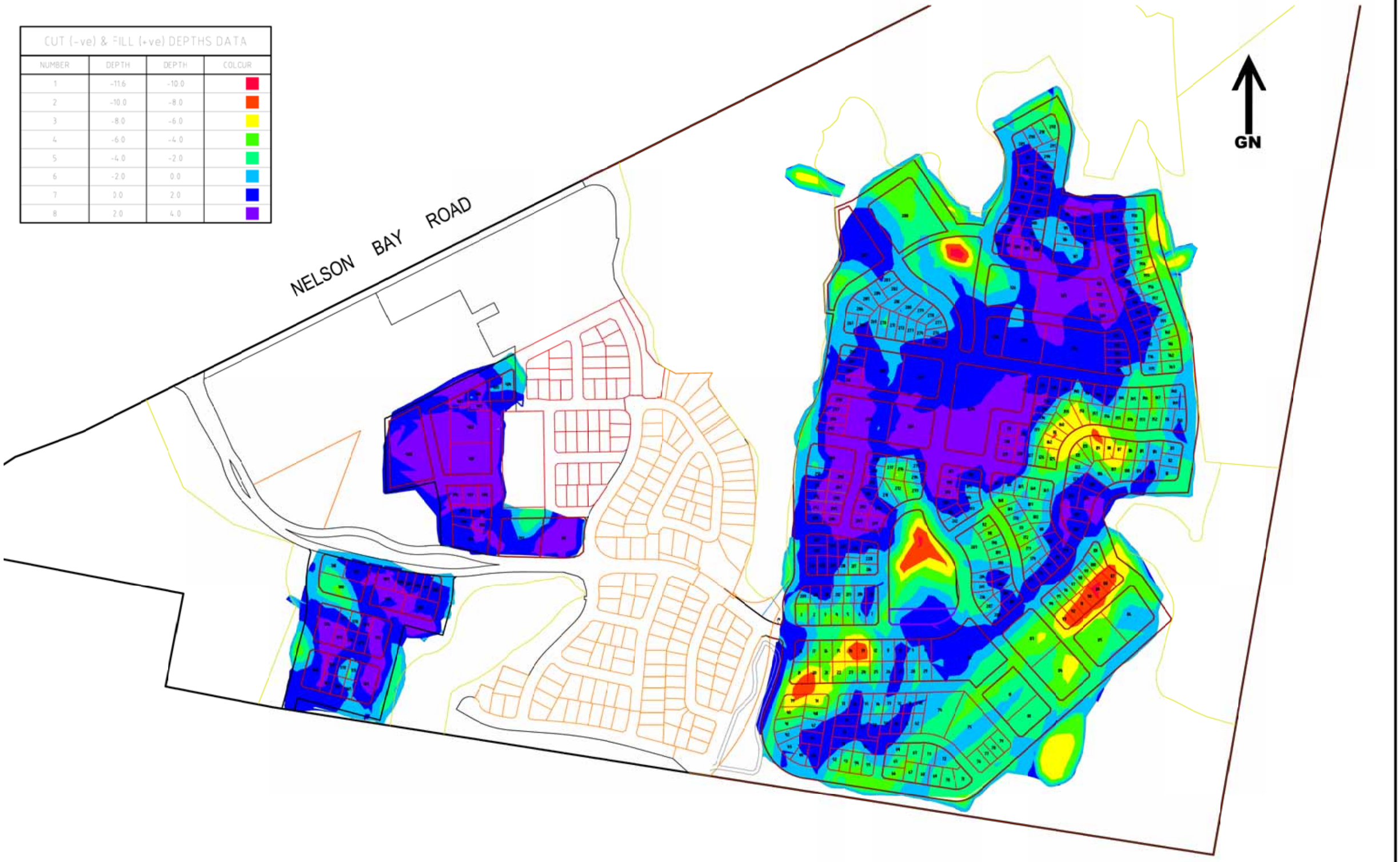
CLIENT: ASPEN GROUP LIMITED

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29850 ----

CUT (-ve) & FILL (+ve) DEPTHS DATA			
NUMBER	DEPTH	DEPTH	COLOUR
1	-11.6	-10.0	
2	-10.0	-8.0	
3	-8.0	-6.0	
4	-6.0	-4.0	
5	-4.0	-2.0	
6	-2.0	0.0	
7	0.0	2.0	
8	2.0	4.0	



A2

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SCALE 1: 4000	DATUM AHD	DRAWING TITLE	BULK EARTHWORKS (CUT-FILL) PLAN
REVISION DATE ----	DEPTH CONTOURS 2 m	DEVELOPMENT	PROJECT PLAN ---- FERN BAY SEASIDE VILLAGE NELSON BAY ROAD, FERN BAY
PLOT DATE 22/12/2009	DRAWN/CHKD BY GJS / AED		
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29850 A

Annex C

Updated Social and Community Analysis

C.1 SOCIAL AND COMMUNITY PROFILE

C.1.1 Introduction

This chapter has been provided as an annexure to *Section 7.3* in the EA, as requested by the Department of Planning. This annexure provides an updated profile of the local Fern Bay area using 2001 and 2006 Australian Bureau of Statistics (ABS) Census Data, and highlights some of the key differences between the 2001 and 2006 Census Data for the area.

C.1.2 Data Considerations

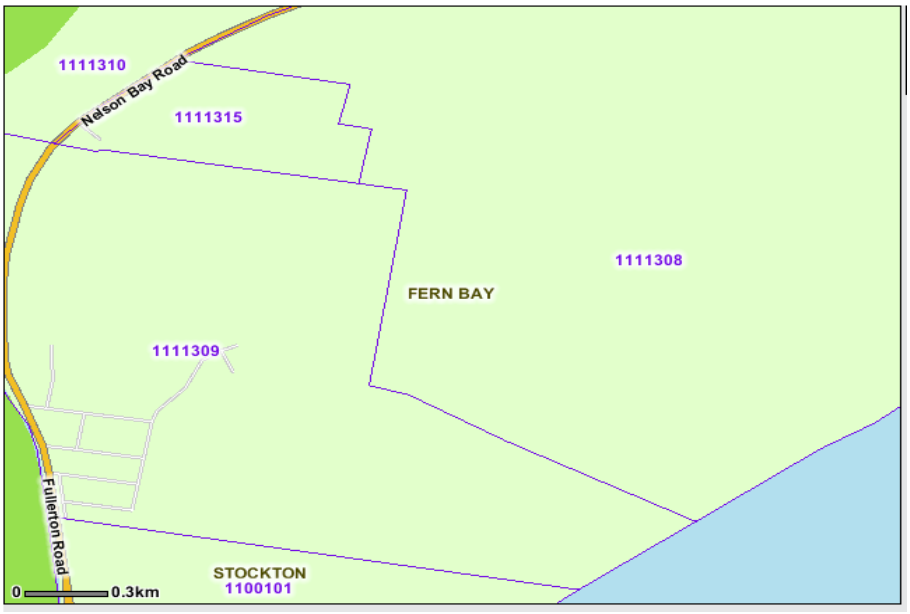
Chapter 7.3, "Social and Community Profile" in the original EA was based on the Socio-Economic Assessment prepared in 2005 in support of the Master Plan. The data in the Socio-Economic Assessment for the Master Plan was based on the Port Stephens Council "*2004 Port Stephens Community Profile*" (February 2004). However, the statistical collection area of data Council used in the community profile (i.e. geographical area from which the statistics were captured) is not clearly defined.

ERM have sought the subsequent updated profile, inclusive of 2006 data, however the information currently available from Council was not directly comparable. This is because Council's current community profile data for 2001 and 2006 is not identical to the 2001 data in their 2004 report and the updated reports do not clearly define the statistical collection area the data was drawn from.

Therefore, the data used in this updated assessment has been directly sourced from the ABS quantitative data, namely the 2001 and 2006 Census of Population and Housing, Basic Community Profile Series, in order to provide an identical comparative analysis.

Three geographical scales were selected in order to compare trends between the 2001 and 2006 Census for the Fern Bay area. Census Collection Districts (CCD) 1111308, 1111309 and 1111315 include the Fern Bay Township and the surrounding area that is outlined in the Master Plan for staged residential development. These areas are outlined below in *Figure C1*.

Figure C.1 *Map of 2006 ABS Census CCDs for Fern Bay Locality*



Source: ABS, 2006 Census Data By Location

Although CCD 1111308 is a large geographical area, the population in 2006 on Census night was 391, revealing a low population density. In 2001, CCD 1111315 did not exist as a separate individual CCD, however this area was captured in the 1111308 CCD in 2001 as shown below in *Figure C2*.

Figure C.2 *Map of 2001 ABS Census CCDs for Fern Bay Locality*



Source: ABS, 2001 Census Data By Location

For the purposes of this assessment, CCD 1111308, 1111309 and 1111315 herein will be referred to as the "Fern Bay Locality."

C.2 EXISTING COMMUNITY PROFILE

At the 2006 ABS Census, the Fern Bay Locality had a total population of 1,525, which declined slightly from 1,531 people in 2001. This decline could potentially be a direct result of the significant change in the population residing in caravan, cabin or houseboat dwellings in the CCD 1111308 between 2001 and 2006. Port Stephens Council predicts the population in the Fern Bay-Fullerton Cove area to grow to 2,396 by 2011 and 5,211 by 2031 (Port Stephens Council, Population Forecast 2009). These figures assume that the areas of the site zoned Residential 2(a) will be developed for residential purposes.

In 2006, the median age of residents within the Fern Bay Locality was 58 years and 37.2% of the Locality was aged 65 years and above. This was a significant difference to the median age of residents in the same area in 2001, which was 48 years, with 27.2% of the population aged 65 years and over. This indicates there is an ageing population residing in the Fern Bay Locality, with potentially many retirees. This ageing population structure for Fern Bay is supported by Council's population forecasts for the Fern Bay-Fullerton Cove area. Council forecasts that the upward trend in the 55 and over age structure will continue from 2006 to 2031.

The vast majority (approximately 80%) of residents within the Fern Bay Locality were Australian born in 2006, which was a slightly lower proportion than in 2001 (approximately 83%).

Median monthly housing loan repayments for households in Fern Bay Locality remained relatively stable between 2001 and 2006, around $800-$999. This was a similar trend for median weekly rents for households, averaging at $100-$149 per week for 2001 and 2006.

There was a growth in the median weekly family income level between 2001 and 2006 for Fern Bay Locality, with median income in 2001 at $500-$599 and $600-$699 in 2006. Of the three CCDs, 1111309 had higher household median weekly incomes for both 2001 and 2006. In 2006, CCD 1111309 households had a median weekly income of $776, which was significantly higher than CCD 1111308 ($430) and CCD 1111315 ($401).

In 2006 the majority of dwellings (99%) within the Fern Bay Locality consisted of a single detached house. This vastly differed to the 2001 proportion; where just over 51% of dwellings consisted of a single detached house for the same area. This difference is predominantly accounted for by the CCD 1111308, whereby in 2001, 302 dwellings consisted of caravans, cabins or houseboats, however in 2006, for CCD 1111308, there were no dwellings consisting of caravans, cabins or houseboats. This could be an indication of the change in residential development planning for the area, and consequently change in lifestyle and type of dwelling.

The statistics between 2001 and 2006 show that family household structures are changing in the Fern Bay Locality. An increasing proportion of couple

families without children were residing in the area in 2006 (over 63%), compared to 55% in 2001. Only just over 22% of family households were couple families with children in 2006, which dropped from 28% in 2001. This change correlates to an increasing proportion of retirees and people aged 65 years and over in the area, as well as a declining fertility rate.

Annex D

Additional Surface Water and Ground Water Assessment

Aspen Group

Amended Water Cycle Management Strategy, Fern Bay Seaside Village, NSW

P0902479JR01V02
December 2009

martens consulting engineers

ENVIRONMENTAL



WATER



WASTEWATER



GEOTECHNICAL



CIVIL



PROJECT MANAGEMENT



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All enquiries regarding this project are to be directed to the Project Manager.

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1 Executive Summary

Overview

The report provides an amended water cycle management strategy for the Fern Bay seaside Village development (the 'development'), located some 8 km north of Newcastle. The development is currently undergoing assessment by the NSW Department of Planning (DoP) under Part 3A of the Environment Planning and Assessment Act 1979. Amendments focus on groundwater and surface water management issues raised as part of the Environmental Assessment Report (EAR) review process. Finally, we note that the modelling that was undertaken as part of the EAR has been fully reviewed and amended. This work should be taken to replace the previous work.

Groundwater

This study provides a comprehensive review of groundwater conditions under existing conditions, developed conditions and under sea level rise conditions of 1 above existing levels. Key components and outcomes of the groundwater investigation are as follows:

1. A groundwater monitoring bore network was established throughout the site. Groundwater was manually measured and monitored continuously at numerous locations within the study area. Previously collected data were complied and contributed to the overall understanding of the local site aquifer.

2. Background groundwater quality was determined through baseline sampling and review of previous data. Previously collected data were complied and contributed to the overall understanding of the local site aquifer.

3. A Visual MODFLOW model was developed of the local aquifer. Models created included existing conditions, developed conditions, and developed conditions with a 1 m sea level rise. Models for steady state and transient conditions (60 year time varying period) were developed in order that groundwater level fluctuations could be determined.

4. Modelling demonstrated that there is an approximately north-south aligned groundwater divide through the site, with groundwater either side of the divide flowing to either the Pacific Ocean or to the Hunter River.

5. Groundwater levels fluctuate with varying seasonal recharge. The level of fluctuation varies across the site depending on location, but a maximum fluctuation range of approximately 500 mm.

Surface Water – Quantity

An amended surface water management scheme was developed for the proposal. Key components and outcomes are as follows:

1. Site drainage is via a series of road side swales (bioretention swales). Three standard swale types/sizes were determined based on flow rates in order that swales could carry the 1 % AEP flow level without spillage to adjoining lands / dwelling allotments.

2. Site drainage discharges to a series of 6 either existing or constructed basins which collect and dispose of stormwater through infiltration. These are shown, together with relevant design levels in the attached site plans.

3. The minimum basin inverts used for DRAINS hydraulic modelling at each basin site were taken as the expected maximum groundwater level at each basin site under a 1 m sea level rise scenario. This provided a high level of conservatism in design of the surface drainage system by increasing buffer distances between existing groundwater levels and infiltration areas.

4. Basin infiltration rates were reviewed in accordance with supplementary site testing with a clogging factor of 4-5 applied.

5. No OSD was included as part of the internal drainage design given that all infiltration basins are self draining and there is no impact expected on adjoining lands or on any Council infrastructure.

Surface Water – Quality

The amended water quality management strategy included the following key components:

1. The stormwater management train included rainwater tanks at each dwelling, road side bioretention swales, gross-pollutant traps (GPTs) at the primary sub-catchment outlets, and infiltration basins.

2. Water quality objectives included the following:

    a. <u>Objective 1: Pollutant Retention Targets</u>
    To comply with the pollutant retention criteria specified by

Port Stephens Council as documented in Table 21.

b. Objective 2: Protection of the Groundwater System
To ensure that the average concentration of pollutants (notably nutrients) in site stormwater discharges should not be greater than the existing average concentration of these pollutants in local groundwater thus ensuring that no adverse impacts on local surface and groundwater quality.

c. Objective 3: Non-reliance On End-of-Line Treatment Measures
To ensure that all water quality treatment occurs upstream of proposed stormwater infiltration basins / areas which ensures that these areas are treated as 'receiving waters'.

3. Water quality modelling using the MUSIC model was undertaken to determine the impact of the development on water quality and compliance with the water quality objectives with modelling demonstrating. The post-development model with treatment systems included was deemed to satisfy the sites water quality objectives.

On-going Management

A preliminary site management plan was prepared for the development which covers the following key elements:

1. Stormwater system operation during construction.
2. On-going maintenance and monitoring of the stormwater system.
3. Groundwater monitoring requirements.
4. Bore field maintenance.
5. Responsibility for the system maintenance.

2 Overview

2.1 Project Background

The report provides an amended water cycle management strategy for the Fern Bay seaside Village development (the 'development'), located some 8 km north of Newcastle. The development is currently undergoing assessment by the NSW Department of Planning (DoP) under Part 3A of the Environment Planning and Assessment Act 1979.

As part of the 3A Application, an Environmental Assessment Report (EAR) was prepared by ERM in February 2009 on behalf of the Aspen Group Pty Ltd. As part of the assessment process, comments on the EAR were received by various stakeholders and by Cardno Lawson Treloar who were commissioned by DoP to undertake a review of the water cycle (stormwater, groundwater and flooding) and coastal management components of the EAR.

The report amends the previous water cycle management strategy and addresses numerous matters raised by the relevant stakeholders and DoP's review consultant. Key EAR reviews considered in developing this amended water cycle management strategy (WCMS) include:

1. Port Stephens Council (June 2009) Review letter to DoP.

2. NSW Department of Water and Energy (DWE) (June 2009) Review letter to DoP.

3. Cardno Lawson Treloar (July 2009) Review letter to DoP.

This report seeks to address surface and groundwater issues raised in the EAR assessment process.

2.2 Study Area Description

The site is located on an approximately northeast – southwest aligned coastal barrier mass which is bounded by the Hunter River to the west and the Pacific Ocean to the east. Site location plans and aerials are provided in Attachment A.

Whilst part of the site is already developed and maintains roads, servicing infrastructure and residential allotments, a large portion of the site remains undeveloped and characterised by relatively dense

coastal vegetation. Uncleared areas generally maintain stabilised [by vegetation] sand dune systems.

No natural water courses traverse the site. Drainage is essentially 'internal' with low lying areas forming points of increased groundwater recharge during rainfall runoff events. Given that the site is characterised by Holocene sand deposits, runoff of incident rainfall only occurs under extreme events.

2.3 Development Proposal Description

The proposal involves the following key elements:

1. Site area is approximately 205 ha of which some 136.4 ha is zoned for residential purposes.

2. A total of 945 residential lots are proposed (comprising 683 new lots, 182 lots from a pre-existing consent and 4 super lots with potential for 84 integrated housing lots).

3. Open space for parks, a Cultural Heritage Reserve, bushfire asset protection zones, managed reserves and bushland open space.

4. Recreational community facilities, public roads, fire trains and pathways, and necessary stormwater infrastructure together with other necessary services including sewer, water, power and telecommunications.

Significantly, the origin and general form of the development comes about from the approved Masterplan (MP 20-4-2005) for the site (approved 8th August, 2005).

2.4 Study Scope

The project scope is summarised as follows:

1. Review existing surface and groundwater data and models.

2. Undertake a comprehensive groundwater field survey to determine existing levels and assess spatial and temporal variations in levels.

3. Develop a groundwater model for existing and developed conditions to determine design 'high water' groundwater levels in order that these can be used as a basis of the concept design for the surface water system.

4. Develop a surface water management strategy covering both quantity and quality issues identified in the EAR review process.

2.5 Summary of Identified Issues

Issues identified in the key EAR review documents are summarised below in Table 1.

Table 1: Summary of key EAR review comments relating to surface and groundwater issues.

Category	Issue	Who	Action Taken
GW	Groundwater level monitoring data is insufficient, notably for basins 3, 5 and 6.	PSC, CLT	Provide additional monitoring data
GW	No attempt to determine maximum predicted groundwater levels. How do maximum groundwater levels relate to proposed basin inverts and infiltration basin performance ?	PSC, CLT	Determine maximum groundwater levels across the site.
GW	Groundwater flows and flow directions have not been assessed with respect to low lying site areas.	PSC, CLT	Model groundwater system.
GW	Impact of developed catchment flows on groundwater levels and basin performance.	PSC	Model groundwater system
GW	Impact of cut / fill operations on groundwater levels	PSC	Review cut/fill operations and comment.
GW	Infiltration rates to existing low lying basins, notably basins 1, 2 and 4. In the case of basin 4, impact of developed site flows on the Nelson Bay pavement.	PSC	Provide additional detail.
GW	A whole site groundwater model should be prepared to assess impact of infiltration systems, variation in water table depth, variations in hydraulic gradient, flow directions, and impacts of urbanisation of	PSC	Prepare a MODFLOW model to evaluate these parameters.
GW	Construct detention basins so as not to intercept the water table. This should account for variations in the water table.	DWE	Review groundwater levels and amend design where possible.
GW	For excavations, maintain a 1 m buffer above the highest predicted groundwater table.	DWE	Review groundwater levels and amend design where possible.
GW	Infiltration basins located within 1 m of the highest predicted water table will need to be lined to prevent direct infiltration to groundwater.	DWE	Review groundwater levels and amend design where possible.
GW	Protection of groundwater dependent ecosystems in accordance with the *NSW Groundwater Dependent Ecosystem Policy*.	DWE	Ensure any stormwater discharge will have a neutral or beneficial impact on groundwater quality.
SW	Not all basins have area and top water levels nominated.	PSC	Clarify and provide detail.
SW	Insufficient information provided in relation to basin infiltration rates. Adoption of a clogging factor of 3-5 to be considered. More testing required and effects of soil compaction to be considered.	PSC, CTL	Provide additional detail.

SW	DRAINS modelling indicates high overland flows along the roads. Insufficient detail provided in how the overland flows are conveyed without impacting private properties	PSC, CLT	Provide additional detail
SW	Catchment parameters not specified for DRAINS modelling.	PSC	Provide additional detail
SW	Peak groundwater levels should be used to determine tail water conditions for surface water DRAINS modelling.	PSC, CLT	Determine peak groundwater levels and incorporate these into design
SW	Climate change impacts on rainfall intensity should be considered in the design of the drainage infrastructure (10-30 % increase).	PSC, CLT	Run the DRAINS model with 20 % rainfall intensity increase.
SW	Confirmation of sub-catchment areas used for DRAINS modelling.	CLT	Check and amend catchment areas and amend DRAINS model.
SW	Clarification of difference (if any) between dispersion and detention areas.	CLT	Clarify that all are termed infiltration basins.
SW	Earthworks for swales is poorly defined.	CLT	Provide additional detail.
SW	Full range of storms for DRAINS output is not provided for review.	CLT	Provide additional detail for full range of storms.
SW	Have detention / infiltration basins been sized for a full range of storms and is there a suitable level of 'fail safe' in the design in the event that basins are not correctly sized.	CLT	Review basin design requirements and provide some 'buffer' in design.
SW	Basin infiltration maintenance requirements, including during construction phase.	CLT	Provide additional detail on maintenance requirements.
WQ	Insufficient treatment of gross pollutants	CLT	Provide additional detail to capture gross pollutants.
WQ	Location of bioretention swales and other water quality infrastructure is missing.	CLT	Update trunk drainage plan to include additional detail.
WQ	Water quality modelling indicates a reliance on natural systems that are off-site.	CLT	Ensure no reliance on off-site / natural systems for water quality management
SW	Groundwater is highly vulnerable from contamination from surface activities.	DWE	Ensure no reliance on off-site / natural systems for water quality management
WQ	Define role of rainwater 3KL tanks in the development.	CLT	Provide additional detail.
WQ	Inadequate definition of catchment water quality performance targets.	CLT	Determine and provide suitable catchment water quality targets.

WQ	Insufficient design information is provided for stormwater treatment devices.	CLT	Provide additional detail
WQ	Clarification of MUSIC calibration / assumptions.	CLT	Provide additional detail
WQ	Impact of groundwater on stormwater treatment devices.	CLT	Provide additional detail

Notes
1. GW = Groundwater
2. SW = Surface Water
3. WQ = Water Quality
4. PSC = Port Stephens Council
5. CLT = Cardno Lawson Treloar on behalf of DoP
6. DWE = NSW Department of Water and Energy

Further to the above, DWE (now DECCW) raise project performance objectives in relation to groundwater. These are summarised in Table 2 which provides a description of the response taken in this report.

Table 2: DWE key project performance objectives.

Item	Principle	Response / Design Action
1	Activities that pose a pollution risk to groundwater should be avoided	o Minimise pollutant generation within the catchment. o Treat all stormwater to levels equal to or better than groundwater concentrations prior to groundwater recharge.
2	Necessary on-site stormwater treatment devices are to be installed to ensure removal of potential pollutants before stormwaters enter the groundwater.	o Treat all stormwater to levels equal to or better than groundwater concentrations prior to groundwater recharge.
3	The quality of any water entering the groundwater aquifer shall be equal to or better than the quality of the receiving groundwater.	o Treat all stormwater to levels equal to or better than groundwater concentrations prior to groundwater recharge.
4	The preparation and implementation of satisfactory plans for stormwater management, groundwater monitoring and contingency strategies.	o Prepare groundwater monitoring network strategy (construction and operational stages) and contingency strategies.
5	Contingency plans shall include trigger values, remediation strategies and communication strategies for events that have the potential to contaminate groundwater. A monitoring networks / reporting program is to be linked to the contingency plan.	o Develop trigger values together with remediation and communication strategy.
6	Identification of responsibilities for monitoring, assessment, contingency arrangements, restoration work and maintenance of the monitoring network.	o Identify roles and responsibilities for groundwater management strategy.

3 Hydrogeological Investigation

3.1 Regional Groundwater Context

3.1.1 Water Sharing Plan

The Site lies within the Stockton Groundwater Source and is therefore subject to management under the Water Sharing Plan for the 'Tomago Tomaree Stockton Groundwater Sources' (DIPNR, 2003). The Water Sharing Plan area covers an area of 275 km^2 and is comprised of three sub-aquifers which each occupy an individual sand member. Sand members include the Tomago Sand, Tomaree Sand and Stockton Sand (which covers the site) members.

The Stockton Sand Member covers an area of approximately 80 km^2 along the coastline between Newcastle and Port Stephens including the study area. It is characterised as an outer barrier dune system which has a series of dunes running parallel to the coast with intervening lowland swales which tend to swamps or groundwater 'window lakes' in some areas. Details are provided in Attachment A.

3.1.2 Water Bearing Strata

Water bearing strata consist generally of unconfined medium grained quartz coastal sand. Aquifer(s) are predominantly confined although semi-confined systems can occur in small isolated areas due to humic deposits in sand layers associated with ancient water tables (Australian Natural Resource Atlas, 2009).

3.1.3 Salinity

Average salinity for the Tomago, Stockton and Tomaree aquifers is 150 mg/L (Australian Natural Resource Atlas, 2009).

3.1.4 Recharge

The Australian Natural Resource Atlas (2009) indicates that recharge as a proportion of annual rainfall was estimated at 30% for the Stockton and Tomaree Sandbed aquifers and 20% for the Tomago sandbeds. According to the Australian Natural Resource Atlas (2009), the sustainable yield is 70% (30% environmental reserve) of the estimated long-term average rainfall. This equates to a sustainable yield of 45,000 ML/yr for the Tomago, Stockton and Tomaree aquifers.

3.1.5 Hydraulic Conductivity (K)

The aquifer(s) in the region of the site are characterised by high K values which are typical of medium grained quartz sand. Published K

values for the Stockton Aquifer are limited, however, Umwelt (2009) utilised a pre-calibration K range of 10 – 30 m/d and final calibrated K value of 10 m/d in a groundwater model which was developed to accompany an EA for a proposed sand quarry. The proposed sand quarry was located approximately 10 km to the east north east of the site within the Stockton dune complex.

A groundwater model developed by SKM (2009) for the Tomago Aquifer utilised a K value of 3 m/d which was based on field testing. Geary (2003) reported that the typical K range for the Tomago Aquifer is 10 – 20 m/d.

The typical likely range of K values for medium grained sand is 8 – 18 m/d and 18 – 80 m/d for course sand (Bair and Lahm, 2006).

Based on the above K can be expected to be of the order of 3 – 80 m/d over the broader region. Values at the upper end of this range are expected in the vicinity of the site as outer barrier deposits associated with the Stockton Sandbeds are likely to be more course grained than the inner barrier deposits which comprise the Tomago Sandbeds.

3.2 Previous Investigations

3.2.1 Overview

A range of investigations relating to groundwater conditions at the site have been undertaken since approximately 1992. These have been briefly summarised by Coffey Geotechnics Pty Ltd in their advice attached to the EAR (12 November, 2007). Studies have included:

1. Coffey Partners International Pty ltd (June 1992) *Fern Bay engineering Study Stage 1 Report*

2. Coffey Partners International Pty Ltd (January 1996) *Assessment of Groundwater Quality and Acid Sulphate Soils*

3. Coffey Partners International (July 1996) *Additional Geotechnical Work*

4. Douglas Partners Pty Ltd (1998) *Geotechnical Investigations*

5. RCA Australia Pty Ltd (2006) *Geotechnical Investigations Entry road*

6. Parsons Brinkerhoff (2006) *Geotechnical Investigation for Sub-division*

7. Coffey Geotechnics (2008) *Fern Bay Seaside Village Sub-division, Fern Bay*

It is noted that the Coffey Geotechnics letter of 12 November 2007 submitted with the EAR indicates that 7 monitoring piezometers were to be installed on about 19 November 2007. Results for these tests are documented in the Coffey Geotechnics 2008 report. Martens & Associates have inspected these piezometers and confirm their installation and that these had been surveyed to mAHD by DMS Surveys.

3.2.2 Groundwater Levels

Groundwater levels at the site were monitored at various locations within the study area by Coffey Partners International (1992) for the period 24.01.1992 – 28.12.1992. A summary of results is provided Table 3 and indicate that groundwater tables are expected to fluctuate in the range of 0.2 – 0.6 m across the site.

Unfortunately at the time of preparing this report, it was not possible to determine the locations of these boreholes and cross-reference these measurements with the current piezometer monitoring data. However, the data is still useful in that it demonstrates that in the low lying areas (< 2 mAHD, eg. bore holes 7, 13, 14, 15 and 22) groundwater levels fluctuate between 0.2 and 0.4 m in response to varying rainfall / evapotranspiration conditions.

Table 3: Summary of site groundwater level monitoring data for period 24.01.1992 – 28.12.1992 (Coffey Partners International Pty Ltd, 1992).

Bore Hole No.	Approx RL (mAHD)	Low (mAHD)	High (mAHD)	Range (m)
3	3.6	1.6	2.0	0.4
7	1.7	0.8	1.2	0.4
8	2.7	1.7	2.0	0.3
9	3.3	1.5	1.7	0.2
10	3.1	1.6	1.9	0.3
11	3.3	1.4	1.8	0.4
12	2.7	1.5	1.8	0.3
13	1.5	1.0	1.3	0.3
14	1.7	1.2	1.5	0.3
15	1.7	1.2	1.6	0.4
17	2.4	1.7	2.0	0.3
18	2.3	1.4	2.0	0.6
19	2.6	1.6	1.9	0.3
20	5.8	1.8	2.1	0.3
21	4.8	1.6	1.8	0.2
22	1.9	1.0	1.4	0.4

Coffey Geotechnics collected additional groundwater level data on 28.11.2007 following submission of the EAR. These data were collected

from a new monitoring network of 7 piezometers (see Attachment A for locations). Groundwater level observations are summarised in Table 4.

Table 4: Summary of site groundwater level monitoring data on 28.11.2007 (Coffey Geotechnics, 2008).

Site	Surface Level (mAHD)	Depth to Groundwater (m)	Groundwater Level (mAHD)
BH101	5.20	3.50	1.70
BH102	3.67	1.95	1.72
BH103	2.79	1.05	1.74
BH104	1.34	0.05	1.29
BH105	4.24	2.60	1.64
BH106	3.00	1.60	1.40
BH107	2.39	1.00	1.39

3.2.3 Groundwater Quality

Coffey Partners International Pty Ltd (1996) have reported limited groundwater quality data for the site based on measurements made at 3 separate boreholes during June 1996. Groundwater quality data are summarised in Table 5 and indicate generally acidic fresh water with elevated nutrient (nitrate and phosphorus) content. The source of nutrients in groundwater was not determined by the Coffey's 1996 investigation, although we expect that these represent background *in-situ* conditions given that the site was largely undeveloped at the time of investigation.

Further to the above, we note that the data presented by Coffey's 1996 investigation indicates that site groundwater does not provide a suitable potable groundwater resource without considerable further treatment due to high total organic carbon and total phosphorus concentrations, and acidic pH levels.

Table 5: Site groundwater quality data collected June 1996 (Coffey Partners International Pty Ltd, 1996).

	Bore Hole Site			
Parameter	CMPS13	CMPS14	CMPS15	Average
Water Table Level (mAHD)	1.80	1.05	0.95	1.27
Total Organic Carbon (mg/L)	0.78	0.65	1.90	1.11
Total Dissolved Salts (mg/L)	210	175	110	165
Nitrate (mg/L)	1.10	0.27	0.22	0.53
Total Phosphorus (mg/L)	0.19	0.16	0.34	0.23
Alkalinity as CaCO3 (mg/L)	< 1	< 1	< 1	< 1
pH	4.90	5.00	4.70	4.87
Dissolved Oxygen (mg/L)	0.00	0.00	0.00	0.00
Conductivity (µS/cm)	400	300	200	300

3.2.4 Permeability and Infiltration Rates

A summary of relevant previously reported data in relation to aquifer permeability and surface infiltration rates is provided Table 6.

Table 6: Site groundwater quality data collected June 1996 (Coffey Partners International Pty Ltd, 1996).

Parameter	Source	Range
Transmissivity (m^2/d)	Coffey Partners International Pty Ltd, 1992	> 600
Hydraulic Conductivity (m/d)	Coffey Partners International Pty Ltd, 1992	20-30
Surface Infiltration Rate (m/d)	Coffey Partners International Pty Ltd, 1996	4-20

3.3 Supplementary Investigations

3.3.1 Field Works

Supplementary groundwater field investigations were undertaken as a part of this study to provide information in addition to already existing groundwater data. The following works were conducted:

1. Walk over by an experienced hydrogeologist and geotechnical engineer of the site and inspection of existing monitoring piezometers previously installed by Coffey Geotechnics in November 2007.

2. Installation of 5 new monitoring piezometers between 31 August 2009 and 1 September 2009 by truck mounted drilling rig using continuous flight augers to varying depths. All piezometers were screened to 3 m, cased and capped.

3. Geotechnical logging of all boreholes.

4. Groundwater sampling at 10 locations including 5 of the Coffey piezometers (101, 102, 104, 105 and 106) and the 5 new piezometers (GWA, GWB, GWC, GWD, GWE). A range of analyses were undertaken including general water chemistry, salinity and nutrients.

5. Collection of various soil samples from existing and proposed infiltration basin sites.

6. Installation of 7 high resolution continuous groundwater level data loggers ('Divers') including 4 level only Divers at piezometers 104, 105, GWC and GWE, and 3 level and salinity Divers at piezometers 101, GWA and GWD. Monitoring period for these Divers was 1 September 2009 – 9 November 2009.

3.3.2 Sub-surface Conditions

The site is underlain by varying marine and Holocene aeolian sand deposits. Review of previous geotechnical data collected by others and the most recent piezometer installations (see Attachment B) indicate a typical profile is characterised in Table 7. Total sand thickness below the site varies up to 40 m.

Table 7: Typical sub-surface conditions.

Unit	Source	Typical Depth (m)
1a	TOPSOIL – Silty SAND, fine to medium grained, grey with traces of organics (roots) in areas where vegetation exists	0.1 – 0.3
2a	AEOLIAN – SAND, fine to medium grained, light brown to brown and light grey to grey, depth varies depending on dune height	to 15
3a	INDURATED – SAND, fine to medium grained, light brown to brown, some silt	to 10

Soil and rock type beneath the Stockton Sandbed group has not been investigated. However, RCA (2007) suggest that a layer of Pleistocene estuary deposits (clays) underlie the sands of the Stockton Sandbed group.

3.3.3 Monitoring Piezometer Network

The monitoring piezometer network used to collect groundwater data and calibrate the groundwater model consisted of:

Coffey Geotechnics sites: 101, 102, 103, 104, 105, 106 and 107
Installed 28.11.2007

Martens & Associates sites: GWA, GWB, GWC, GWD and GWE
Installed 31.08.2009 – 01.09.2009

Details of each monitoring piezometer are provided in Table 8.

Table 8: Site monitoring piezometer network details.

Site	Surface Elevation (mAHD)	Depth Drilled (m)	Total GMB Depth (mBGL)	Screen Interval (mBGL)	Screened Inserted Into
BH101	5.20	8.8	8.75	5.75-8.75	Sand
BH102	3.67	8.8	8.75	5.75-8.75	Sand
BH103	2.79	5.5	5.25	2.25-5.25	Sand
BH104	1.34	2.0	1.95	0.00-1.95	Organic silt/sand
BH105	4.24	8.8	8.75	5.75-8.75	Sand
BH106	3.00	4.0	3.95	0.95-1.95	Sand
BH107	2.39	4.0	3.95	0.95-3.95	Sand
GWA	1.55	5.5	3.78	2.28-3.78	Sand
GWB	3.41	7.0	3.36	1.86-3.36	Sand
GWC	3.09	7.0	4.30	2.80-4.30	Sand
GWD	1.79	5.5	4.30	2.80-4.30	Sand
GWE	2.38	5.5	2.90	1.40-2.90	Silty Sand

3.3.4 Manual Groundwater Level Measurement

Manual piezometer water level measurement (ie. dip measurements) made with the monitoring network are summarised in Table 9. Data indicate reasonably uniform groundwater levels between periods with maximum fluctuations in the range of 0.1 m. These fluctuations are slightly lower than those reported by Coffey Partners International (1992) which were typically 0.2-0.4 m.

Figure 6 provides a plot of surface level against mean groundwater depth (below ground level, mBGL) and mean groundwater level (mAHD). The figure shows that ground water levels are generally very low and insensitive to elevation indicating that site earthworks are not expected to have a significant effect on groundwater levels and flow directions.

Table 9: Manual groundwater level measurements (mAHD).

Site	28.11.2007 [1]	29.08.2009 [2]	01.09.2009 [2]	09.09.2009 [2]
BH101	1.70	1.80	1.76	
BH102	1.72	1.77	1.75	
BH103	1.74	1.74	1.72	
BH104	1.24	0.87	1.26	
BH105	1.64	1.69	1.67	
BH106	1.40	1.45		
BH107	1.39	1.48		
GWA			1.14	
GWB			1.63	1.62
BWC			1.55	
GWD			1.66	
GWE			1.66	

[1.] Measurements taken by Coffey. [2.] Measurements taken by Martens and Associates.

3.3.5 Continuous Level Measurements

Continuous monitoring of groundwater level at 15 minute intervals was completed at 6 monitoring stations with the Diver installed at site 106 failing during the monitoring period. During the 2 month monitoring period, some 94.2 mm of rain fell over the site, enabling an assessment of the impact of rainfall on transient groundwater conditions. Monitoring also enabled the impact of ocean tidal cycles to be observed on site ground water conditions.

Results of the monitoring are provided in Figure 7 which provides a plot of groundwater level at each monitoring station together with a plot of daily rainfall received at the site. Rainfall data were taken as 24 hour rainfall totals at 9am from Newcastle Nobbys Signal Station which is located approximately 5.4 km's from site. In addition to the raw data plot, Figure 8 provides a plot of mean daily groundwater residual levels (ie. level relative to mean monitoring period level and excluding tidal effects) in order that data can be easily compared. Comments on the data are as follows:

1. Rainfall did not appear to have a significant effect on most of the monitoring sites. During the period of October 3 to 10, there were several small rainfall events ranging between approximately 4 and 10 mm. These resulted in a minor rise of approximately 100 mm in water table height at sites 104 and GWA without about 1 day of rainfall. These sites are both low lying and adjacent to Nelson Bay Road. In these areas, relatively rapid responses appear to reflect the influence of local surface water conditions and subsequent

interaction with local groundwater.

2. Groundwater response to rainfall at other monitoring sites located within the primary sand complex and away from Nelson Bay Road, was delayed by approximately 2 weeks with a cumulative rainfall total of 41 mm resulting in a mean water table rise of approximately 70-80 mm. On this basis, a 100 mm rainfall event could conceivably increase groundwater levels temporarily by up to 200 mm for a 2-3 day period.

3. Tidal influence on groundwater level was observed at all monitoring sites. The influence was most marked at Piezometer 104 which showed semi-diurnal groundwater level fluctuations in the range of 100 mm/day. At other monitoring sites, fluctuations were diurnal in the range of 20-50 mm/day. These tide related fluctuations are attributed to changing ocean levels affecting local hydraulic gradients and therefore groundwater discharge rates.

4. The presence of a strong tidal signal throughout the site reflects the high hydraulic conductivity of the underlying aquifer.

3.3.6 Hydraulic Conductivity

Slug testing was undertaken from a number of monitoring piezometers throughout the study area on the 1st September, 2009. Tests were undertaken by either adding or withdrawing a 20 L to / from the aquifer. All responses were monitored automatically using an in-borehole Diver. Results are provided in Table 10 and compare well to previous site testing reported by Coffey Partners International Pty Ltd (1992).

Table 10: Slug testing results for 01.09.2009.

GMB	K Estimate (m/d)
101	14.09
106	7.07
107	60.52
GWA	108.44
GWB	12.68
GWC	13.55
GWD	9.11
GWE	13.55
Geometric Mean	18.06

3.3.7 Groundwater Quality

Groundwater quality data were collected on 18.09.2009 from various site monitoring piezometers. A summary of results is provided in Table 11 with detailed laboratory data provided in Attachment E.

Table 11: Groundwater sampling results for site monitoring piezometers (18.09.2009)

Site	101	102	104	105	106	GWA	GWB	GWC	GWD	GWE	Mean
Calcium - Dissolved	1.5	1.0	2.2	0.9	6.0	4.5	1.0	3.4	4.9	1.0	2.6
Potassium - Dissolved	1.9	1.2	2.1	3.7	1.6	1.2	3.9	1.7	2.2	1.5	2.1
Sodium - Dissolved	34.0	30.0	100.0	32.0	19.0	28.0	13.0	34.0	42.0	25.0	35.7
Magnesium - Dissolved	3.1	2.0	9.4	1.3	3.3	4.9	2.3	5.5	5.9	2.8	4.0
Hydroxide Alkalinity (OH-)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity	<0.1	<0.1	<0.1	3.0	3.0	3.0	<0.1	<0.1	<0.1	<0.1	1.0
Carbonate Alkalinity	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity	<0.1	<0.1	<0.1	3.0	3.0	3.0	<0.1	<0.1	<0.1	<0.1	1.0
Sulphate, SO4	9.0	8.0	30.0	16.0	7.0	11.0	6.0	15.0	28.0	<5	13.5
Chloride (titration)	49.0	57.0	180.0	62.0	51.0	62.0	23.0	72.0	81.0	55.0	69.2
Ionic Balance (%)	8.1	-6.9	-4.2	-13.0	-6.4	-4.0	7.5	-4.3	-4.6	-4.9	-3.3
pH	5.6	5.2	3.7	5.3	5.3	5.6	5.2	4.4	5.0	4.6	5.0
EC (µS/cm)	175	150	590	140	140	190	83	210	270	140	209
Total Dissolved Solids	195	210	470	410	160	140	170	210	200	160	233
NOx as N in water	<0.2	<0.2	1.0	0.3	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3
TKN in water	1.15	1.00	14.00	3.30	2.90	0.90	1.50	1.00	<0.5	5.60	3.20
Ammonia as N in water	0.25	0.30	0.30	0.80	0.30	0.40	0.60	0.50	0.20	0.50	0.42
Total Nitrogen	1.35	1.20	15.00	3.60	1.55	0.55	0.85	0.60	0.35	2.90	2.80
Phosphorus - Total	<0.05	<0.05	0.21	0.10	0.13	<0.05	0.09	<0.05	<0.05	0.44	0.14
Phosphorus - Dissolved	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05

Comments are as follows:

1. Groundwater chemistry is relatively uniform throughout the study area.

2. Groundwater conditions are fresh with electrical conductivity (EC) ranging between 83 – 590 µS/cm. These data compare well with previously reported data of Coffey Partners International (1996).

3. Nutrient levels are elevated with mean Total Nitrogen being 2.80 mg/L and mean Total Phosphorus being 0.14 mg/L. These data compare well with previously reported data of Coffey Partners International (1996) which also showed elevated nutrient levels despite relatively undeveloped site conditions.

3.3.8 Time Varying Salinity Conditions

At monitoring piezometers 101, GWA and GWD, CTD Divers were installed for the continuous monitoring period in order that time varying salinity levels could be observed. Recorded data are provided in Figure 9 and indicate relatively constant salinity levels within the aquifer. A minor decrease in salinity (ie. electrical conductivity) was observed at site GWA, possibly in relation to rainfall. However, similar minor deviations in response to rainfall were not observed at sites 101 and GWD.

3.4 Groundwater Modelling

3.4.1 Model Development Approach

To assist with determining the spatial extent and variability of groundwater resources below the site, a series of groundwater models of the study area, extending to the Hunter River in the west and the Pacific Ocean in the east were developed Using Visual MODFLOW 2009.1 Pro. MODFLOW is a 3D modelling platform that is capable of simulating groundwater flow through porous media under both steady state (ie. fixed time instance) and transient (ie. time varying) boundary conditions. The following scenarios were modelled as part of this investigation:

Model 1 (M1): Existing Conditions (steady state)
Using past and the current site geotechnical data, a single layered steady state model was developed. The primary purpose of the model was to enable calibration of the various MODFLOW boundary conditions in order that more detailed transient modelling could be undertaken.

Model 2 (M2): Existing Conditions (transient)
Using model M1 as the calibrated basis for transient modelling, model M2 was developed to determine existing time varying (ie. transient) aquifer behaviour. The transient simulation period was taken on the basis of historical rainfall data being 1950 – 2009 (60 years).

Model 3 (M3): Developed Conditions (steady state)
Model 3 was developed to examine the impact of the proposed development on steady state groundwater conditions. In particular, model M3 reduced recharge rates within the urban footprint and locally increased recharge rates (on the basis of bulk water balances) at each of the site sub-catchment discharge locations.

Model 4 (M4): Developed Conditions (transient)
Model 4 was developed to examine the impact of the proposed development on transient groundwater conditions with calibration being essentially similar to model M3. Simulation period was taken on the basis of historical rainfall data being 1950 – 2009 (60 years).

Model 5 (M5): Developed Conditions + Sea Level Rise (steady state)
Model M5 was identical to model M3 except that sea level boundary conditions at the Hunter River and the Pacific Ocean were increased to 1 mAHD to simulate potential sea level rise in the coming 100 years.

Model 6 (M6): Developed Conditions + Sea Level Rise (transient)
Model M6 was identical to model M5 except that transient conditions were modelled in order that basin invert levels under sea level rise conditions could be investigated. Simulation period was taken on the basis of historical rainfall data being 1950 – 2009 (60 years).

3.4.2 General Boundary Conditions

Boundary used in the various MODFLOW models are summarised in Table 12. Models assumed essentially homogeneous conditions and no aquifer abstraction. Existing road side drains along Nelson Bay Road were included as boundary conditions.

Table 12: MODFLOW boundary conditions for various modelling scenarios.

Property	Value / Details
Model Area	Approximately 650 ha
Grid cell size	20 x 20 m
Layer thickness	20-50 m
Topography	Adapted from site survey data
Constant head conditions	
Hunter River	0 mAHD increasing to 1 mAHD with sea level rise in 2100
Pacific Ocean	0 mAHD increasing to 1 mAHD with sea level rise in 2100
Model Period	1950 - 2009
Calibration Period	2007-2009
Hydraulic Conductivity (K, m/d)	20 primary aquifer, 25 for unvegetated dunes / beach face
Specific Yield (Sy, %)	10-20
Effective Porosity (%)	15
Total Porosity (%)	30
Recharge (% of rainfall)	10 – 30 (range explored during model calibration)
Evapotranspiration	85 % of pan evaporation

3.4.3 Recharge Rates

Steady state recharge rates for the site were estimated through iteration and modelling convergence procedures. A steady-state recharge value of 260 mm/yr produced the best calibration statistics. This equates to 24% of median annual rainfall and is close to the Australian Natural Resource Atlas (2009) estimate of 30% for the site.

A zone of higher recharge was applied to areas of non-vegetated dune immediately adjacent to the ocean. A steady-state recharge value of 600 mm/yr was assigned after calibration. This equates to 56% of median annual rainfall.

Transient recharge data were derived from historical daily rain data observations taken at Nobby's BOM station (5.4 km from Fern Bay).

For post development conditions, recharge in new urban areas was conservatively reduced to 130 mm/year (ie. 50 % reduction) with the balance 130 mm/year being increased surface runoff to the infiltration basin sites. At each site discharge location, recharge was increased over the proposed infiltration basins by a depth equivalent to the volume of water draining from the sub-catchment to the basin area (eg. 130 mm/year surface runoff from an urban area of 2 ha discharging to a basin with a surface area of 0.75 ha translates to an increase in recharge within the basin of 347 mm/year).

3.4.4 Calibration

Modelled steady state levels were within 0-10 cm of the observed monitoring data, with mean difference between observed and modelled levels being 1.8 cm and standard error of the piezometric surface estimate being 1.7 cm (Figure 12). The calibrated MODFLOW model was deemed to be suitable for extended transient modelling.

3.4.5 Modelled Groundwater Levels – Steady State Models

Steady state modelling results are discussed below:

Model 1 (M1): Existing Conditions (steady state)
Simulation results are provided in Figure 13 which indicate a groundwater divide occurs within approximately the central portion of the site, being aligned approximately in a NE – SW direction. Groundwater reaches maximum heights of approximately 1.7 mAHD at the divide and flows either to the Pacific Ocean to the east or to the Hunter River to the west.

Model 3 (M3): Developed Conditions (steady State)
Simulation results are provided in Figure 14 which

indicate that under developed conditions there will be negligible changes to groundwater conditions. This is demonstrated in Figure 15 which provides a drawdown (ie. water table difference) plot between developed and existing conditions. This demonstrates that changes to mean water table elevations will be of the order of 2 cm.

Model 5 (M5): Developed Conditions + Sea Level Rise (steady state)
Simulation results are provided in Figure 16 which indicate with a sea level rise of 1 m imposed as a boundary condition at the Hunter River and the Pacific Ocean, groundwater levels rise within the site of the order of 0.3 – 0.6 m depending on location.

3.4.6 Modelled Groundwater Levels – Transient Models

Transient modelling results are provided in Figure 17 through to Figure 22 and discussed below:

1. Modelled existing conditions (Model M2) show that groundwater varies across the site by up to approximately 500 mm, depending on seasonal rainfall & recharge variations. This is similar to the range observed by Coffey Partners International Pty Ltd (1992). Individual rainfall events or series of events may affect mean groundwater levels temporarily by of the order of 200-300 mm.

2. A comparison of modelled existing (Model M2) and proposed conditions (Model M4) suggests that there will be little to no observable difference in temporal groundwater regime once the development has been built. This corresponds with steady state modelling observations.

3. A comparison of modelling developed condition (Model M4) and developed condition with 1 m sea level rise (Model M6) indicates that groundwater levels will rise to varying degrees across the site. This corresponds with steady state modelling observations.

3.4.7 Design Inverts for Infiltration Basins

Design basins invert levels have been derived based on transient modelling results for the site. Invert levels are taken from the nearest relevant piezometer site using results for the developed condition with a 1 m sea level rise and are provided in Table 13. This will provide a significant level of conservatism in design of the surface drainage system.

Table 13: Design invert levels for site infiltration basins based on groundwater modelling with sea level rise scenario of 1.0 m (Model M6).

Basin	Typical Piezometer	EAR Invert (mAHD)	Design Invert (mAHD)
1	106	1.35	1.8
2	107	1.35	2.0
3	GWB	1.70	2.5
4	GWA	1.35	1.8
5	102	1.80	2.7
6	101	1.90	2.5

4 Surface Water Hydrology

4.1 Overview

Previous DRAINS surface water hydraulic models prepared by DMS Survey Pty Ltd as part of the EAR were reviewed and modified as part of this study. Primary matters considered / amendments made were as follows:

1. Basin Sizing Details
   All basins were reviewed and updated data for design invert and top water levels were developed.

2. Basin Infiltration Rates
   Basin infiltration rates were reviewed against previous test data, comments received and supplementary field testing data.

3. Catchment Areas
   All catchment areas were reviewed with missing areas (such as those surrounding basin areas) included in the amended model.

4. Road Overland Flow Paths
   All overland flow swales were sized to ensure that overland flows for the 1% AEP flow rate were contained within the drainage swale system.

5. Catchment Parameters
   All catchment parameters, including pervious and impervious percentages, soil properties, areas and gradients were reviewed and modified as required.

6. Full Range of Storm Events
   The hydraulic model was run for a full range of storm events up to and including the 72 hour storm in order that critical durations for peak flow events and [separately] critical durations for peak basin water level events could be determined.

7. Rainfall IFD Data
   Intensity-frequency-duration data were reviewed and amended as part of the hydraulic model development process.

8. Impact of Groundwater Conditions
   Groundwater tail water conditions for a 1 m sea level rise were incorporated into the model.

9. Minimise Drainage Footprint
   The surface water management system has been amended to minimise the drainage footprint, notably in areas outside of the designated urban development footprint.

10. Climate Change
    A model run was prepared which incorporated a 20 % increase in rainfall intensities to accommodate climate change.

4.2 System Design Parameters

4.2.1 Infiltration Basin Works

The site drainage system utilises 6 primary internal discharge locations. These are self draining areas which are termed 'basins' where stormwater is temporarily detailed prior to groundwater infiltration. Some of these areas are existing natural low lying depressions whilst others are to be constructed (or have already been partly constructed). Basin locations and preliminary details are provided in the attached plans and summarised in Table 14. General design requirements are specified as follows:

1. All stormwater outlets to basins shall be fitted with an appropriately sized sediment trapping system to detain sand prior to discharge to the basin. This will prevent basin fouling and maintain infiltration rates.

2. Constructed basins beds will be lined with a 100 mm thick bed of clean durable 20-40 mm aggregate as is common practice in many local government areas in this part of the NSW coastline (see Figure 24 for example at Forster). Aggregate lining will prevent bed revegetation and promote infiltration whilst minimising any on-going maintenance requirements.

3. Where overland swales are to be constructed to reach a basin (ie. basins 4 and 5), these shall also be lined with a 100 mm thick bed of clean durable 20-40 mm aggregate to prevent bed revegetation and promote infiltration whilst minimising any on-going maintenance requirements. Preliminary specifications are provided in Figure 25.

Table 14: Maximum ground water level and preliminary construction requirements at site basins.

Basin ID	Details	Construction Requirements
1	Existing depression / basin with footprint to be slightly modified during development earthworks.	Installation of outlet headwall from site drainage to basin. Sediment trapping structure to be constructed at basin inlet to prevent sediment fouling. Minor localised earthworks.
2	Existing depression / basin with footprint to be slightly modified during development earthworks.	Installation of outlet headwall from site drainage to basin. Sediment trapping structure to be constructed at basin inlet to prevent sediment fouling. Localised earthworks.
3	Partly constructed basin with current invert near final design levels.	Raise bed and create final batters. Sediment trapping structure to be constructed at basin inlet(s) to prevent sediment fouling. Line basin with 100 mm 20-40 mm aggregate to prevent revegetation, reduce maintenance and promote infiltration.
4	Existing depression / basin already receiving discharge from existing development.	Construct overland flow path from sub-catchment to basin with appropriate batters. Sediment trapping structure to be constructed at swale inlet to prevent sediment fouling. Revegetate batters and line overland flow path with 100 mm 20-40 mm aggregate to prevent revegetation and promote infiltration.
5	Existing depression / basin. Drainage swale from site to the basin is proposed. No works on basin proposed.	Construct overland flow path from sub-catchment to basin with appropriate batters. Sediment trapping structure to be constructed at swale inlet to prevent sediment fouling. Revegetate batters and line overland flow path with 100 mm 20-40 mm aggregate to prevent revegetation and promote infiltration.
6	New basin to be constructed. No works have been undertaken at present	Line basin with 100 mm 20-40 mm aggregate to prevent revegetation and promote infiltration. Sediment trapping structure to be constructed at basin inlet to prevent sediment fouling. Revegetate all batters not protected by aggregate.

4.2.2 Basin Infiltration Rates

A design basin infiltration rate of 5 x 10^{-5} m/s (ie. 4.32 m/d) was used for modelling and determined on the basis of the following:

1. Mean groundwater hydraulic conductivity is approximately 20 m/d. Adopting 4.32 m/d for infiltration provides a factor of safety (FOS) of approximately 5 against future potential surface clogging. This is consistent with the soil material existing at the site, including that

within the existing low lying areas.

2. Where natural basins / low lying areas are used for infiltration, these basins have very large surface areas relative to the developed catchment draining to the basin ensuring that there is adequate capacity to accommodate any minor underestimates in infiltration rate.

3. Basins which are small relative to catchment area (ie. Basin 3 and 6) will be lined with aggregate to prevent revegetation and ensure long-term high infiltration rates.

4. Overland flow paths to basins 5 and 4 will also be lined with aggregate to prevent revegetation and ensure long-term high infiltration rates. These have not been included in the modelling.

5. Assumed basin bottom water levels (BWL) are taken as the high groundwater level under a 1 m sea level rise. This means that the majority of basins maintain a considerable buffer between actual basin invert or mean ponded water level and the assumed BWL.

4.2.3 On-site Stormwater Detention Requirements

On the basis of all site drainage being contained to internal draining basins and not to any existing Council or other public infrastructure, it is not considered necessary to provide on-site stormwater detention as a part of the surface drainage scheme. This matter was discussed with NSW DoP's consultants and was agreed as an appropriate means of managing surface water from the site.

4.2.4 Catchments

Catchment boundaries are shown on the concept stormwater catchment plan provided in the attached plans. Total area, total pervious area and impervious area of each primary catchment [draining to a basin] are summarised in Table 15.

Table 15: Summary of catchment details in DRAINS model**.**

Catchment	Total area (ha)	Total Pervious area (ha)	Total Impervious area (ha)
1	10.16	8.55	1.43
2	12.56	5.66	3.90
3	21.16	13.09	8.07
4	41.72	28.37	13.35
5	34.20	28.54	5.37
6	20.17	15.25	4.92

Assumptions of pervious and impervious area in catchments in DRAINS modelling are provided in Table 16.

Table 16: Summary of pervious and impervious area of catchment in DRAINS model.

Area	Pervious (%)	Impervious (%)
Road[1]	0	100
Allotment	40	60
Commercial space	40	60
Reserve area	100	0
Road strip	100	0
Roadside swale	100	0
Up-slope undeveloped area	100	0

[1] All roads are assumed to be 6 m wide

4.2.5 Modelling Approach

The DRAINS hydrological and hydraulic modelling program was used to determine the developed peak discharge rates under post-development conditions for design storm events. The following matters are noted:

- 21 1 % AEP storm events were simulated with durations ranging from 5 mins to 72 hours.
- Overland drainage within the development is to be serviced by swales of varying sizes.
- To simulate the effect of climate change, the post-development model was re-run using a 20 % increase in rainfall intensity data for the critical storm durations.
- An amended concept site drainage plan is provided in the attached plans.
- DRAINS soil type 1 was used to reflect the sand soils at the site.
- Paved and supplementary depression storages were taken as 1 mm while grassed areas were attributed a depression storage of 20 mm.
- Pervious and impervious catchment percentages were calculated on a sub-catchment by sub-catchment basis.

4.2.6 Rainfall data

IFD data taken from Fern Bay used in DRAINS model is summarised in Table 17.

Table 17: IFD data used in DRAINS model.

Element	IFD Data
1 Hour Rainfall Intensity (mm/hr) - 2 Year	34
12 Hour Rainfall Intensity (mm/hr) - 2 Year	6.9
72 Hour Rainfall Intensity (mm/hr) - 2 Year	2.33
1 Hour Rainfall Intensity (mm/hr) - 50 Year	65.2
12 Hour Rainfall Intensity (mm/hr) - 50 Year	13.6
72 Hour Rainfall Intensity (mm/hr) - 50 Year	4.7
G	0.02
F2	4.315
F50	16.05

4.3 Modelling Results

4.3.1 1% AEP Event – No Climate Change

Results for 1% AEP storm event at each basin site is provided in Table 18. These show peak water levels and maximum storage levels during the critical storm duration event.

Notably, in the case of Basin 4 which is located adjacent to Nelson Bay Road, modelling indicates that there will not be any measureable change in water level (about 1 cm in the 1% AEP event) due to the development.

Table 18: Results for 1% AEP storm event at each basin site under developed conditions with no climate change.

Basin	Peak Water Level[1] (mAHD)	Maximum Ponded Volume[1] (m^3)	Critical Storm Duration for Peak Water Level me (hr)	Peak Inflow Rate (m^3/s) (all 1hr event)
1	1.80	0	ALL	0.39
2	2.04	426.6	1.5	0.83
3	3.09	4419.7	3.0	1.83
4	1.81	274.3	1.5	3.50
5	2.73	509.3	1.0	1.08
6	2.98	2415.9	2.0	1.20

[1] Peak water level assuming invert is at peak ground water level with 1m sea level rise.

4.3.2 1 % AEP Event – With Climate Change

Results for 1% AEP storm event with 20 % increase in storm intensity (for climate change) at each basin site is provided in Table 19. These show

peak water levels and maximum storage levels during the critical storm duration event.

Table 19: Results for 1% AEP storm event at each basin site under developed conditions with climate change.

Basin	Peak Water Level[1] (mAHD)	Maximum Ponded Volume[1] (m^3)	Critical Storm Duration for Peak Water Level me (hr)	Peak Inflow Rate (m^3/s) (all 1hr event)
1	1.80	Negligible	na	0.49
2	2.08	884.0	1.5	1.04
3	3.28	5952.7	3.0	2.29
4	1.81	485.7	1.5	4.21
5	2.76	1067.0	1.0	1.37
6	3.12	3189.7	2.0	1.51

[1] Peak water level assuming invert is at peak ground water level with 1m sea level rise.

4.3.3 Design Levels

Design basin levels based on hydraulic modelling are provided Table 27. These have been reproduced in the attached site plans.

Table 20: Basin water levels and inverts.

Basin ID	Base Area (m^2)	IWL	BWL	TWL
1	27880	1.35	1.80	1.80
2	10970	1.35	2.00	2.08
3	7000	2.30	2.50	3.28
4	52870	1.35	1.80	1.81
5	15050	2.50	2.70	2.76
6	4500	2.50	2.50	3.12

IWL = Design basin invert level or existing mean ponded water level.
BWL = Assumed level at high groundwater condition with 1 m sea level rise.
TWL = Peak water level during critical storm event above the groundwater level with 1 m sea level rise and including climate change effect (20 rainfall intensity increase).

Placing the above design levels within the context of existing development levels, typical road levels at existing site low points range between 2.2 – 2.7 mAHD. Low elevation drainage outlets typically maintain inverts which are range between 1.2 and 1.3 mAHD. In some instances this has left existing stormwater outlets partially submerged by 100-200 mm (eg. as is the case at the outlet located at the northern

end of Wingen Street draining into the low lying swamp area where outlet inverts are approximately 1.2 m and mean standing water level is approximately 1.35 mAHD).

The amended design levels for basin inlet inverts, and therefore for the site drainage system will be significantly more elevated above existing and future (under climate change) groundwater levels. This will ensure a robust surface drainage system not subject to potential failure due to intermittently rising groundwater tables.

4.3.4 Road Drainage

The concept drainage plan provided in the attached plans provides the locations for Type 1, Type 2 and Type 3 swales. Swale type details are provided in Figure 23. Swales have been sized to contain / accommodate the 1% AEP storm flow event such that there is no spillage to adjoining site allotments.

4.3.5 Basin 3 Spillway

We understand that a 4WD access track has been provided at the southern extremity of Basin 3. The lowest point at the access track provides a level of 3.6 mAHD. We have reviewed levels within this basin and make the following observations:

1. Critical storm duration (producing maximum water level) is 3 hours.

2. 500 year storm level with climate change rainfall intensity increase of 20 % is 3.50 mAHD.

3. The spill way is not likely to overtop for the range of events up to the 1 in 500 year ARI event.

5 Water Quality Management

5.1 Approach

A concept stormwater quality management strategy has been prepared for the development. The strategy aims to ensure that stormwater management within the development is best practice engineering, ecologically sustainable and complies with the relevant standards.

An assessment of existing, post-development without treatment and post-development with treatment measures has been completed using the 'MUSIC' urban stormwater computer modelling programme. Stormwater control and treatment structures have been recommended on the basis of the results of this modelling.

Finally we note that the modelling that was undertaken as part of the EAR has been fully reviewed and amended. This work should be taken to replace the previous work.

5.2 Relevant Policies and Guidelines

The following specific planning controls, policy objectives and design principles have been considered in the development of this concept stormwater management strategy.

5.2.1 PSC Water Quality Management Plan 2003

The Port Stephens Council (PSC) Urban Stormwater and Rural Water Quality Management Plan (2003) document outlines qualitative long-term and short-term water quality objectives for the Port Stephens LGA. Long-term qualitative stormwater quality objectives are:

- *"To meet 90% of samples ANZECC faecal coliform, nitrogen and phosphorus guidelines for ambient water quality at the outlet of urban stormwater drains..";*
- *"To maximise the value of riparian, terrestrial, foreshore, floodplain and wetland vegetation";* and
- *"To maximise stormwater re-use and infiltration opportunities in the Port Stephens LGA".*

The following specific qualitative objectives apply to the Fern Bay area:

- *"To minimise the impacts of developments on receiving waters";* and

- *"The minimisation of the impacts of stormwater on community health and safety"*

Quantitative performance objectives for stormwater pollutant retention in new urban developments are reproduced in Table 21.

Table 21: Stormwater pollutant retention performance objectives for new urban developments (PSC, 2003).

Pollutant	Retention Criteria[1]
Coarse sediment	80% of average annual load for particles ≤ 0.5 mm
Fine particles	50% of average annual load for particles ≤ 0.1 mm
Total Phosphorus	45% of average annual pollutant load
Total Nitrogen	45% of average annual pollutant load
Litter / gross pollutants	70% of average annual litter load ≥ 5 mm
Hydrocarbons	90% of average annual pollutant load

1. For all flows up to and including 25% of the 1 in 1 year ARI peak flow for the development site.

5.2.2 PSC Development Control Plan 2007

There are no specific water quality objectives relating to stormwater in the Port Stephens Council DCP 2007. However, this document does detail general requirements for roads and drainage for urban subdivisions in the Port Stephens LGA including minimum road reserve and verge widths and provisions for stormwater infrastructure.

5.2.3 Other Guidelines

Managing Urban Stormwater: Treatment Techniques (NSW EPA, 1997).

This guideline provides guidance to stormwater planners and designers on the selection and functional (or conceptual) design of a range of structural stormwater quality management practices. The stormwater management plan presented in this report has been designed with consideration of this guideline.

National Water Quality Management Strategy. Australian Guidelines for Urban Stormwater Management (ANZECC, 2000).

This document provides a strategic framework for the appropriate integrated management of urban stormwater quality for the protection of public health and the environment. The main objective of this strategy is:

> *"To achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development."*

Water Sensitive Urban Design (WSUD).

Water Sensitive Urban Design (WSUD) is a philosophical approach to urban planning and design that aims to minimise the hydrological impacts of urban development on the surrounding environment. Stormwater management is an integral part of WSUD, directed at flood control, flow management, water quality improvements and opportunities to harvest stormwater and implement water conservation measures.

Key planning and design objectives encapsulated in Best Practice Water Sensitive Urban Design are to:

- *Protect and enhance natural water systems.*
- *Integrate stormwater treatment into the landscape by incorporating multiple use corridors that maximise the visual and recreational amenity of the development.*
- *Protect water quality draining from developments.*
- *Reduce runoff and peak flows from developments by employing local detention measures and minimising impervious areas.*
- *Add value while minimising drainage infrastructure development costs.*
- *Provide an effective water conservation strategy, with consideration to wastewater and stormwater re-use and water demand reduction measures.*

5.3 Adopted Performance Objectives

The concept stormwater management strategy has been designed to meet the following water quality objectives:

1. Objective 1: Pollutant Retention Targets
   To comply with the pollutant retention criteria specified by Port Stephens Council as documented in Table 21.

2. Objective 2: Protection of the Groundwater System
   To ensure that the average concentration of pollutants (notably nutrients) in site stormwater discharges should not be greater than the existing average concentration of these pollutants in local groundwater thus ensuring that no adverse impacts on local surface and groundwater quality.

3. Objective 3: Non-reliance On End-of-Line Treatment Measures
   To ensure that all water quality treatment occurs upstream of

proposed stormwater infiltration basins / areas which ensures that these areas are treated as 'receiving waters'.

5.4 Water Quality Management Strategy

5.4.1 Modelling Overview

The Model for Urban Stormwater Improvement Conceptualisation computer modelling application (MUSIC version 3.0) developed by the Cooperative Research Centre (CRC) for Catchment Hydrology was utilised to evaluate pre-development and post-development key pollutant loads and concentrations emanating from the site. Although the model is not a precise engineering tool, it provides a useful mechanism for investigating and refining the performance of a stormwater management scheme so that best management practices are achieved at a site.

5.4.2 Modelling Scenarios

Three site scenarios were modelled;

1. Pre-development (existing) conditions.
2. Post-development - Untreated conditions without any water quality treatment structures.
3. Post-development - Treated conditions based on the proposed site development with stormwater treatment measures.

Modelling scenario 3 was undertaken iteratively in order to ensure that water quality and stormwater management objectives were met. Modelling layouts for each scenario are provided in the attached site plans.

5.4.3 Pollutant Generation Rates

Pollutant event mean concentrations (EMC's) for each land-use type adopted in the MUSIC models are provided in Table 22.

Table 22: Adopted EMCs for MUSIC modelling by land-use category.

		Storm Flow		Base Flow	
Landuse	**Parameter**	**Log (mean)**	**EMC (mg/L)**	**Log (mean)**	**BC (mg/L)**
Urban – Residential	TN	0.447	2.800	0.114	1.300
	TP	-0.495	0.320	-0.842	0.144
	TSS	2.146	140.0	1.699	50.0
Urban Roads	TN	0.342	2.200	0.041	1.100
	TP	-0.666	0.216	-1.178	0.066
	TSS	2.398	250.0	1.944	88.0
Forest	TN	-0.086	0.820	-0.432	0.370
	TP	-1.234	0.058	-1.578	0.026
	TSS	1.903	80.0	1.602	40.0

[1] EMC values are derived from Australian Runoff Quality (Engineers Australia, 2006) and Bui *et al.* (November, 2002).

5.4.4 MUSIC Model Catchments

Table 23 and Table 24 provide MUSIC model sub-catchment land-use summaries for both existing and developed (untreated and treated) conditions. Post-development catchments were further split into smaller sub-catchments to more accurately assess pollutant generation rates and proposed treatment measures.

It is noted that areas within the site not proposed to be developed were excluded from the model as pollutant generation rates in these areas are not anticipated to change from existing conditions to post development conditions. These areas are also predominantly forested dunes with limited potential for additional pollutant load creation.

Table 23: Summary of MUSIC model catchments for existing conditions.

Catchment	Land-Use Category	MUSIC Node	Area (ha)	Pervious (%)	Impervious (%)
1 – Existing	Forest	Forest	4.294	100.0	0.0
2 – Existing	Forest	Forest	9.262	100.0	0.0
3 – Existing	Forest	Forest	18.907	100.0	0.0
4 – Existing	Forest	Forest	20.356	100.0	0.0
5 – Existing	Forest	Forest	16.669	100.0	0.0
6 – Existing	Forest	Forest	12.529	100.0	0.0

Table 24: Summary of MUSIC model catchments for proposed conditions.

Catchment	Land-Use Category	MUSIC Node	Area (ha)	Pervious (%)	Impervious (%)
1 – Urban	Urban – Residential	Urban	3.763	71.3	28.7
1 – Roads	Urban – Roads	Urban	0.531	0.0	100.0
2 – Urban	Urban – Residential	Urban	8.235	70.9	29.1
2 – Roads	Urban – Roads	Urban	1.027	0.0	100.0
3 – Urban	Urban – Residential	Urban	17.079	63.5	36.5
3 – Roads	Urban – Roads	Urban	1.828	0.0	100.0
4 – Urban	Urban – Residential	Urban	18.726	71.2	28.8
4 – Roads	Urban – Roads	Urban	1.630	0.0	100.0
5 – Urban	Urban – Residential	Urban	15.411	71.4	28.6
5 – Roads	Urban – Roads	Urban	1.257	0.0	100.0
6 – Urban	Urban – Residential	Urban	11.406	66.7	33.3
6 – Roads	Urban – Roads	Urban	1.123	0.0	100.0

5.4.5 Proposed Stormwater Management Train

The stormwater treatment train for the proposed development is described in Table 25 and maintains the following key features:

1. We understand that 3KL rainwater tanks will be included on proposed lots for the re-use of stormwater runoff from site roofs. These tanks were not included in the post-development modelling scenarios. This is anticipated to give a conservative modelling result.

2. Generally the site is drained via a series of variably sized bioremediation swales which convey surface water through the site. 3 swale sizes (based on carrying flow capacity) are included in the scheme. For the purposes of water quality modelling, all modelling was based on the smallest swale type (ie. 1m wide base infiltration area).

3. Swales provide for distributed infiltration, treatment and conveyance of the 1% AEP flows from the development.

4. Swales drain to a series of GPTs which are distributed throughout the site at sub-catchment discharge locations to infiltration basins.

5. The outlets and overflow bypasses from proposed gross pollutant traps shall be appropriately designed to prevent scour and erosion.

6. A series of 6 infiltration basins (some existing and some constructed) to receive and contain site discharge.

Table 25: Proposed concept stormwater management train.

Element	Water Quality Function	Description	Preliminary Specification(s)
Bioretention Swales	Primary sediment, grease and sediment removal mechanism	Runoff from all site roads and residential lots is to be directed to a series of bioretention swales prior to discharge into stormwater receiving basins.	Preliminary sizing specifications have been provided in Section 4 of this report and in Attachment A (Figure 23). Total swale lengths created for the site will be in the order of the following: Type 1: 8,310 m Type 2: 2,475 m Type 3: 360 m Swale properties assumed for modelling purposes included: Extended detention: 0.25 m Filter depth: 500 mm Filter media d_{50}: 1.5mm Filter K_{sat}: 62.5 mm/hr
Gross Pollutant Traps (GPT)	Primary litter removal mechanism	Runoff from bioretention swales is to be directed to a series of gross pollutant traps directly upslope of stormwater infiltration basins / areas.	At this stage, the GPT have not been specified. They will ultimately depend on inflow rates and may consist of CDS units or some other commercially available equivalent. All GPTs are to be constructed prior to site discharges to the infiltration basins. In total 8 GPTs have been included in the post-development water quality model. Treatment efficiencies of each GPT were assumed as follows: TSS 70 % retention TN 0 % retention TP 30 % retention Gross pollutants 98 % retention
Infiltration Basins / Areas	Not used for water quality treatment	6 Infiltration basins are proposed. Some of these are existing / natural basins whereas others are to be (or already have been) constructed.	Preliminary specifications have been provided in Section 4 of this report. An example of a typical constructed basin has been provided in Figure 24. Basins were not included in the water quality modelling. Preliminary specifications for constructed basins are: Internal batters: 1(V):2(H) Surface material: 100mm depth 20-30 mm aggregate

5.4.6 MUSIC Model Results

Modelling results for mean annual pollutant loads and daily pollutant concentrations under each modelling scenario are provided in Table 26 and Table 27.

Table 26: Average annual pollutant loads for existing and post development (untreated and treated) conditions for the development.

Water Quality Parameter	Existing conditions (kg/year)	Post Development Untreated (kg/year)	Post Development Treated (kg/year)	Load Reduction (%)
TSS	12294	64280	158	99.9
TP	8.49	122.77	2.43	98.0
TN	118.9	1101.8	49.5	95.5
Gross Pollutants	0	12534	0	100

Table 27: Average pollutant concentrations for existing and post development (untreated and treated) conditions for the development.

Water Quality Parameter	Mean Groundwater Conditions (mg/L)	Modelled Existing Conditions (mg/L)	Modelled Post Development Untreated (mg/L)	Modelled Post Development Treated (mg/L)
TSS	na	51	141	5
TP	0.140	0.035	0.269	0.075
TN	2.800	0.494	2.424	1.520

Comments are as follows:

1. Modelling indicates that the proposed stormwater treatment measures for the development will achieve the target pollutant retention objectives outlined in Table 21 and satisfies water quality Objective 1 of this study.

2. Results indicate that stormwater release to the infiltration basins will be of a better quality than existing average groundwater conditions and satisfies water quality Objective 2 of this study.

3. The development will not have a net detrimental impact on receiving waters and does not rely on the treatment capacity of the proposed infiltration basins and satisfies water quality Objective 3 of this study.

5.4.7 Basin Liners

Given the elevation of design basin inverts, we do not recommend that basins are lined. Adequate water treatment will occur in a distributed treatment system within the catchment prior to discharge to the 6 infiltration basins.

5.5 Benefits of the Stormwater Management Approach

The proposed stormwater management strategy maintains the following benefits:

1. Will reduce key stormwater pollutants in-line with the design objectives outlined in this report (i.e. neutral or beneficial impact is satisfied).

2. The proposed scheme is practical, cost effective and can be readily maintained.

3. The proposed scheme is ecologically sustainable and demonstrates 'best management practice' solutions in-line with the principles of Water Sensitive Urban Design (WSUD) and Ecologically Sustainable Development (ESD).

6 Preliminary Site Management Plan

6.1 Stormwater System

6.1.1 Operation During Construction

During construction, of the site, the following is recommended with respect to the infiltration basins:

1. Existing Basins
   Suitable sediment and erosion control structures will need to be used to ensure that construction based sediment does not reach the basins. A detailed sediment and erosion control plan will need to be prepared prior to issue of the Construction Certificate to ensure that basins are protected.

2. New Basins
   Where possible, construction of new basins should be delayed as long as possible until such time as road infrastructure and verge vegetation has been fully established. This should preferably take place prior to construction of dwellings.

3. New Dwellings
   All new dwelling constructions will need to incorporate suitable sediment and erosion control measures to ensure that there is no sediment loss off the construction allotment.

6.1.2 On-going Maintenance Requirements

The stormwater system will require on-going maintenance. A detailed maintenance plan should be prepared prior to issue of the Construction Certificate. At a minimum, we see that the following elements will be required:

1. Swales
   Vegetation in swales will need to be inspected and maintained at least on an annual basis. During these inspections, sediment which has accumulated will need to be removed and vegetation re-established as required.

2. GPT's
   GPT's will need to be inspected and cleaned as required on a 6 monthly basis at a minimum.

3. Outlet Structures
   All outlet structures will need to be inspected on an annual basis for signs of erosion. Where noted, erosion shall be repaired as required.

4. Basins – Constructed
   Constructed basins shall be inspected on an annual basis with sediment and vegetation removed as required.

5. Basins – Existing / Natural
   Existing / natural basins shall be inspected on an annual basis with excess sediment removed as required. Where infiltration rates decline, the base (or part thereof as directed by a suitably qualified engineer) will need to be remediated (by sediment and vegetation removal) to improve bed hydraulic efficiency.

6.1.3 On-going Monitoring Requirements

We recommend that the following on-going surface water monitoring be undertaken as part of the development:

1. Water Quality
   Surface water quality at each basin site should be collected on an annual basis (where water is available). Data should be retrieved and an annual report on surface water quality should be prepared by a suitably qualified consultant. Minimum analytes to be included in the sampling program should include:

   - Electrical conductivity
   - Total nitrogen and nitrogen sub-species
   - Total phosphorus
   - Hydrocarbons

6.1.4 Trigger Values and Response Actions

As part of the development of the surface water monitoring scheme, a suitably qualified consultant, in consultation with NSW DECCW, will need to prepare a list of surface water trigger values based on background groundwater quality data. Response actions where these trigger values are exceeded will need to be determined.

6.2 Groundwater System

6.2.1 Bore Monitoring Network

We recommend that the following on-going groundwater monitoring be undertaken as part of the development:

2. Groundwater Levels
   A monitoring network of a minimum of 5 bores should be established to provide long-term groundwater level data around the perimeter of the development. These bores should be instrumented with high resolution Divers set to record levels at 30 minute intervals. Data should be retrieved on a 6 monthly basis and an annual report on groundwater conditions should be prepared by a suitably qualified consultant.

   Location of the monitoring bore network should be established prior to issue of the Construction Certificate.

3. Groundwater Quality
   Groundwater quality at each of the monitoring bores (nominate above) should be collected on an annual basis. Data should be retrieved and an annual report on groundwater conditions should be prepared by a suitably qualified consultant. Minimum analytes to be included in the sampling program should include:

   - Electrical conductivity
   - Total nitrogen and nitrogen sub-species
   - Total Phosphorus
   - Hydrocarbons

6.2.2 Trigger Values and Response Actions

As part of the development of the monitoring bore network, a suitably qualified consultant, in consultation with NSW DECCW, will need to prepare a list of groundwater trigger values based on background groundwater quality data. Response actions where these trigger values are exceeded will need to be determined.

6.2.3 Bore-field Maintenance

As part of the routine bore field inspections, the bore-field shall be maintained on an annual basis to ensure that collected groundwater samples are representative. Maintenance shall include at a minimum visual inspection and purging the well twice or until such time as water quality being pumped is uniform.

6.3 Contingencies

In the event that adverse impacts on the quality of surface water or groundwater are observed, a suitably qualified engineer shall be consulted to determine an appropriate course of action. This action shall be undertaken in consultation with Port Stephens Council and NSW DECCW.

6.4 Communication

All annual stormwater and groundwater monitoring reports shall be retained by site management and a copy forwarded to NSW DECCW and Port Stephens Council.

6.5 Preliminary Monitoring Schedule

In summary, we recommend the following [preliminary] on-going monitoring schedule. This will need to be updated as part of the detailed design process prior to the issue of a site Construction Certificate.

Table 28: Preliminary monitoring schedule.

Element	Location	Frequency	Responsibility
Stormwater swales	Within road network	Annual	Site owner
Stormwater GPTs	At site discharge points	6 monthly	Council
Stormwater basins	At site discharge points	Annual	Council
Stormwater quality	At site discharge points	Annual	Council or site owner
Groundwater level	Distributed throughout site	6 monthly	Site owner
Groundwater quality	Distributed throughout site	Annual	Site owner
Borefield maintenance	Distributed throughout site	Annual	Site owner

7 References

ANZECC (2000) National Water Quality Management Strategy. *Australian Guidelines for Urban Stormwater Management*

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Geary, P. M (2003) On-site *Treatment System Failure and Shellfish Contamination in Port Stephens, NSW* – SepticSafe enhancement Grant Project E08

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NSW EPA (1997) *Managing Urban Stormwater: Treatment Techniques*

Port Stephens Council (PSC, 2003) *Urban Stormwater and Rural Water Quality Management Plan*

Port Stephens Council (2007) *Development Control Plan 2007*

RCA Australia Pty Ltd (2006) *Geotechnical Investigations Entry road*

Parsons Brinkerhoff (2006) *Geotechnical Investigation for Sub-division*

8 Attachment A – Figures



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**STUDY AREA LOCATION**	Drawing No: **FIGURE 1**
Approved:	DMM		
Date:	09.12.09		
Scale:	Approx. 1:140,000		Job No: P0902479



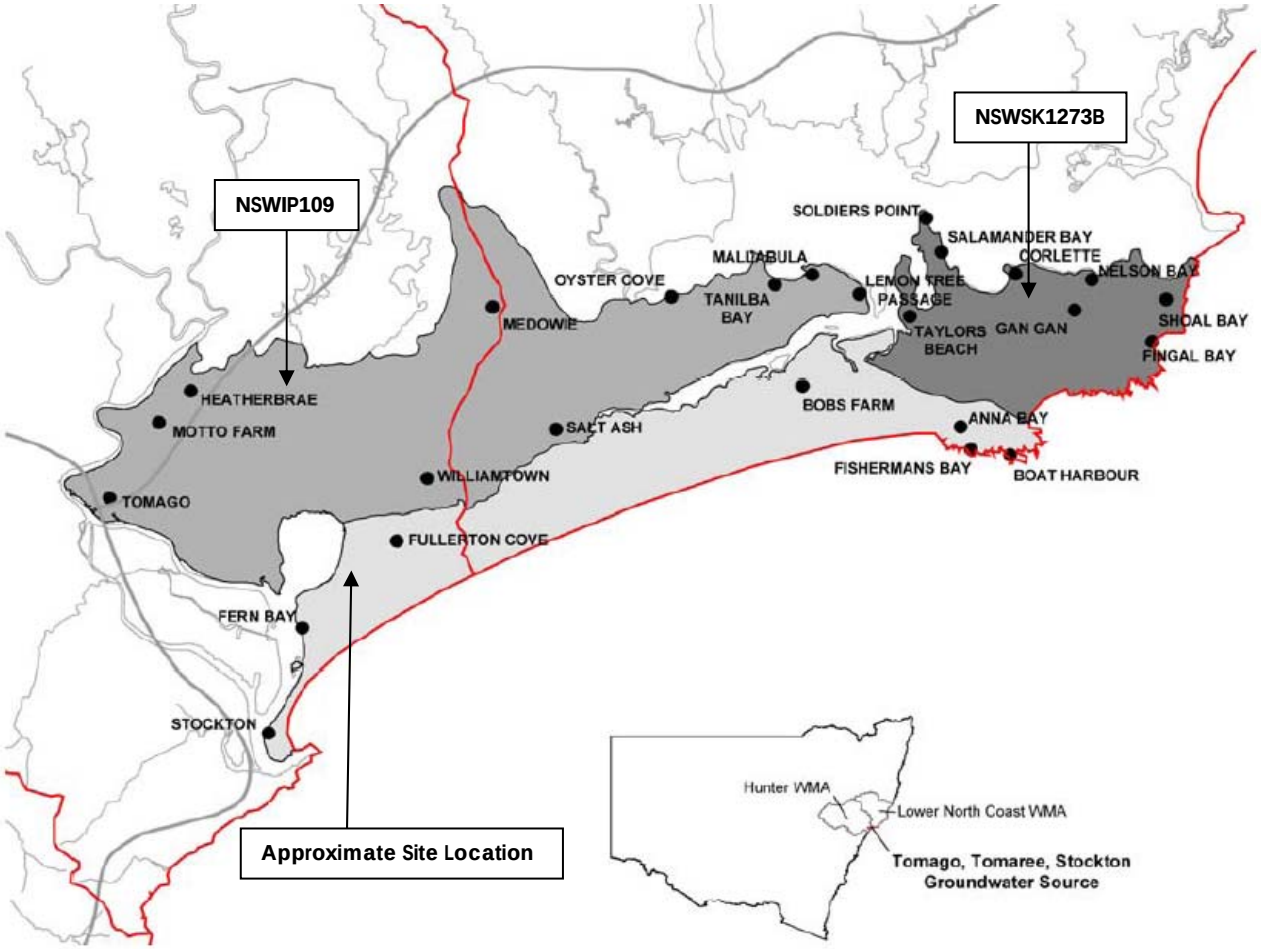
martens

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**SITE BOUNDARY WITH CADASTA**	Drawing No: **FIGURE 2**
Approved:	DMM		
Date:	09.12.09		
Scale:	Approx. 1:18,000		Job No: P0902479



martens

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**SITE BOUNDARY WITH AERIAL**	Drawing No: **FIGURE 3**
Approved:	DMM		
Date:	09.12.09		
Scale:	Approx. 1:18,000		Job No: P0902479



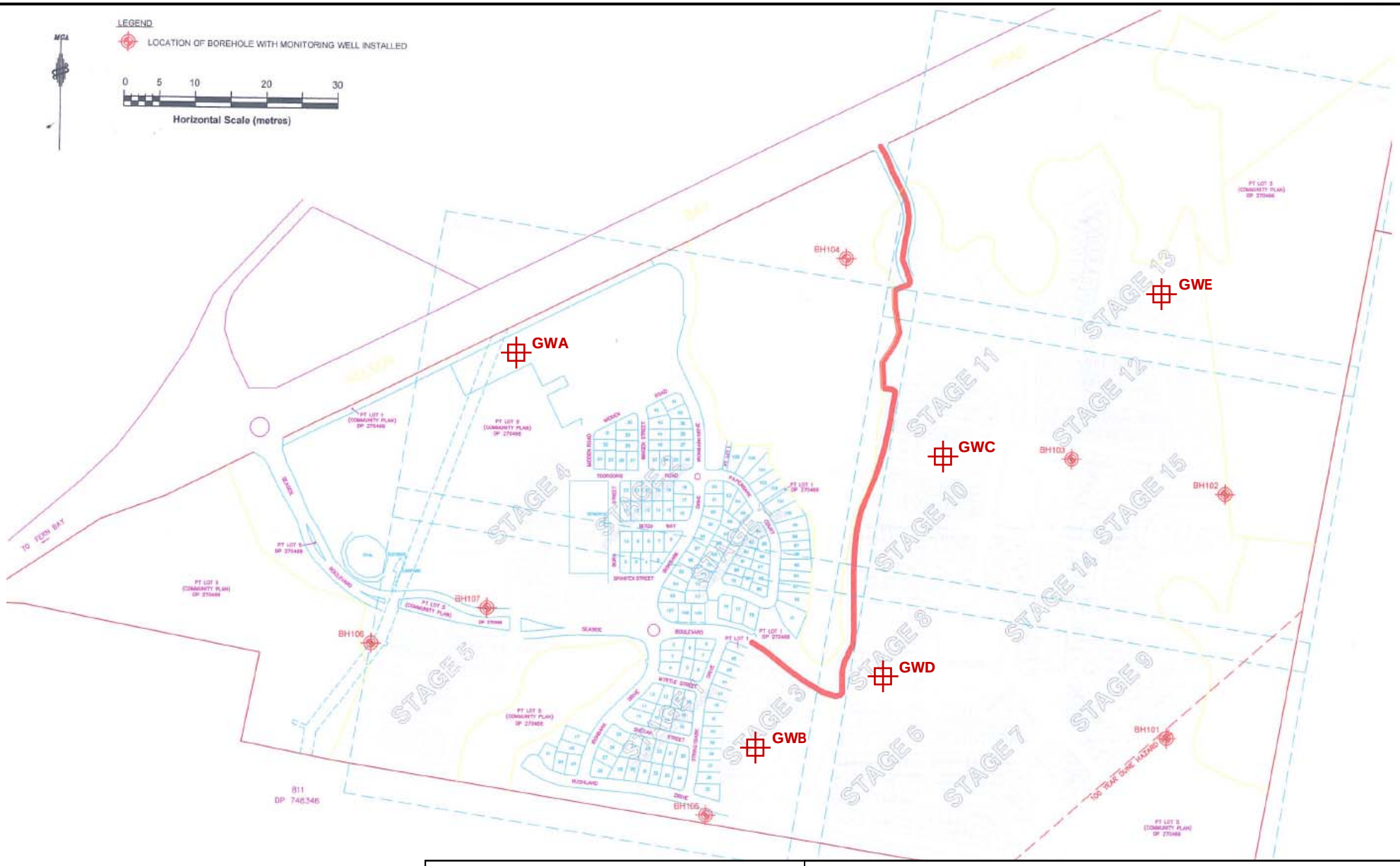
Legend

- Town
- River and Creek
- Road and Highway
- Water Management Area
- Stockton Groundwater Source
- Tomago Groundwater Source
- Tomaree Groundwater Source

N

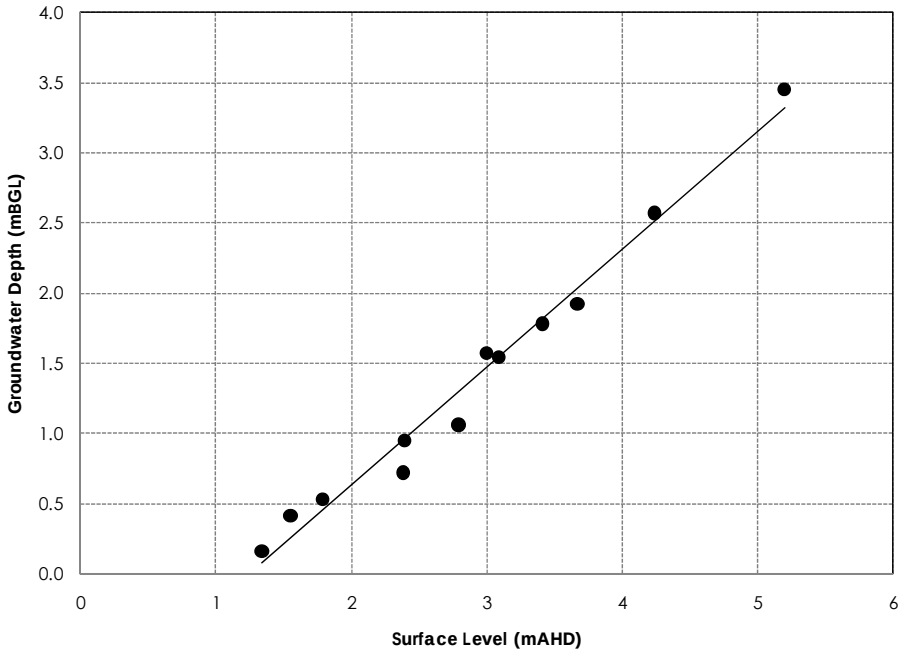
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TOMAGO, TOMAREE, STOCKTON GROUNDWATER RESOURCE (DWE, 2003)**	Drawing No: **FIGURE 4**
Approved:	DMM		
Date:	09.12.09		
Scale:	Approx. 1:300,000		Job No: P0902479

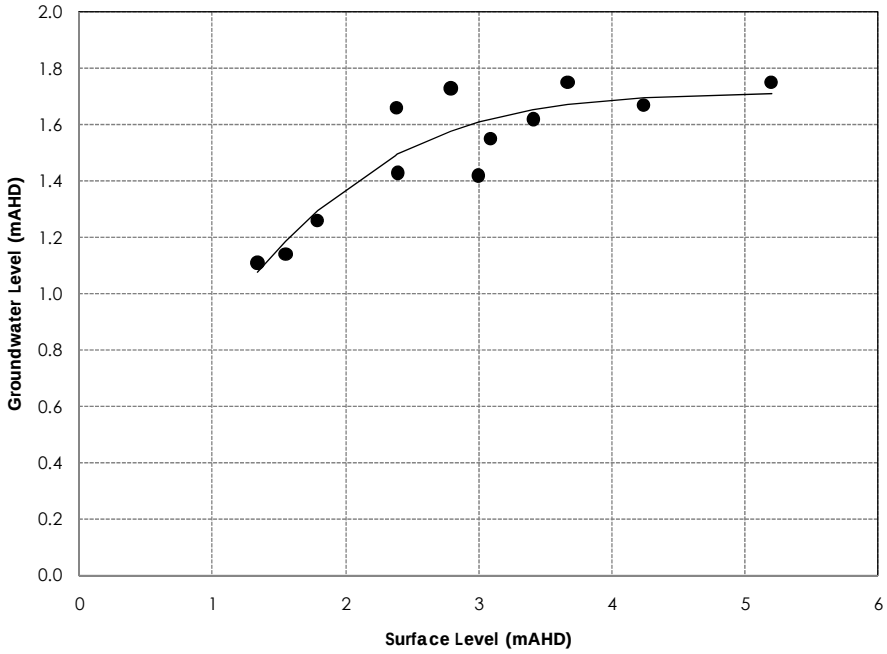
martens



martens

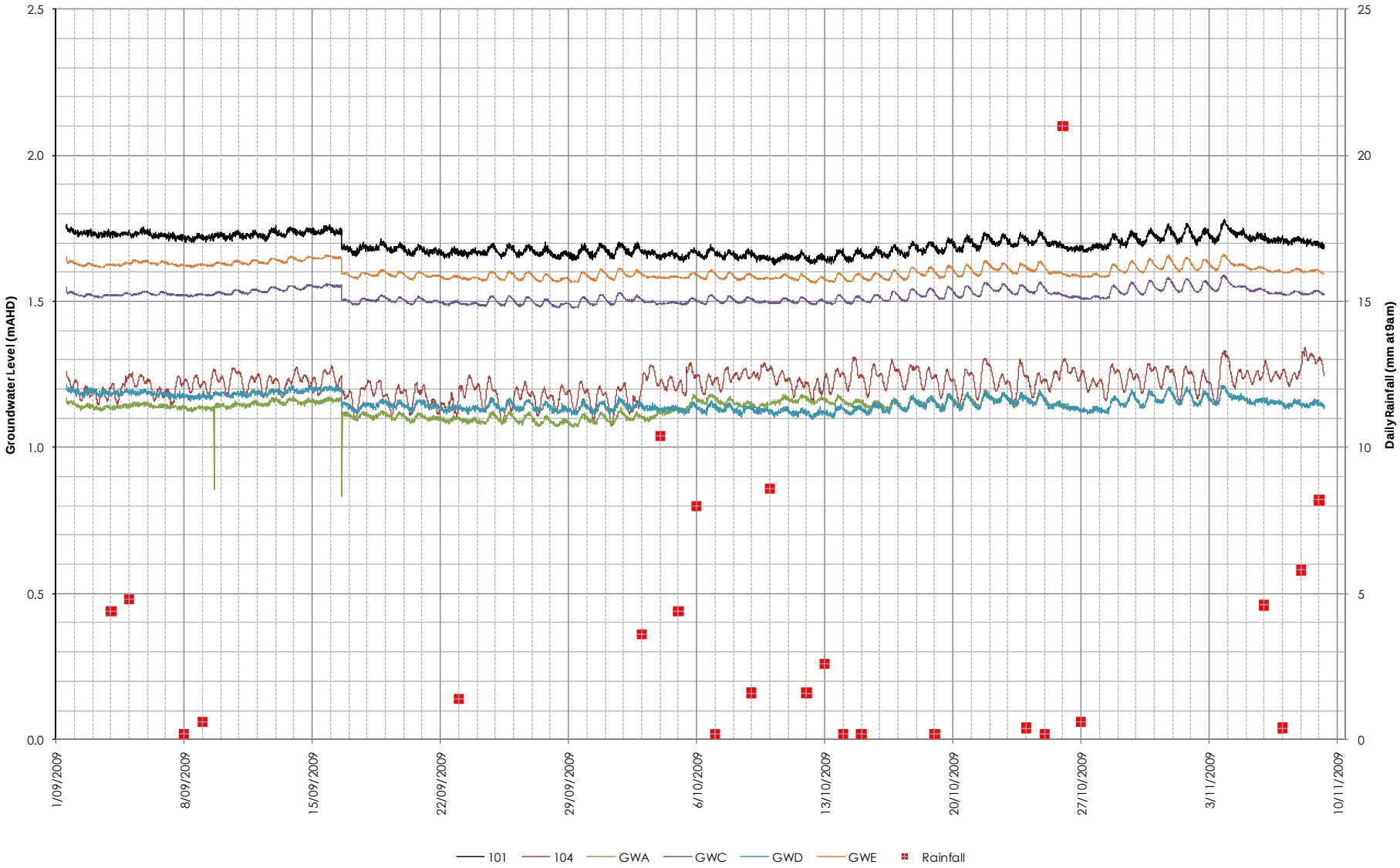
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**PIEZOMETER LOCATIONS:** **COFFEY GEOTECHNICS- 28.11.2007** **MARTENS - 31.08.2009 (GWA-GWE)**	Drawing No: **FIGURE 5**
Approved:	DMM		
Date:	11.12.09		
Scale:	Approx. 1:750		Job No: P0902479





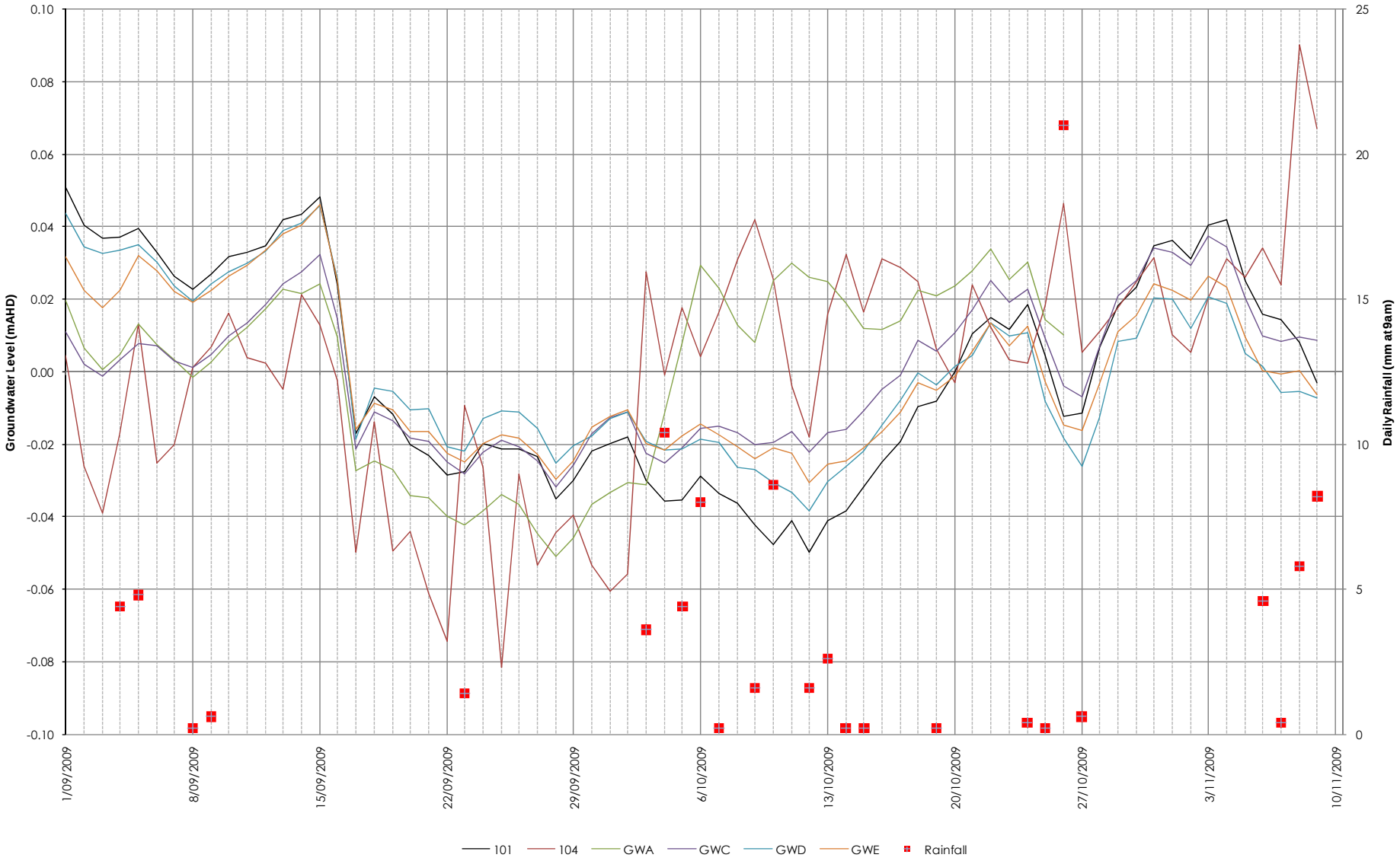
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**SURFACE LEVEL AND DEPTH TO GROUNDWATER / GRONDWATER LEVEL SUMMARY**	Drawing No: **FIGURE 6**
Approved:	DMM		
Date:	12.12.09		
Scale:	na		Job No: P0902479

martens

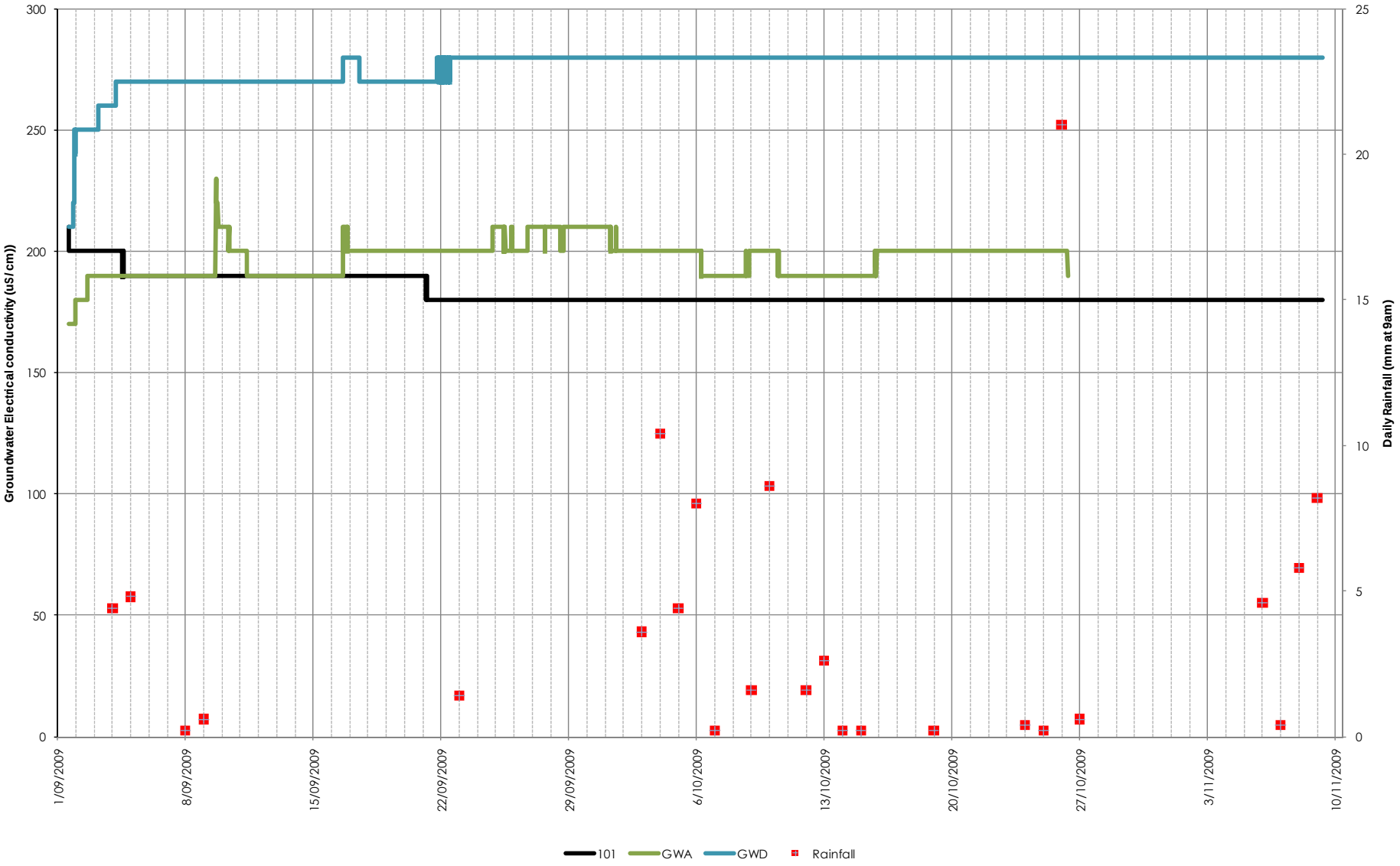


martens

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**GROUNDWATER LEVEL AND RAINFALL DATA FOR PERIOD 01.09.2009 – 09.11.2009**	Drawing No: **FIGURE 7**
Approved:	DMM		
Date:	13.12.09		
Scale:	na		Job No: P0902479



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**GROUNDWATER LEVEL MEAN DAILY RESIDUALS AND RAINFALL DATA FOR PERIOD 01.09.2009 – 09.11.2009**	Drawing No: **FIGURE 8**
Approved:	DMM		
Date:	11.12.09		
Scale:	na		Job No: P0902479



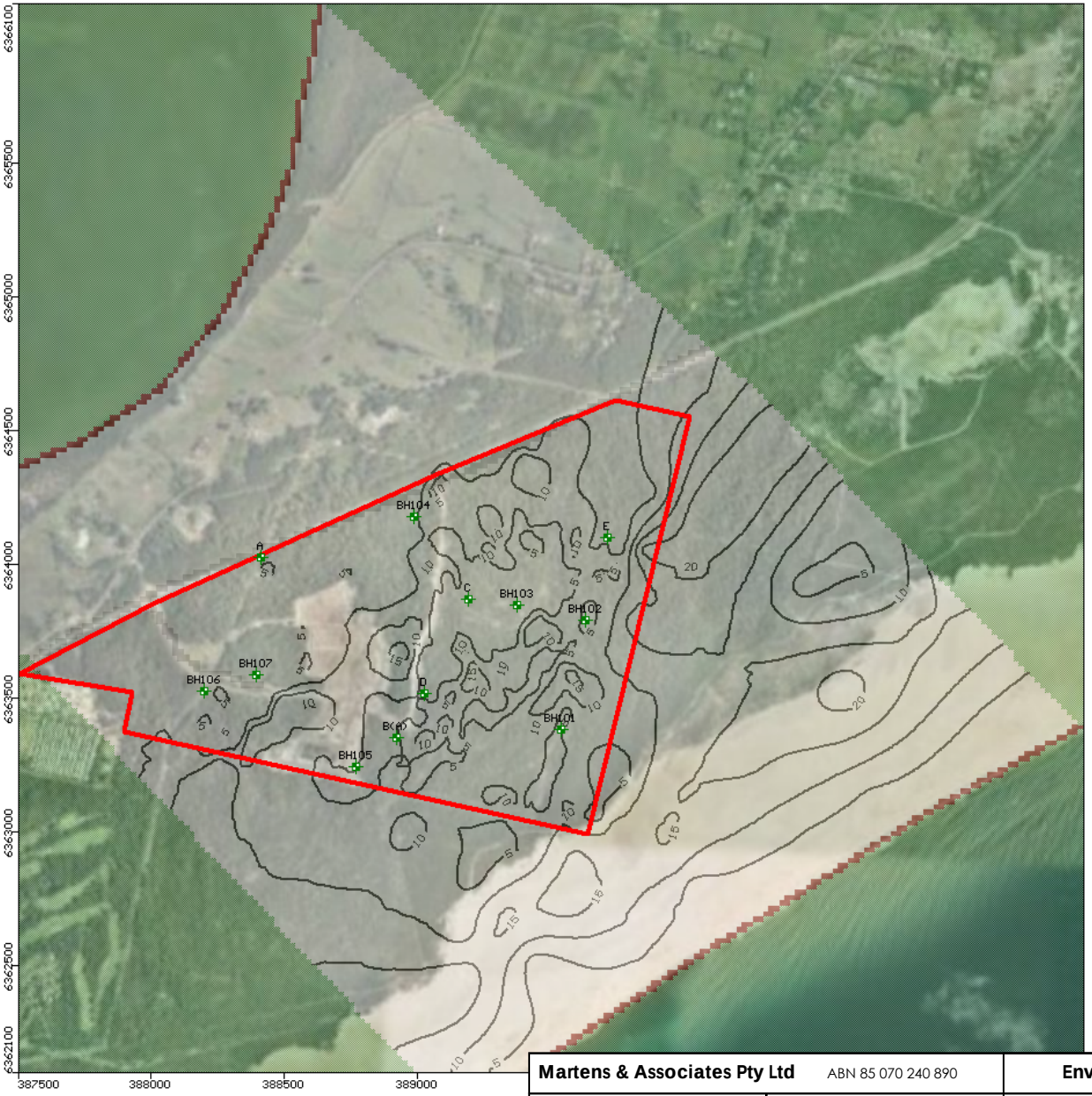
martens

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**GROUNDWATER ELECTRICAL CONDUCTIVITY AND RAINFALL DATA FOR PERIOD 01.09.2009 – 09.11.2009**	Drawing No: **FIGURE 9**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479



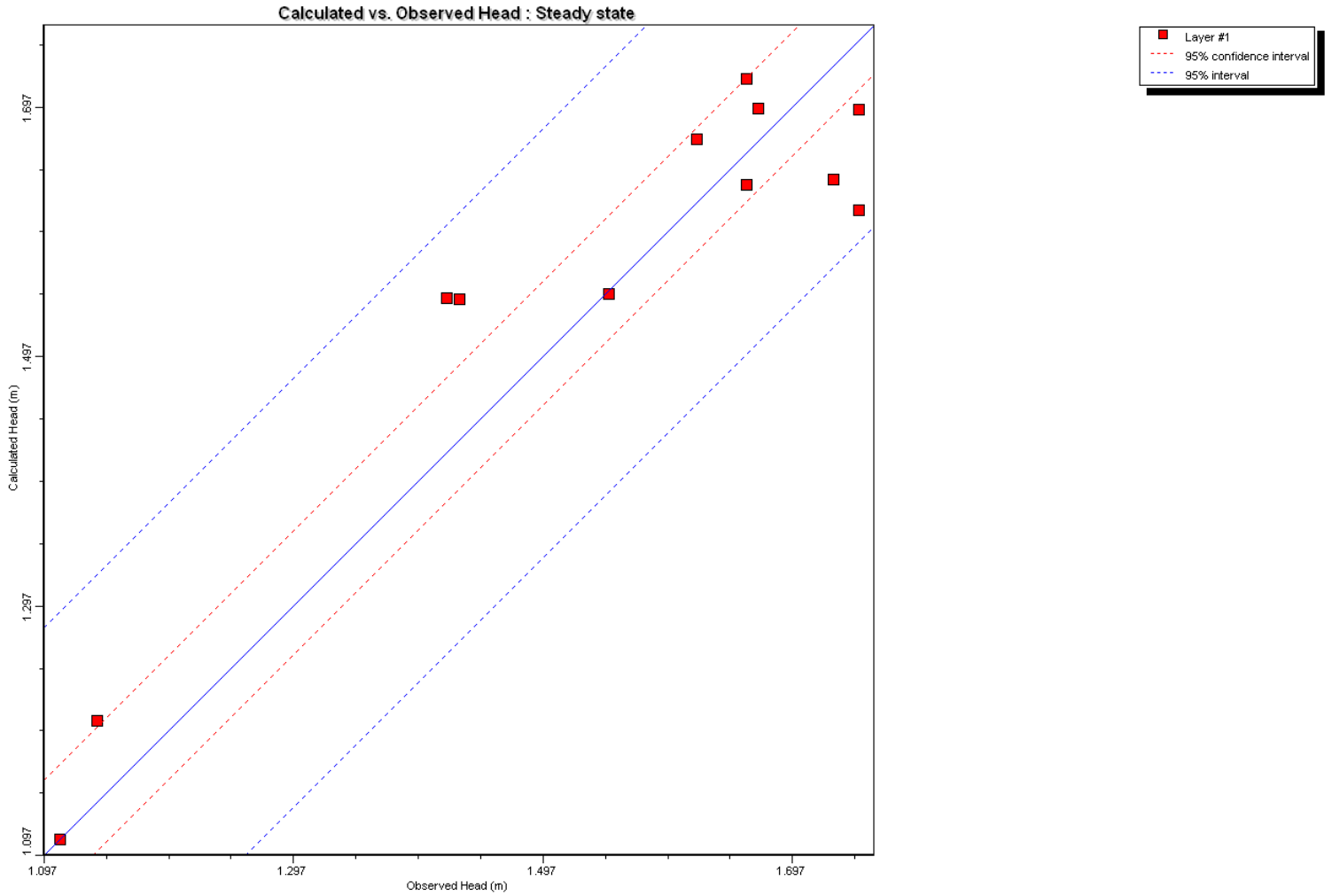
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**MODFLOW MODEL - BOUNDARY EXTENTS, SITE (RED), AND PIEZOMETER NETROWK**	Drawing No: **FIGURE 10**
Approved:	DMM		
Date:	15.12.09		
Scale:	1:25 000		Job No: P0902479

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**MODFLOW MODEL - SURFACE TOPOGRAPHY AND CONSTANT HEAD BOUNDARY CONDITIONS (MAROON)**	Drawing No: **FIGURE 11**
Approved:	DMM		
Date:	15.12.09		
Scale:	1:25 000		Job No: P0902479

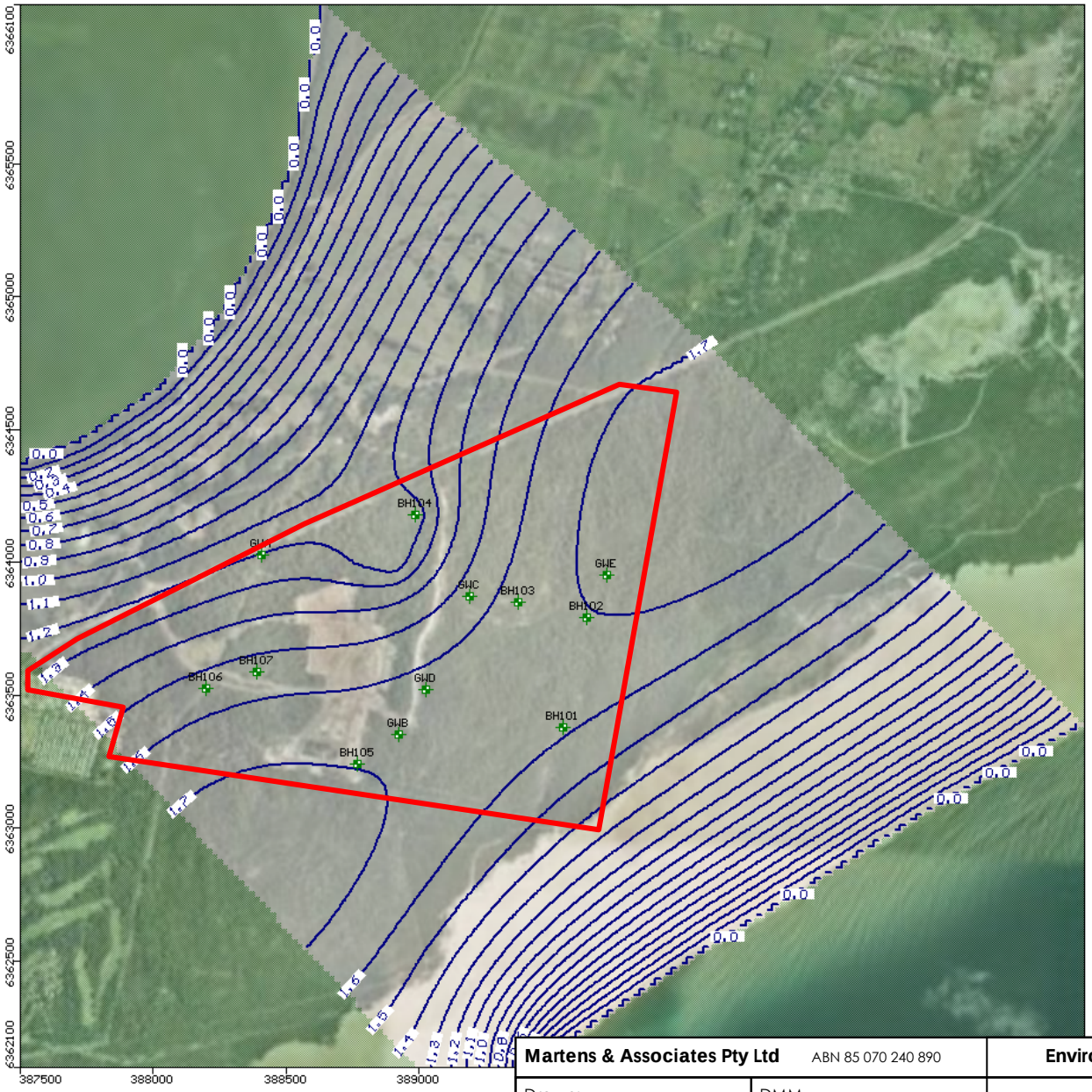


Max. Residual: -0.136 (m) at BH101/*
Min. Residual: 0 (m) at BH104/*
Residual Mean : 0.011 (m)
Abs. Residual Mean : 0.062 (m)

Num. of Data Points : 12
Standard Error of the Estimate : 0.023 (m)
Root Mean Squared : 0.076 (m)
Normalized RMS : 11.905 (%)
Correlation Coefficient : 0.938

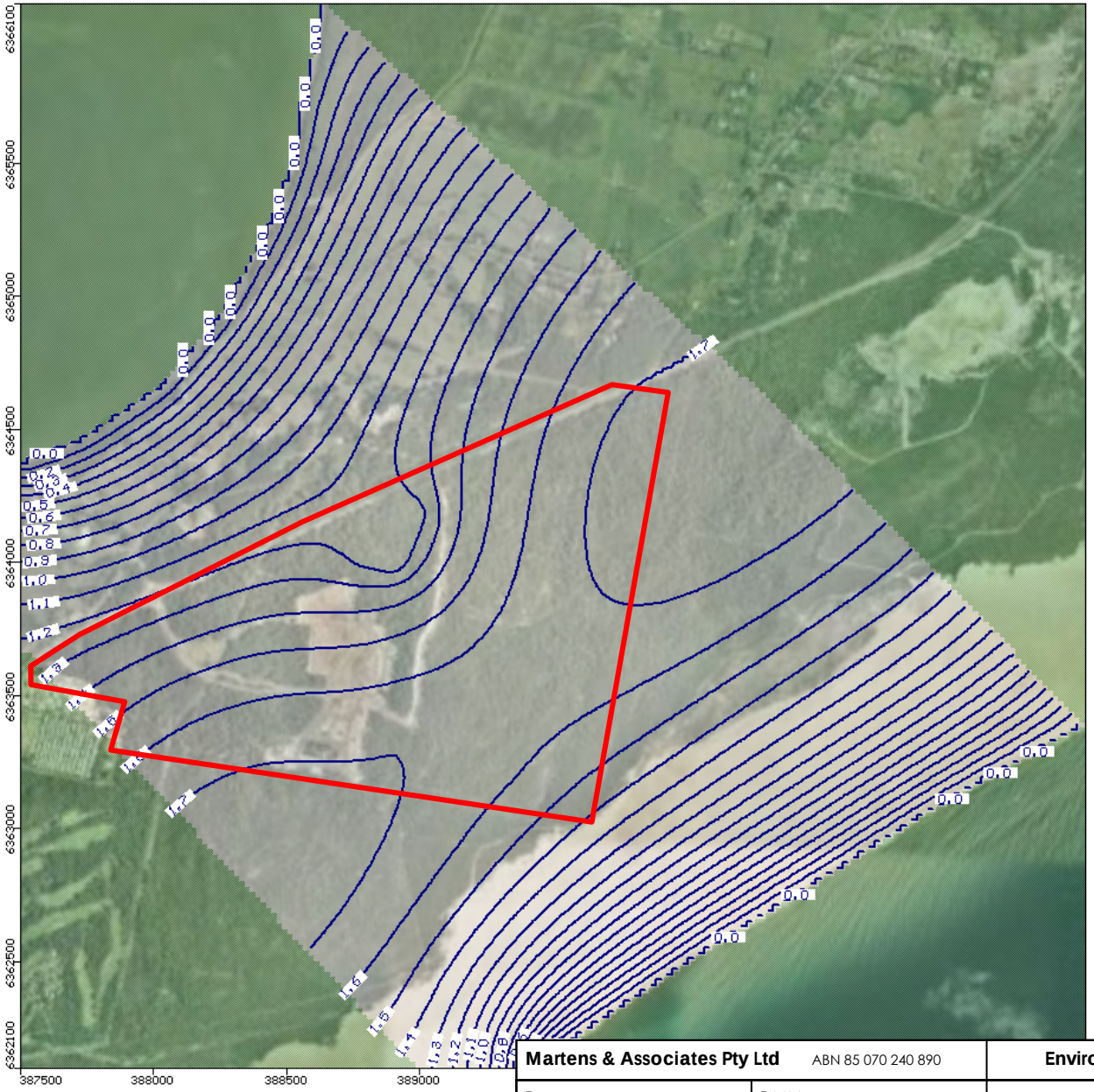
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**MODFLOW MODEL M1- EXISTING CONDITIONS CALCULATED VERSUS OBSERVED HEAD**	Drawing No: **FIGURE 12**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**MODFLOW MODEL M1- EXISTING CONDITIONS STEADY STATE PIEZOMETRIC SURFACE**	Drawing No: **FIGURE 13**
Approved:	DMM		
Date:	15.12.09		
Scale:	1:25 000		Job No: P0902479



Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**
Drawn:	DMM	**MODFLOW MODEL M3-** **DEVELOPED CONDITIONS** **STEADY STATE PIEZOMETRIC SURFACE**
Approved:	DMM	
Date:	15.12.09	
Scale:	1:25 000	

Drawing No:

FIGURE 14

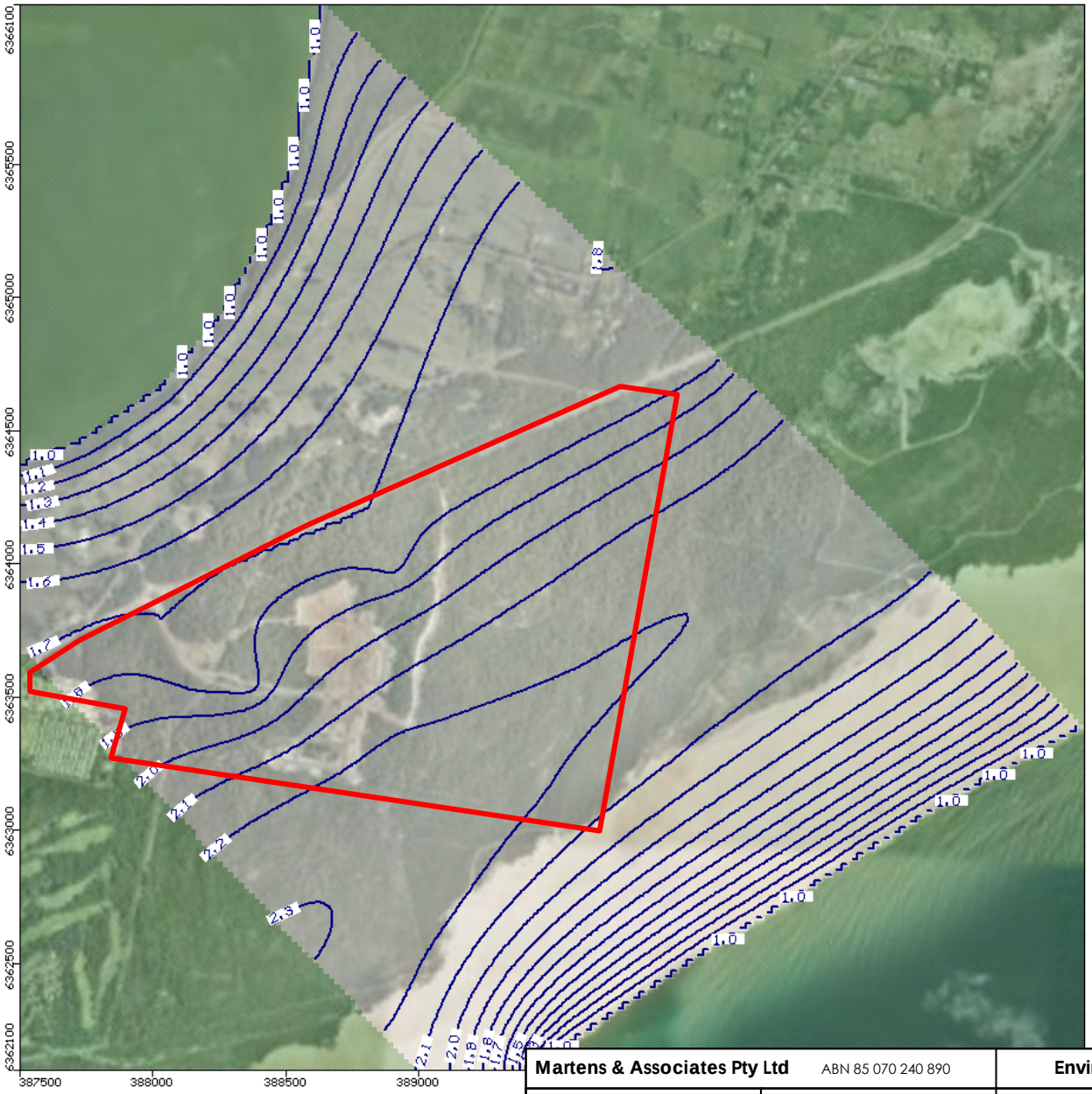
Job No: P0902479

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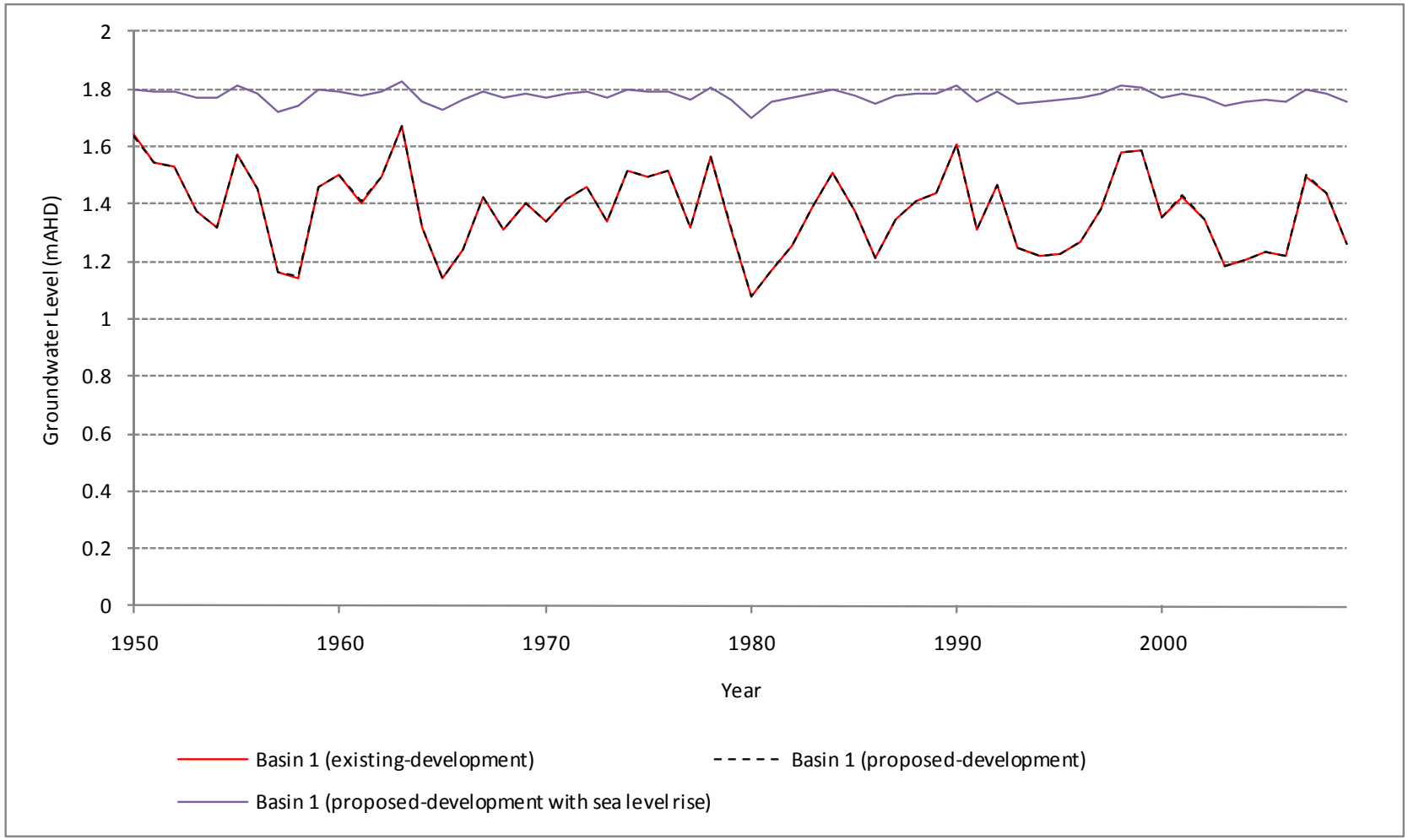
martens

Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	DMM	**DRAWDOWN PLOT BETWEEN DEVELOPED (M3) AND EXISTING (M1) CONDITIONS**	Drawing No: **FIGURE 15**
Approved:	DMM		
Date:	15.12.09		
Scale:	1:25 000		Job No: P0902479



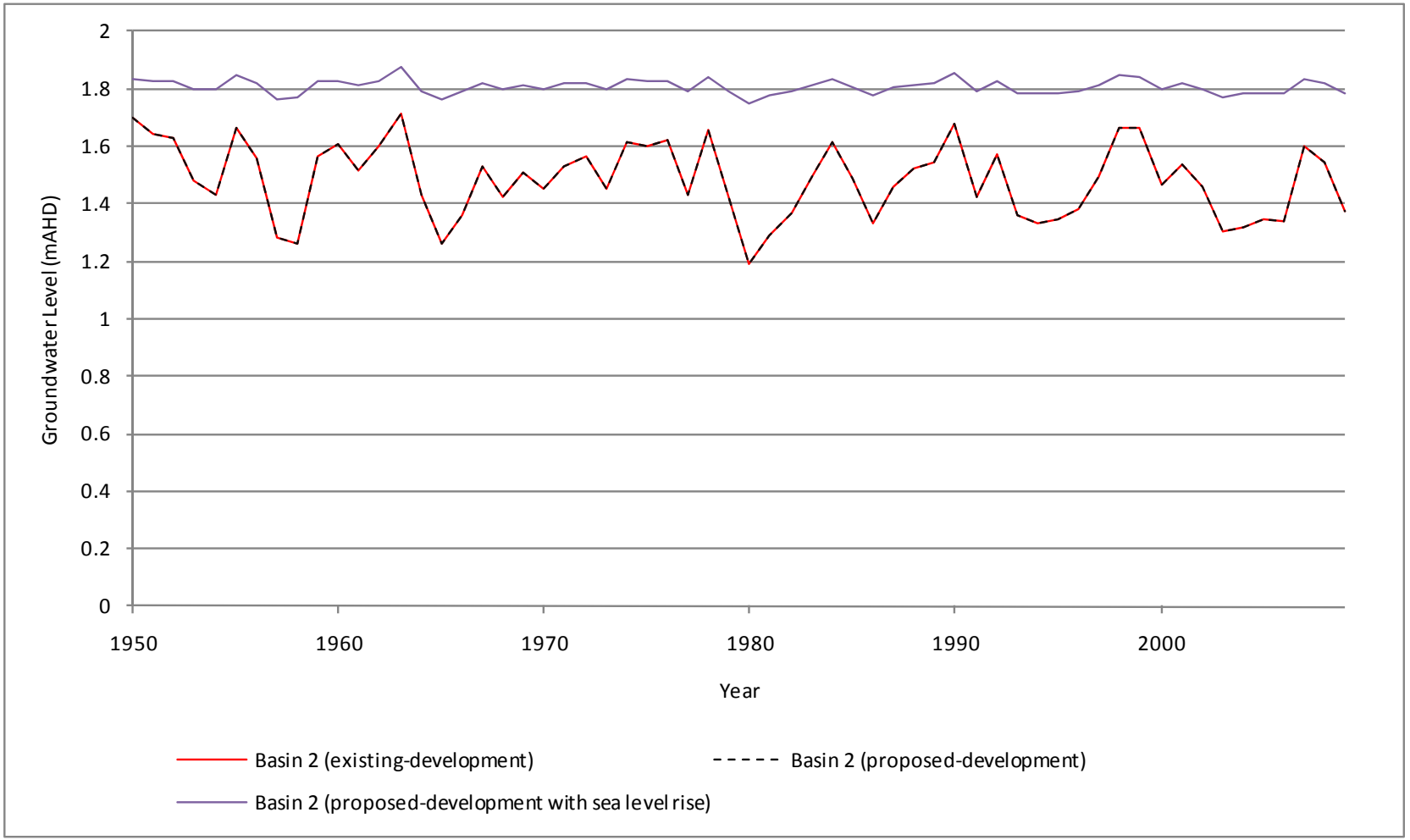
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**MODFLOW MODEL M5- DEVELOPED CONDITIONS + 1m SEA LEVEL RISE STEADY STATE PIEZOMETRIC SURFACE**	Drawing No: **FIGURE 16**
Approved:	DMM		
Date:	15.12.09		
Scale:	1:25 000		Job No: P0902479

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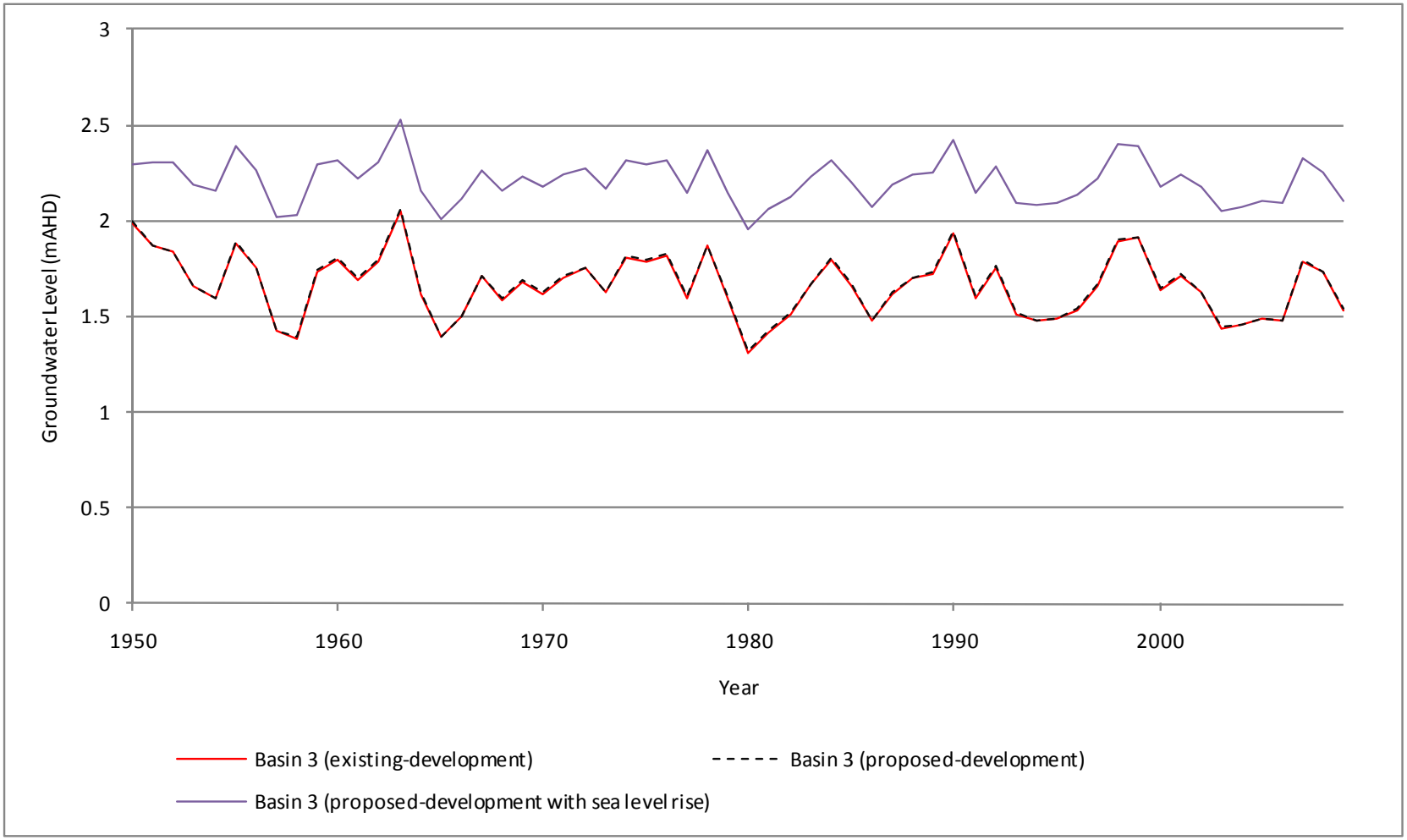


Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 1**	Drawing No: **FIGURE 17**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

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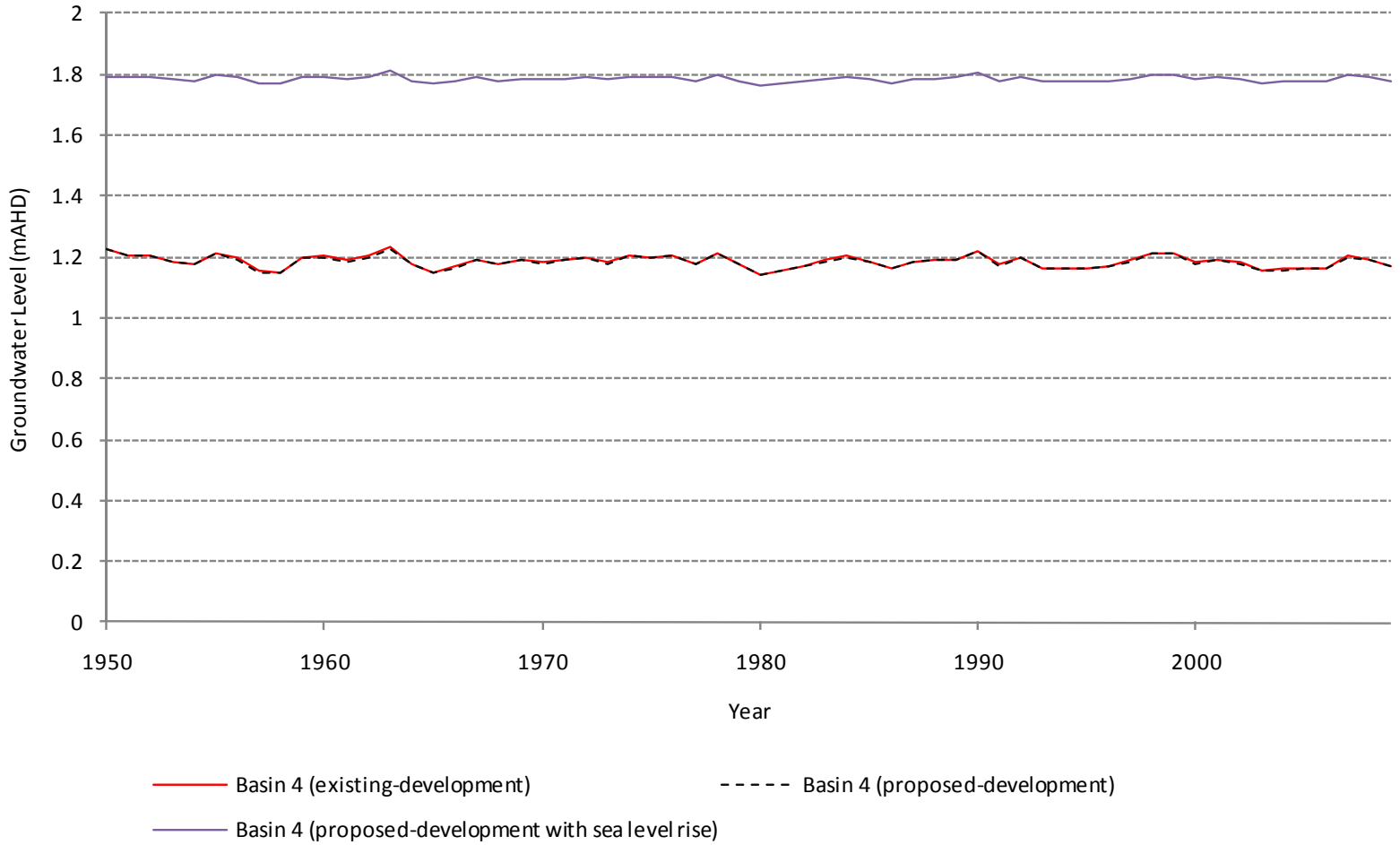


Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 2**	Drawing No: **FIGURE 18**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

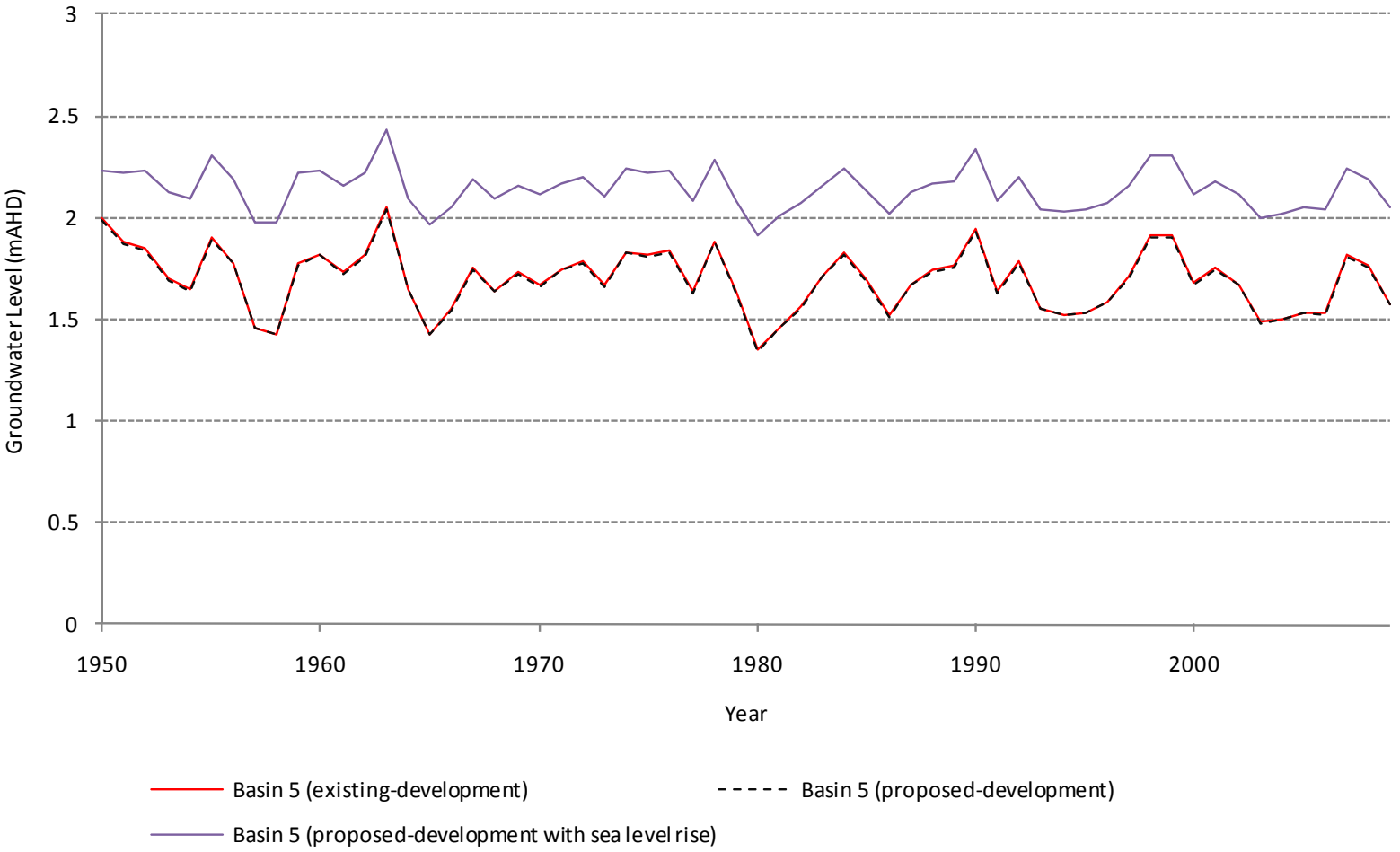


Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 3**	Drawing No: **FIGURE 19**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

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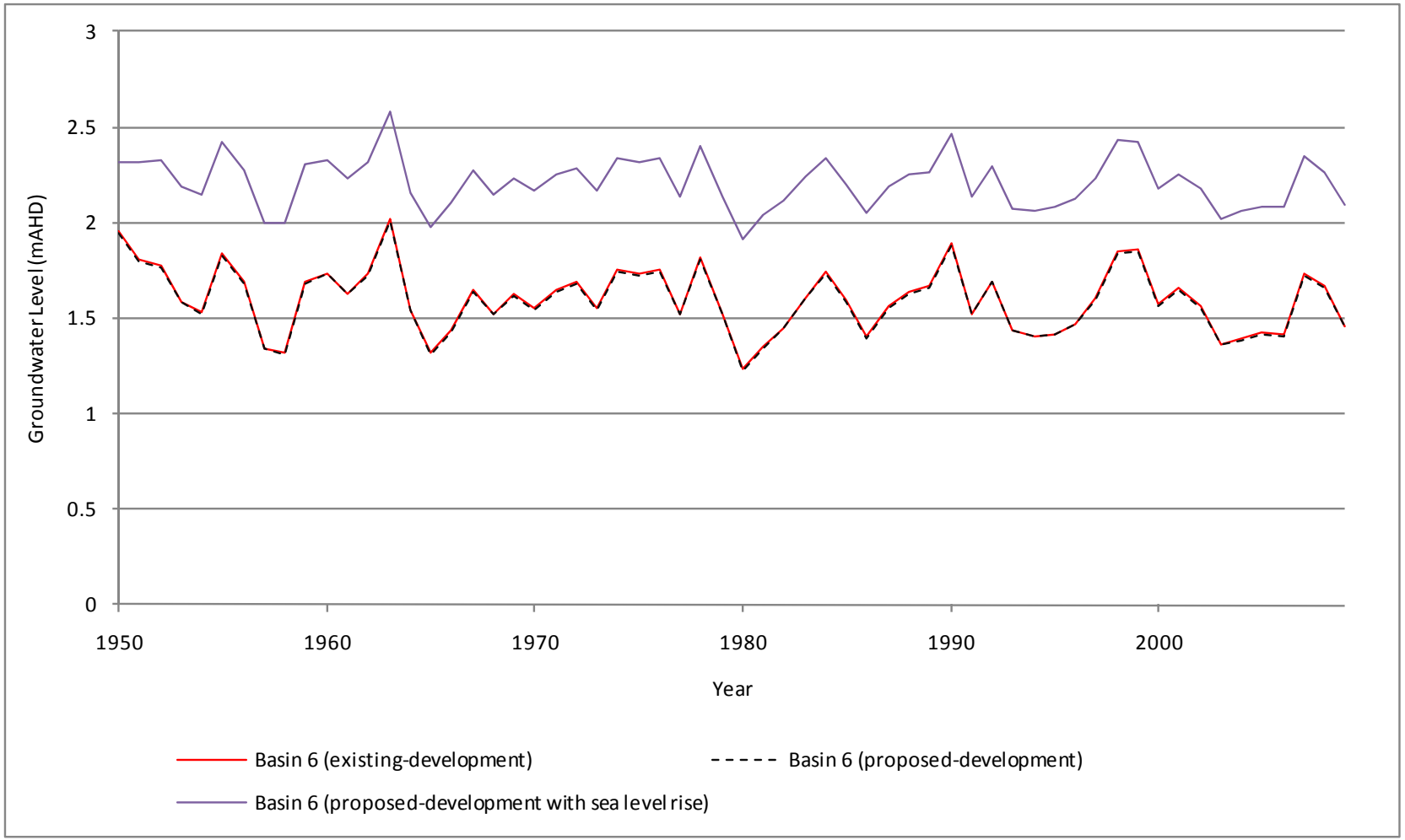


Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 4**	Drawing No: **FIGURE 20**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479



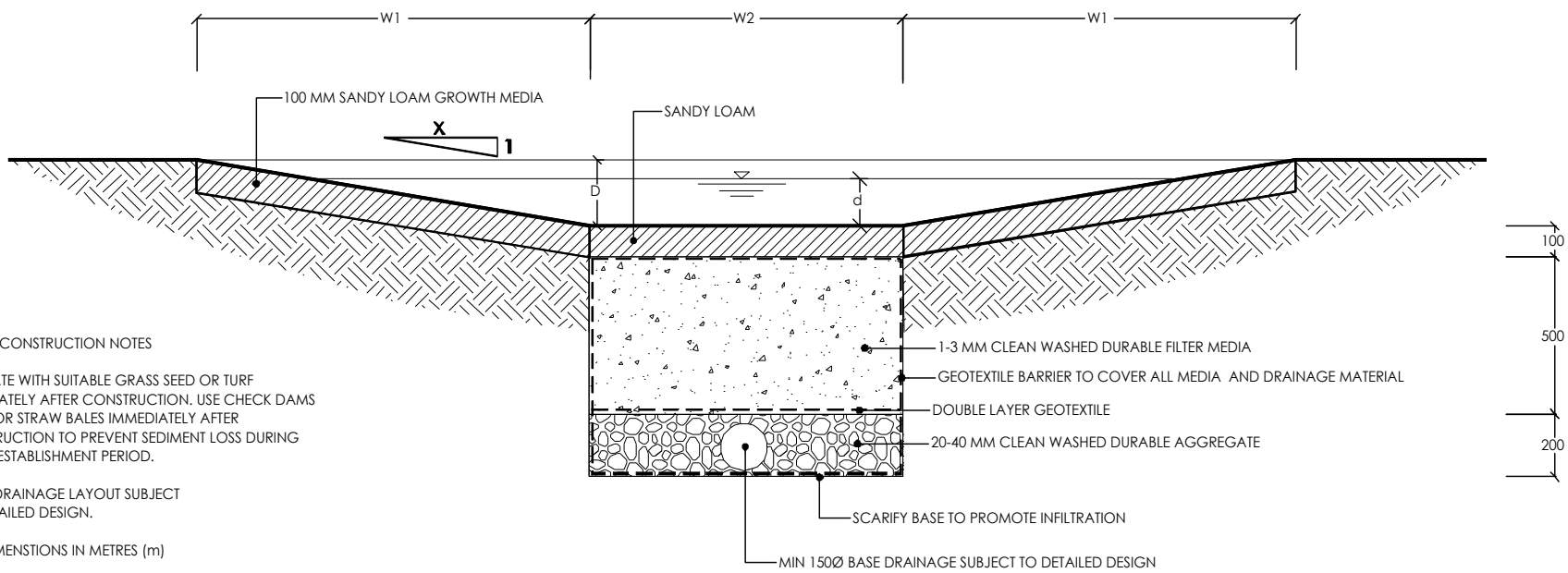
Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 5**	Drawing No: **FIGURE 21**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**TRANSIENT MODFLOW MODELS M2, M4, M6 BASIN SITE 6**	Drawing No: **FIGURE 22**
Approved:	DMM		
Date:	15.12.09		
Scale:	na		Job No: P0902479

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GENERAL CONSTRUCTION NOTES

1. VEGETATE WITH SUITABLE GRASS SEED OR TURF IMMEDIATELY AFTER CONSTRUCTION. USE CHECK DAMS AND / OR STRAW BALES IMMEDIATELY AFTER CONSTRUCTION TO PREVENT SEDIMENT LOSS DURING SWALE ESTABLISHMENT PERIOD.
2. FINAL DRAINAGE LAYOUT SUBJECT TO DETAILED DESIGN.
3. ALL DIMENSTIONS IN METRES (m)
4. FILTER WIDTH MAY BE VARIED TO ACHIEVE MEAN OF 1 M AVERAGE WIDTH ALONG ANY SINGLE SWALE RUN.
5. FILTER DEPTH MAY BE VARIED DEPENDING ON DESIGN SOIL DEPTH. DEPTH REDUCTIONS SHOULD BE COMPENSATED BY FILTER BASE WIDTH INCREASES.

Type	Flow Condition (m^3/s)	W1 (m)	W2 (m)	D (m)	X	Min. Bed Grade (%)	Max. Flow Width (m)	Max Flow Depth (m)	Velocity (m/s)	Vd Product (m^2/S)
1	<0.2	1	1	0.25	4	0.5	3.44	0.31	0.59	0.18
2	0.2 -0.8	2	2	0.50	4	0.5	4.77	0.35	0.68	0.24
3	>0.8	2	4	0.50	4	0.5	7.00	0.38	0.78	0.29

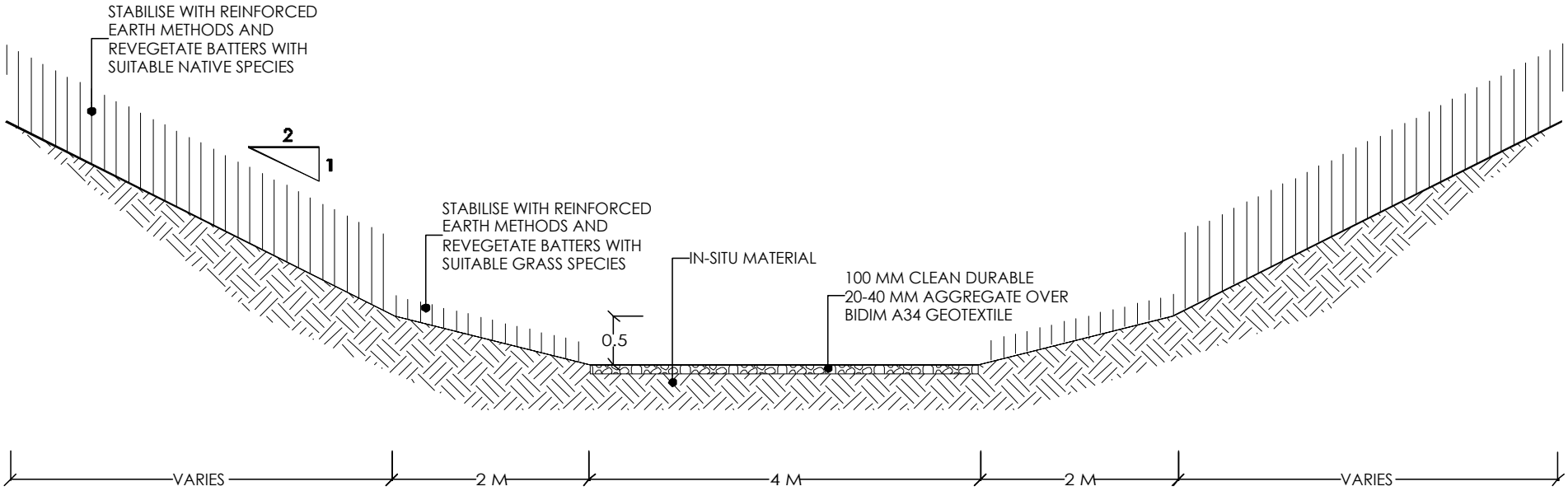
Martens & Associates Pty Ltd ABN 85 070 240 890		Environment | Water | Wastewater | Geotechnical | Civil | Management	
Drawn:	DMM	**PRELIMINARY BIORETENTION SWALE SPECIFICATIONS**	Drawing No: **FIGURE 23**
Approved:	DMM		
Date:	16.12.09		
Scale:	na		Job No: P0902479



Typical constructed infiltration basin in sand dune areas (Forster, NSW).

Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**EXAMPLE CONSTRUCTED INFILTRATION BASIN**	Drawing No: **FIGURE 24**
Approved:	DMM		
Date:	16.12.09		
Scale:	na		Job No: P0902479

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Martens & Associates Pty Ltd ABN 85 070 240 890		**Environment | Water | Wastewater | Geotechnical | Civil | Management**	
Drawn:	DMM	**PRELIMINARY OVERLAND FLOW SWALE DETAIL TO BASINS 4 AND 5**	Drawing No: **FIGURE 25**
Approved:	DMM		
Date:	21.12.09		
Scale:	na		Job No: P0902479

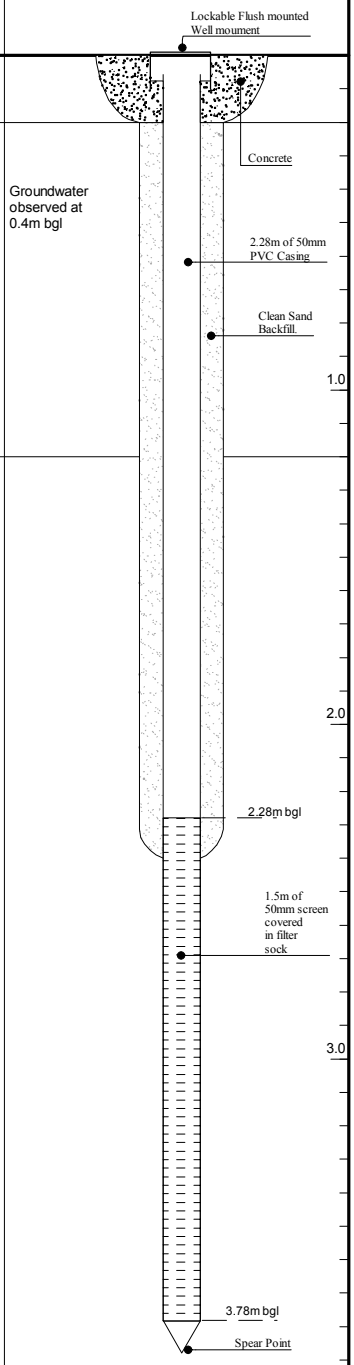
martens

9 Attachment B – Piezometer Bore Logs

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH A**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**1 of 2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	1-2°

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.2			SM	ORGANIC SILTY SAND – Dark grey, moist, medium grained.					
		0.4 ▽											Groundwater observed at 0.4m bgl
A	Nil	Y	W	1.0			SP	SAND – Light grey, dry grading to moist, fine to medium grained.					
				1.2									
A	Nil	Y	W	2.0			SP	SAND – Light brown, medium grained grading to medium coarse grained, wet, slight sulfur odour.					
				3.0									
				4.0									
				4.5									



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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mail@martens.com.au WEB: http://www.martens.com.au
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Engineering Log - Borehole

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH A**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**2** of **2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	1-2°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	Y	W	4.5 5.0 5.5			SP	SAND – Light brown, medium grained grading to medium coarse grained, wet, slight sulfur odour.					
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on sand.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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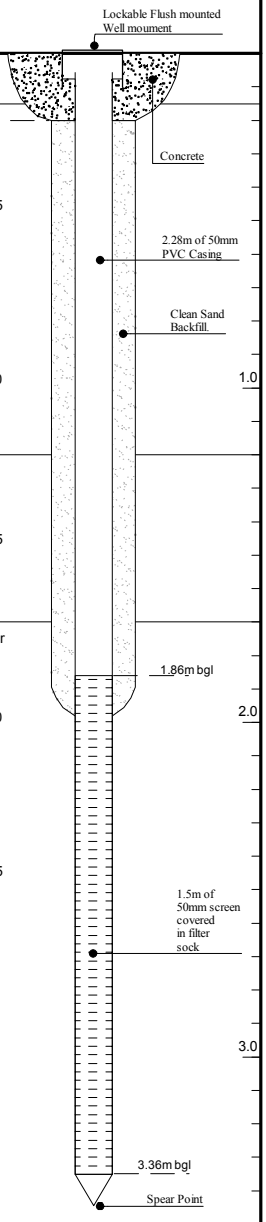
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Engineering Log - Borehole

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH B**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**1 of 2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	SAND	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 7.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	1-2°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.15			SM	SILTY SAND – Grey brown, dry, fine to medium grained.			B	0.1	2479/B/ 0.1
A	Nil	N	M	1.0			SP	SAND – Light grey, dry grading to moist, fine to medium grained.			B	0.5	2479/B/ 0.5
				1.2							B	1.0	2479/B/ 1.0
A	Nil	N	W	1.7			SP	SAND – Dark brown, wet, medium grained.			B	1.5	2479/B/ 1.5
A	Nil	Y	W	2.0 3.0 4.0 4.5			SP	SAND – Red/brown, wet, medium grained.			B B	2.0 2.5	2479/B/ 2.0 2479/B/ 2.5



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH B**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**2** of **2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 7.0m depth	**NORTHING**	NA	**ASPECT**	East	**SLOPE**	1-2°

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	Y	W	4.5			SP	SAND – Red/brown, wet, medium grained.					
				5.0									
				6.0									
				7.0				Borehole terminated at 7.0m on sand.					
				8.0									
				9.0									

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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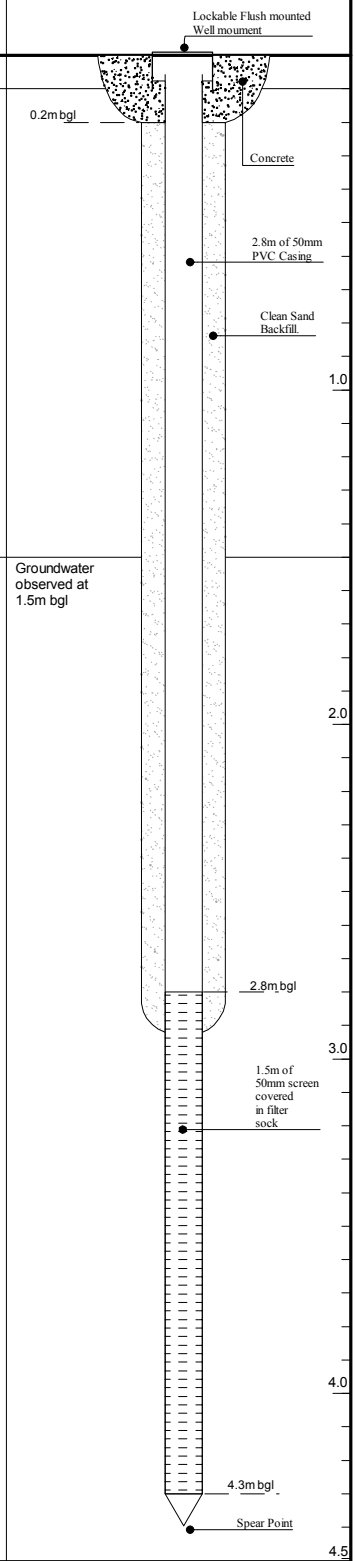
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CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH C**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**1 of 2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 7.0m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	<1°

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)
A	Nil	N	D	0.1			SM	SILTY SAND – Grey brown, dry, fine to medium grained.				
A	Nil	N	M	1.0			SP	SAND – Light grey, dry grading to moist, fine to medium grained.				
		1.5 ▽		1.5								
A	Nil	Y	W	2.0			SP	SAND – Brown, medium grained grading to medium coarse grained, wet, slight sulfur odour.				
				3.0								
				4.0								
				4.5								

RESULTS AND ADDITIONAL OBSERVATIONS



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH C**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**2** of **2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 7.0m depth	**NORTHING**	NA	**ASPECT**	North	**SLOPE**	<1°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	Y	W	4.5 5.0 6.0 7.0			SP	SAND – Brown, medium grained grading to medium coarse grained, wet, slight sulfur odour.					4.5 5.0 6.0 7.0
				8.0 9.0				Borehole terminated at 7.0m on sand.					8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

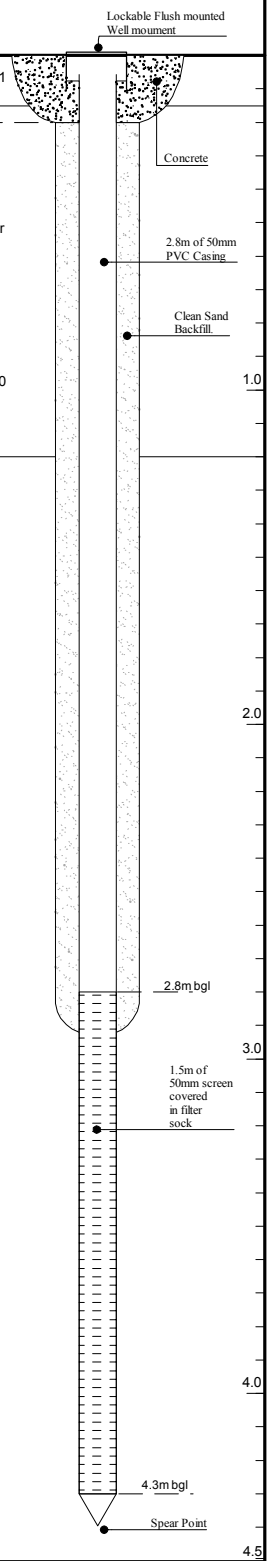
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CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH D**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**1 of 2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1°

EXCAVATION DATA						MATERIAL DATA				SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	M	0.15			SM	SILTY SAND – Dark grey, moist, medium grained.			B	0.1	2479/D/ 0.1
A	Nil	0.5 ▽ Y	W	1.0 1.2			SP	SAND – Light grey, moist (wet below 0.5m), fine to medium grained.			B	1.0	2479/D/ 1.0
A	Nil	Y	W	2.0 3.0 4.0 4.5			SP	SAND – Light brown, wet, medium grained.					



EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
▽ Water level
◁ Water outflow
▷ Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH D**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**2** of **2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING		
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	Y	W	4.5 5.0 5.5			SP	SAND – Light brown, wet, medium grained.					
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on sand.					

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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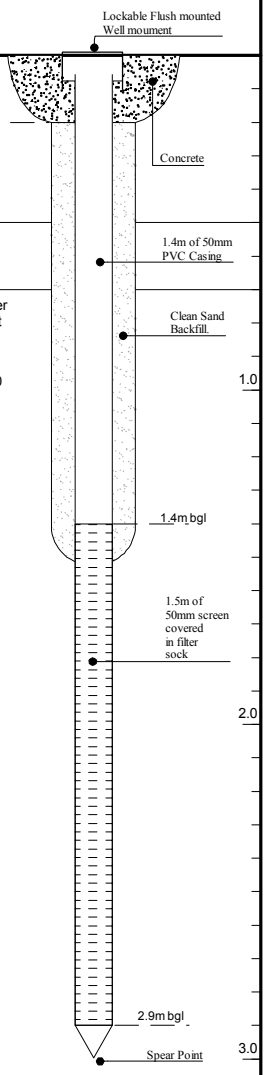
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Engineering Log - Borehole

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH E**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**1 of 2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	North West	**SLOPE**	1°

EXCAVATION DATA / MATERIAL DATA / SAMPLING & TESTING

METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA (Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.)	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	N	D	0.5			SM	SILTY SAND – Charcoal grey, dry, fine to medium grained, some organics.			B	0.1	2479/E/ 0.1
											B	0.5	2479/E/ 0.5
A	Nil	N 0.7 ▽	M	0.7			SM	SILTY SAND – Charcoal grey, moist, fine to medium grained.					
A	Nil	Y	W	1.0 2.0 3.0 4.0 4.5			SM	SILTY SAND – Dark brown (ie: colour of coffee rock), medium grained, wet, minor sulfur odour.			B	1.0	Groundwater observed at 0.7m bgl 2479/E/ 1.0
											B	1.5	2479/E/ 1.5



EQUIPMENT / METHOD: N Natural exposure; X Existing excavation; BH Backhoe bucket; E Excavator; HA Hand auger; S Hand spade; PT Push tube; A Auger; CC Concrete Corer

SUPPORT: SH Shoring; SC Shotcrete; RB Rock Bolts; Nil No support

WATER: N None observed; X Not measured; ▽ Water level; ◁ Water outflow; ▷ Water inflow

MOISTURE: D Dry; M Moist; W Wet; Wp Plastic limit; Wl Liquid limit

PENETRATION: L Low; M Moderate; H High; R Refusal

CONSISTENCY: VS Very Soft; S Soft; F Firm; St Stiff; VSt Very Stiff; H Hard; F Friable

DENSITY: VL Very Loose; L Loose; MD Medium Dense; D Dense; VD Very Dense

SAMPLING & TESTING: A Auger sample; B Bulk sample; U Undisturbed sample; D Disturbed sample; M Moisture content; Ux Tube sample (x mm); pp Pocket penetrometer; S Standard penetration test; VS Vane shear; DCP Dynamic cone penetrometer; FD Field density; WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION: Y USCS; N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

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Engineering Log - Borehole

CLIENT	**ASPEN GROUP PTY LTD**	**COMMENCED**	31/08/09	**COMPLETED**	1/09/09	**REF**	**BH E**
PROJECT	**GROUNDWATER ASSESSMENT**	**LOGGED**	BJR	**CHECKED**	JSF	**Sheet**	**2** of **2**
SITE	**FERN BAY, NSW**	**GEOLOGY**	QUATERNARY	**VEGETATION**	HEATH	**PROJECT NO.**	P0902479
EQUIPMENT	4WD MOUNTED AUGER	**EASTING**	NA	**RL SURFACE**	NA		
EXCAVATION DIMENSIONS	Ø 95mm X 5.5m depth	**NORTHING**	NA	**ASPECT**	North East	**SLOPE**	1°

EXCAVATION DATA						MATERIAL DATA					SAMPLING & TESTING			
METHOD	SUPPORT	WATER	MOISTURE	DEPTH (M)	PENETRATION RESISTANCE (L M H R)	GRAPHIC LOG	CLASSIFICATION	DESCRIPTION OF STRATA Soil type, texture, structure, mottling, colour, plasticity, rocks, oxidation, particle characteristics, organics, secondary and minor components, fill, contamination, odour.	CONSISTENCY	DENSITY INDEX	TYPE	DEPTH (M)	RESULTS AND ADDITIONAL OBSERVATIONS
A	Nil	Y	W	4.5 5.0 5.5			SM	SILTY SAND – Dark brown (ie: colour of coffee rock), medium grained, wet, minor sulfur odour.					4.5 5.0
				6.0 7.0 8.0 9.0				Borehole terminated at 5.5m on silty sand.					6.0 7.0 8.0 9.0

EQUIPMENT / METHOD
N Natural exposure
X Existing excavation
BH Backhoe bucket
E Excavator
HA Hand auger
S Hand spade
PT Push tube
A Auger
CC Concrete Corer

SUPPORT
SH Shoring
SC Shotcrete
RB Rock Bolts
Nil No support

WATER
N None observed
X Not measured
Water level
Water outflow
Water inflow

MOISTURE
D Dry
M Moist
W Wet
Wp Plastic limit
Wl Liquid limit

PENETRATION
L Low
M Moderate
H High
R Refusal

CONSISTENCY
VS Very Soft
S Soft
F Firm
St Stiff
VSt Very Stiff
H Hard
F Friable

DENSITY
VL Very Loose
L Loose
MD Medium Dense
D Dense
VD Very Dense

SAMPLING & TESTING
A Auger sample
B Bulk sample
U Undisturbed sample
D Disturbed sample
M Moisture content
Ux Tube sample (x mm)

pp Pocket penetrometer
S Standard penetration test
VS Vane shear
DCP Dynamic cone penetrometer
FD Field density
WS Water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
Y USCS
N Agricultural

EXCAVATION LOG TO BE READ IN CONJUNCTION WITH ACCOMPANYING REPORT NOTES AND ABBREVIATIONS

Quality Sheet No. 4

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Engineering Log - Borehole

10 Attachment C – Laboratory Test Data

Envirolab Services Pty Ltd
ABN 37 112 535 645
12 Ashley St Chatswood NSW 2067
ph 02 9910 6200 fax 02 9910 6201
enquiries@envirolabservices.com.au
www.envirolabservices.com.au

CERTIFICATE OF ANALYSIS 33311

Client:
Martens & Associates
6/37 Leighton Place
Hornsby
NSW 2077

Attention: Jeff Fulton

Sample log in details:

Your Reference:	**P0902479, GW Assessment Fern Bay**
No. of samples:	10 Waters
Date samples received:	17/09/09
Date completed instructions received:	17/09/09

Analysis Details:
Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last page of this report for any comments relating to the results.

Report Details:

Date results requested by:	24/09/09
Date of Preliminary Report:	Not issued
Issue Date:	25/09/09

NATA accreditation number 2901. This document shall not be reproduced except in full.
This document is issued in accordance with NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025.
Tests not covered by NATA are denoted with *.

Results Approved By:

David Springer
Business Development & Quality Manager

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Ion Balance						
Our Reference:	UNITS	33311-1	33311-2	33311-3	33311-4	33311-5
Your Reference	----------	2479/GW-101	2479/GW-102	2479/GW-104	2479/GW-105	2479/GW-106
Date Sampled	----------	16/09/2009	16/09/2009	16/09/2009	16/09/2009	16/09/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	18/09/2009	18/09/2009	18/09/2009	18/09/2009	18/09/2009
Date analysed	-	21/09/2009	21/09/2009	21/09/2009	21/09/2009	21/09/2009
Calcium - Dissolved	mg/L	1.5	0.98	2.2	0.86	6.0
Potassium - Dissolved	mg/L	1.9	1.2	2.1	3.7	1.6
Sodium - Dissolved	mg/L	35	30	100	32	19
Magnesium - Dissolved	mg/L	3.0	2.0	9.4	1.3	3.3
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	3	3
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	3	3
Sulphate, SO4	mg/L	9	8	30	16	7
Chloride (titration) - water	mg/L	48	57	180	62	51
Ionic Balance	%	10	-6.9	-4.2	-13	-6.4

Ion Balance						
Our Reference:	UNITS	33311-6	33311-7	33311-8	33311-9	33311-10
Your Reference	----------	2479/GW-A	2479/GW-B	2479/GW-C	2479/GW-D	2479/GW-E
Date Sampled	----------	16/09/2009	16/09/2009	16/09/2009	16/09/2009	16/09/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	18/09/2009	18/09/2009	18/09/2009	18/09/2009	18/09/2009
Date analysed	-	21/09/2009	21/09/2009	21/09/2009	21/09/2009	21/09/2009
Calcium - Dissolved	mg/L	4.5	0.98	3.4	4.9	0.95
Potassium - Dissolved	mg/L	1.2	3.9	1.7	2.2	1.5
Sodium - Dissolved	mg/L	28	13	34	42	25
Magnesium - Dissolved	mg/L	4.9	2.3	5.5	5.9	2.8
Hydroxide Alkalinity (OH^-) as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate Alkalinity as $CaCO_3$	mg/L	3	<0.1	<0.1	<0.1	<0.1
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity as $CaCO_3$	mg/L	3	<0.1	<0.1	<0.1	<0.1
Sulphate, SO4	mg/L	11	6	15	28	<5
Chloride (titration) - water	mg/L	62	23	72	81	55
Ionic Balance	%	-4.0	7.5	-4.3	-4.6	-4.9

Miscellaneous Inorganics						
Our Reference:	UNITS	33311-1	33311-2	33311-3	33311-4	33311-5
Your Reference	----------	2479/GW-101	2479/GW-102	2479/GW-104	2479/GW-105	2479/GW-106
Date Sampled	----------	16/09/2009	16/09/2009	16/09/2009	16/09/2009	16/09/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	23/09/2009	23/09/2009	23/09/2009	23/09/2009	23/09/2009
Date analysed	-	23/09/2009	23/09/2009	23/09/2009	23/09/2009	23/09/2009
pH	pH Units	5.6	5.2	3.7	5.3	5.3
Electrical Conductivity	µS/cm	180	150	590	140	140
Total Dissolved Solids (grav)	mg/L	210	210	470	410	160
NOx as N in water	mg/L	<0.2	<0.2	1.0	0.3	<0.2
TKN in water	mg/L	1.2	1.0	14	3.3	2.9
Ammonia as N in water	mg/L	0.3	0.3	0.3	0.8	0.3
Phosphorus - Total	mg/L	<0.050	<0.050	0.21	0.10	0.13
Phosphorus - Dissolved	mg/L	<0.050	<0.050	<0.050	0.060	<0.050

Miscellaneous Inorganics						
Our Reference:	UNITS	33311-6	33311-7	33311-8	33311-9	33311-10
Your Reference	----------	2479/GW-A	2479/GW-B	2479/GW-C	2479/GW-D	2479/GW-E
Date Sampled	----------	16/09/2009	16/09/2009	16/09/2009	16/09/2009	16/09/2009
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	23/09/2009	23/09/2009	23/09/2009	23/09/2009	23/09/2009
Date analysed	-	23/09/2009	23/09/2009	23/09/2009	23/09/2009	23/09/2009
pH	pH Units	5.6	5.2	4.4	5.0	4.6
Electrical Conductivity	µS/cm	190	83	210	270	140
Total Dissolved Solids (grav)	mg/L	140	170	210	200	160
NOx as N in water	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2
TKN in water	mg/L	0.9	1.5	1.0	<0.5	5.6
Ammonia as N in water	mg/L	0.4	0.6	0.5	0.2	0.5
Phosphorus - Total	mg/L	<0.050	0.090	<0.050	<0.050	0.44
Phosphorus - Dissolved	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050

Method ID	Methodology Summary
Metals.20 ICP-AES	Determination of various metals by ICP-AES.
LAB.6	Alkalinity - determined titrimetrically in accordance with APHA 20th ED, 2320-B.
LAB.9	Sulphate determined turbidimetrically.
LAB.11	Chloride determined by argentometric titration.
LAB.41	Gravimetric determination of the total solids content of water.
LAB.1	pH - Measured using pH meter and electrode in accordance with APHA 20th ED, 4500-H+.
LAB.2	Conductivity and Salinity - measured using a conductivity cell and dedicated meter, in accordance with APHA2510 20th ED and Rayment & Higginson.
LAB.18	Total Dissolved Solids - determined gravimetrically by drying the sample, in accordance with APHA 20th ED, 2540-C.
LAB.55	Nitrate water extractable - determined colourimetrically based on EPA114A.
LAB.62	TKN - determined colourimetrically based on EPA110A.
LAB.57	Ammonia water extractable - determined colourimetrically based on EPA350.1

QUALITY CONTROL Ion Balance	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			18/09/2009	33311-1	18/09/2009 || 18/09/2009	LCS-W1	18/09/2009
Date analysed	-			21/09/09	33311-1	21/09/2009 || 21/09/2009	LCS-W1	21/09/09
Calcium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	33311-1	1.5 || 1.5 || RPD: 0	LCS-W1	101%
Potassium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	33311-1	1.9 || 1.9 || RPD: 0	LCS-W1	97%
Sodium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	33311-1	35 || 33 || RPD: 6	LCS-W1	93%
Magnesium - Dissolved	mg/L	0.03	Metals.20 ICP-AES	<0.030	33311-1	3.0 || 3.1 || RPD: 3	LCS-W1	99%
Bicarbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	33311-1	<0.1 || <0.1	LCS-W1	105%
Carbonate Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	33311-1	<0.1 || <0.1	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	0.1	LAB.6	<0.1	33311-1	<0.1 || <0.1	LCS-W1	105%
Sulphate, SO4	mg/L	5	LAB.9	<5	33311-1	9 || 9 || RPD: 0	[NR]	[NR]
Chloride (titration) - water	mg/L	20	LAB.11	<20	33311-1	48 || 50 || RPD: 4	LCS-W1	100%
Ionic Balance	%		LAB.41	[NT]	33311-1	10 || 6.2 || RPD: 47	[NR]	[NR]

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			23/09/09	33311-1	23/09/2009 || 23/09/2009	LCS-W1	23/09/09
Date analysed	-			23/09/09	33311-1	23/09/2009 || 23/09/2009	LCS-W1	23/09/09
pH	pH Units		LAB.1	[NT]	33311-1	5.6 || 5.6 || RPD: 0	LCS-W1	101%
Electrical Conductivity	µS/cm	1	LAB.2	<1.0	33311-1	180 || 170 || RPD: 6	LCS-W1	100%
Total Dissolved Solids (grav)	mg/L	5	LAB.18	<5	33311-1	210 || 180 || RPD: 15	LCS-W1	94%
NOx as N in water	mg/L	0.2	LAB.55	<0.2	33311-1	<0.2 || <0.2	LCS-W1	98%
TKN in water	mg/L	0.5	LAB.62	<0.5	33311-1	1.2 || 1.1 || RPD: 9	LCS-W1	99%
Ammonia as N in water	mg/L	0.1	LAB.57	<0.1	33311-1	0.3 || 0.2 || RPD: 40	LCS-W1	105%
Phosphorus - Total	mg/L	0.05	Metals.20 ICP-AES	<0.050	33311-1	<0.050 || <0.050	LCS-W1	93%
Phosphorus - Dissolved	mg/L	0.05	Metals.20 ICP-AES	<0.050	33311-1	<0.050 || <0.050	LCS-W1	99%

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QUALITY CONTROL Ion Balance	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	33311-2	18/09/09
Date analysed	-	[NT]	[NT]	33311-2	21/09/09
Calcium - Dissolved	mg/L	[NT]	[NT]	33311-2	96%
Potassium - Dissolved	mg/L	[NT]	[NT]	33311-2	99%
Sodium - Dissolved	mg/L	[NT]	[NT]	33311-2	98%
Magnesium - Dissolved	mg/L	[NT]	[NT]	33311-2	96%
Bicarbonate Alkalinity as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Carbonate Alkalinity as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Total Alkalinity as $CaCO_3$	mg/L	[NT]	[NT]	[NR]	[NR]
Sulphate, SO4	mg/L	[NT]	[NT]	33311-2	97%
Chloride (titration) - water	mg/L	[NT]	[NT]	[NR]	[NR]
Ionic Balance	%	[NT]	[NT]	[NR]	[NR]
QUALITY CONTROL Miscellaneous Inorganics	UNITS	Dup. Sm#	Duplicate Base + Duplicate + %RPD	Spike Sm#	Spike % Recovery
Date prepared	-	[NT]	[NT]	33311-2	23/09/09
Date analysed	-	[NT]	[NT]	33311-2	23/09/09
pH	pH Units	[NT]	[NT]	[NR]	[NR]
Electrical Conductivity	µS/cm	[NT]	[NT]	[NR]	[NR]
Total Dissolved Solids (grav)	mg/L	[NT]	[NT]	[NR]	[NR]
NOx as N in water	mg/L	[NT]	[NT]	33311-2	96%
TKN in water	mg/L	[NT]	[NT]	33311-2	96%
Ammonia as N in water	mg/L	[NT]	[NT]	33311-2	96%
Phosphorus - Total	mg/L	[NT]	[NT]	33311-2	88%
Phosphorus - Dissolved	mg/L	[NT]	[NT]	33311-2	94%

Report Comments:

Asbestos was analysed by Approved Identifier: Not applicable for this job
INS: Insufficient sample for this test NT: Not tested PQL: Practical Quantitation Limit <: Less than >: Greater than
RPD: Relative Percent Difference NA: Test not required LCS: Laboratory Control Sample NR: Not requested

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike: A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample): This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria:

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the sample batch were within laboratory acceptance criteria.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes and LCS: Generally 70-130% for inorganics/metals; 60-140% for organics and 10-140% for SVOC and speciated phenols is acceptable. Surrogates: 60-140% is acceptable for general organics and 10-140% for SVOC and speciated phenols.

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11 Attachment D – Slug Test Data

Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by pouring 10 L of water into Piezo.

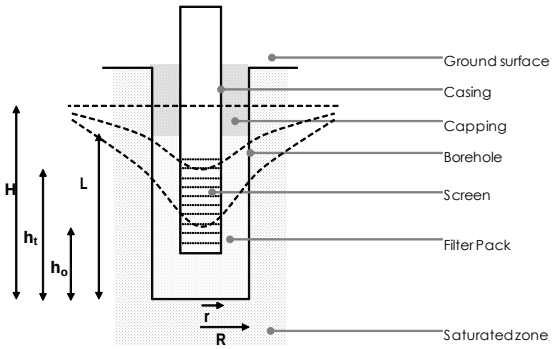
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PROJECT DETAILS

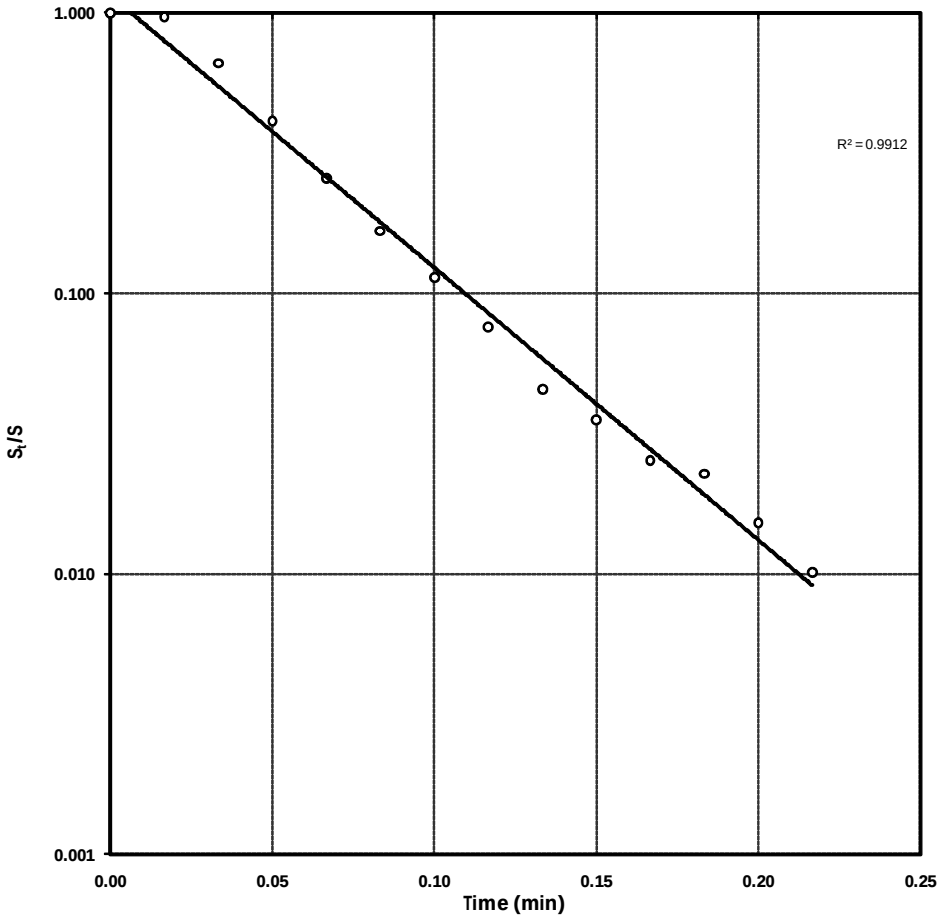
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	101	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	14.93	m
h_o - Water level reading at time = 0 (depth)	15.32	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.05	minutes
K_{sat} - Saturated hydraulic conductivity	14.09	m/d



DATA PLOT



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ABN 85 070 240 890 ACN 070 240 890

Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by pouring 10 L of water into Piezo.

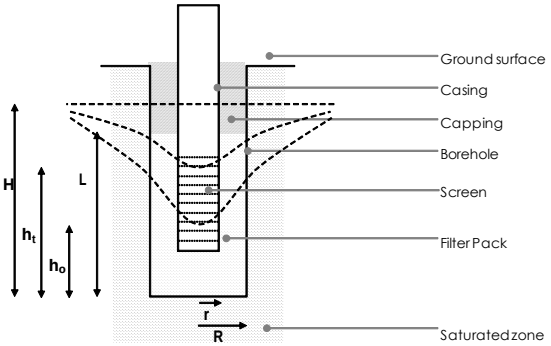
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PROJECT DETAILS

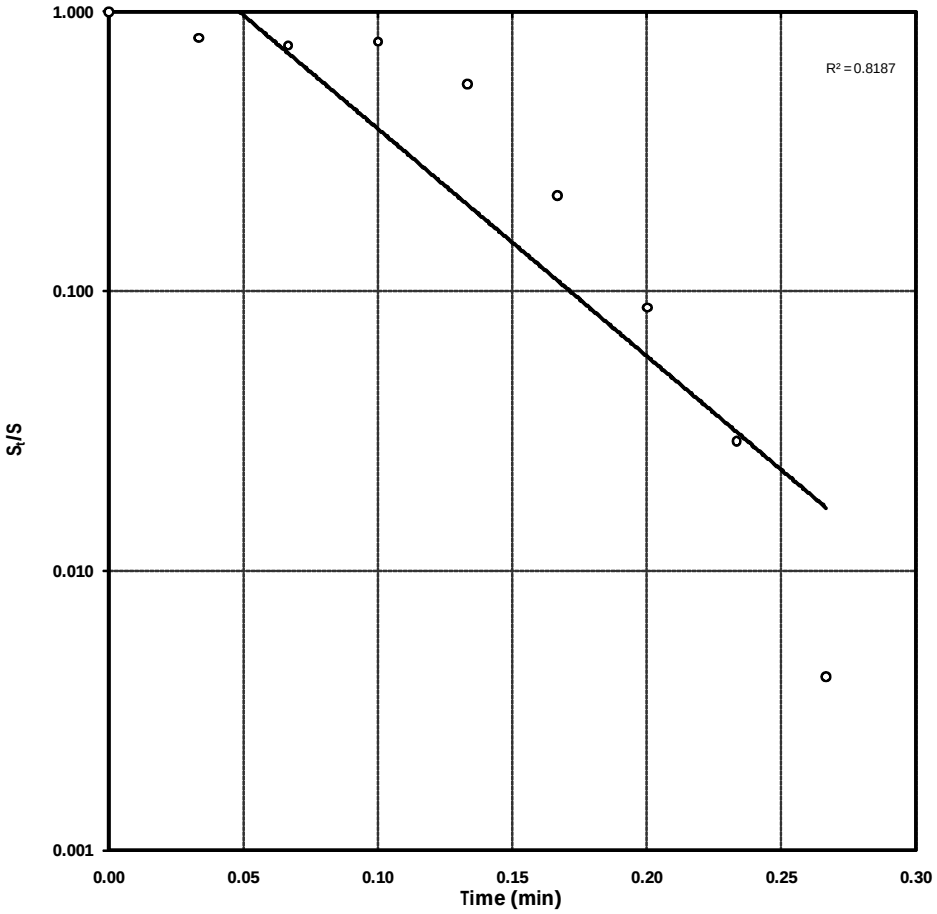
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	106	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	12.56	m
h_o - Water level reading at time = 0 (depth)	12.80	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.10	minutes
K_{sat} - Saturated hydraulic conductivity	7.07	m/d



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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by displacement with 40 mm OD PVC slug.

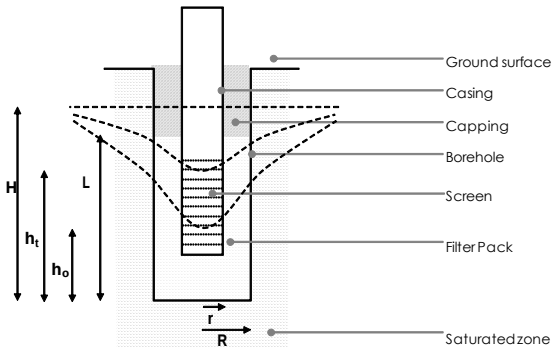
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PROJECT DETAILS

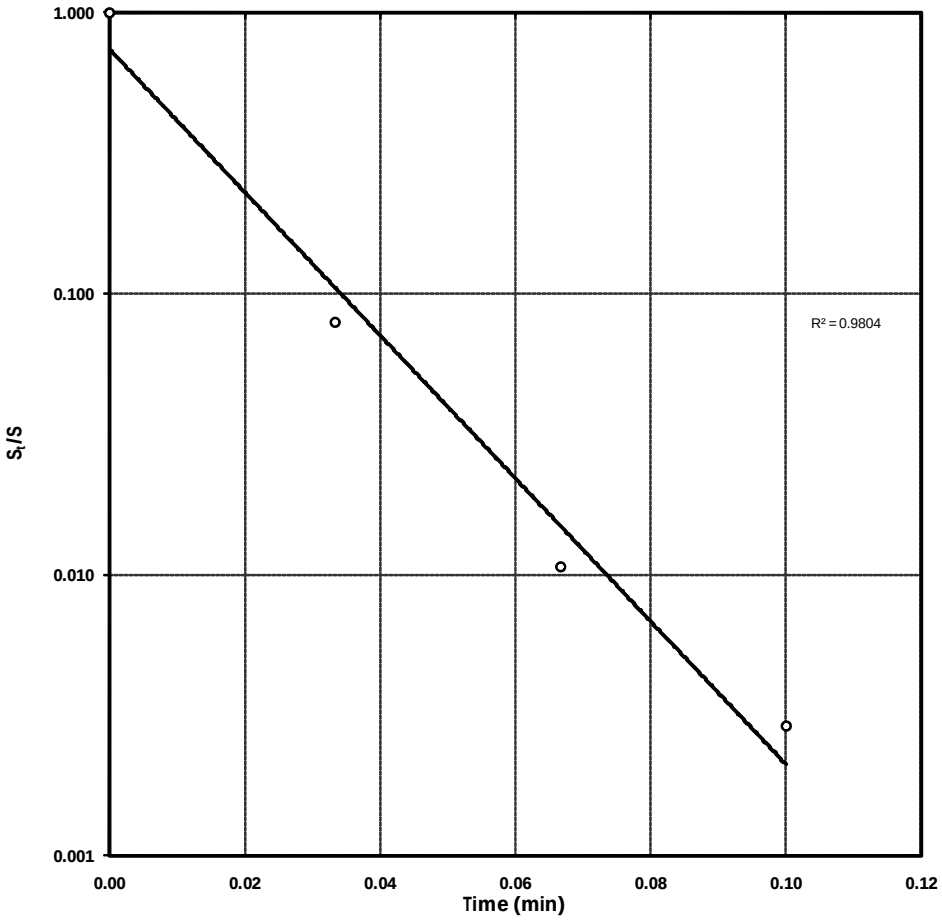
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	107	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	13.20	m
h_o - Water level reading at time = 0 (depth)	15.26	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.01	minutes
K_{sat} - Saturated hydraulic conductivity	60.52	m/d



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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

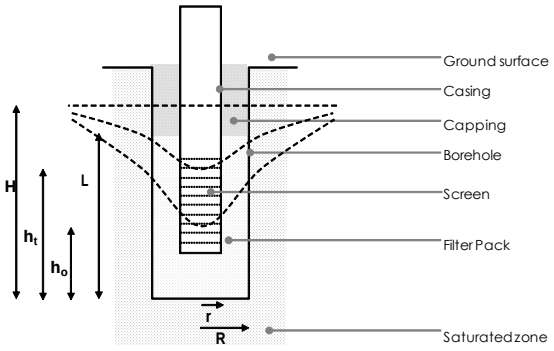
Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by displacement with 40 mm OD PVC slug.

PROJECT DETAILS

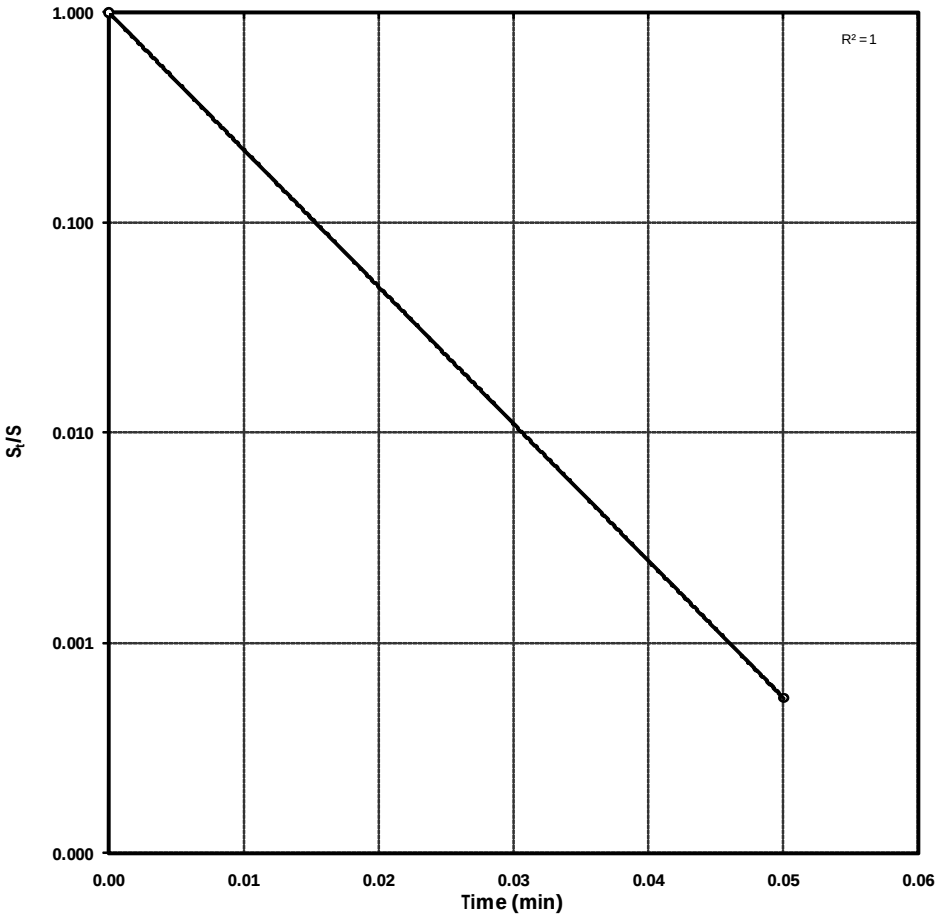
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	GWA	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	13.79	m
h_o - Water level reading at time = 0 (depth)	15.61	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.01	minutes
K_{sat} - Saturated hydraulic conductivity	108.44	m/d



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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by pouring 10 L of water into Piezo.

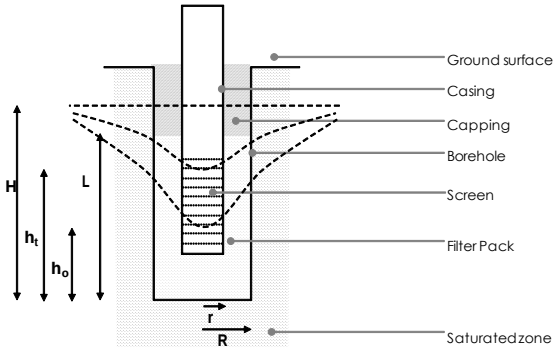
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PROJECT DETAILS

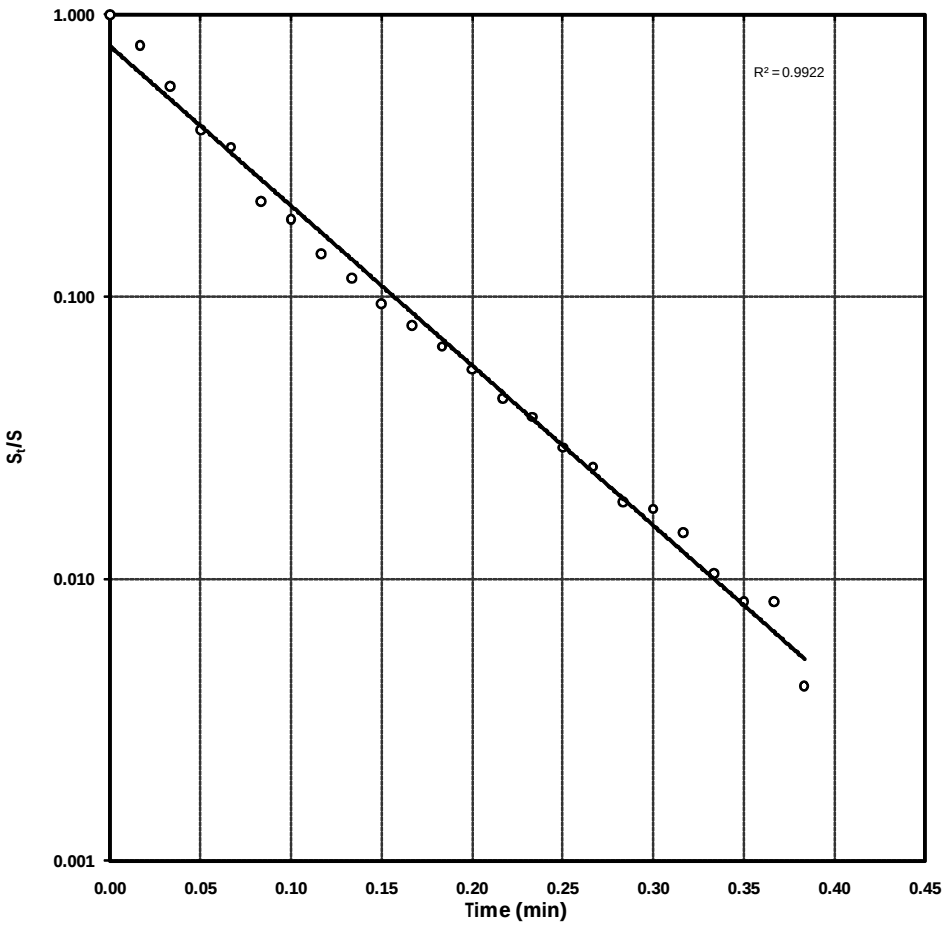
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	GWB	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	12.07	m
h_o - Water level reading at time = 0 (depth)	13.03	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.06	minutes
K_{sat} - Saturated hydraulic conductivity	12.68	m/d



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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by pouring 10 L of water into Piezo.

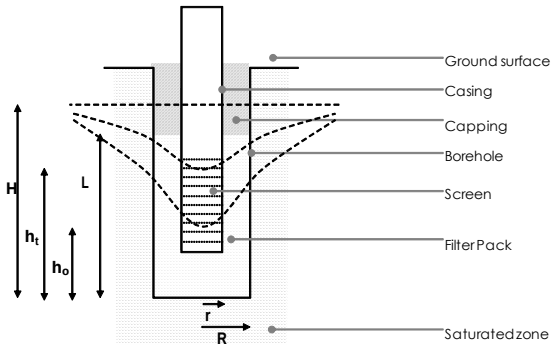
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PROJECT DETAILS

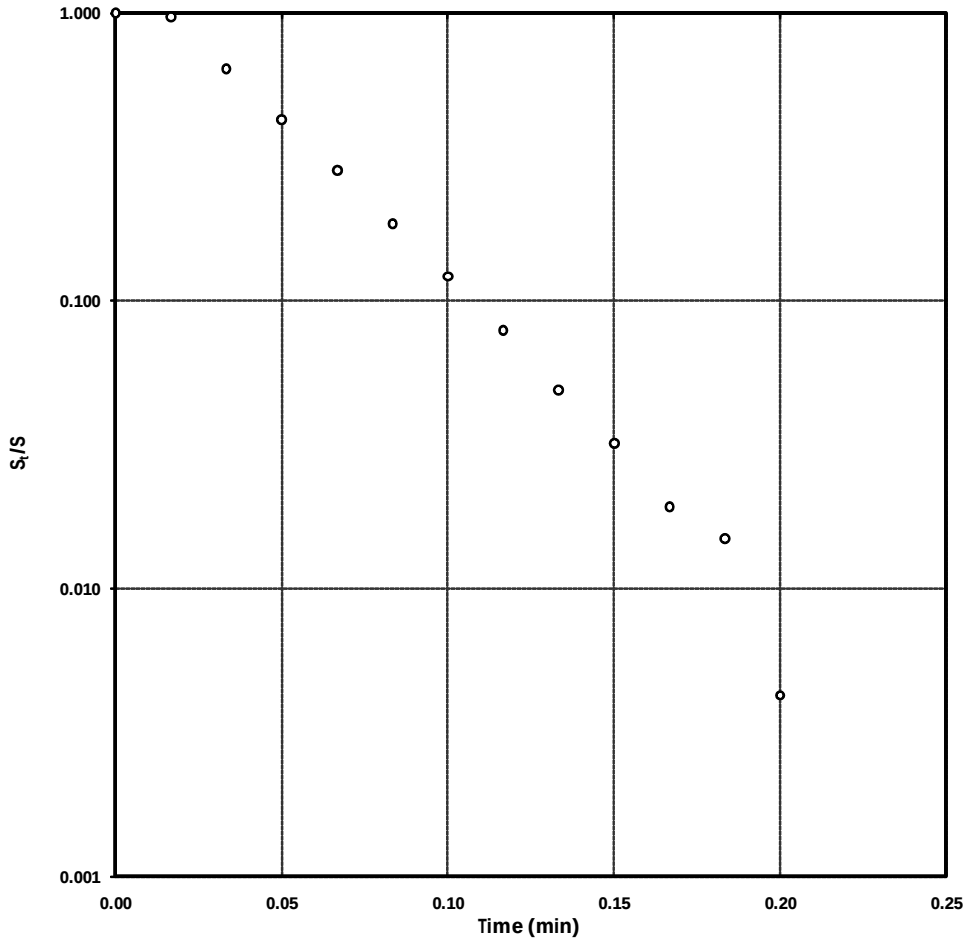
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	GWC	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	14.01	m
h_o - Water level reading at time = 0 (depth)	14.48	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.05	minutes
K_{sat} - Saturated hydraulic conductivity	13.55	m/d



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Single Bore Slug Test (Rising or Falling)

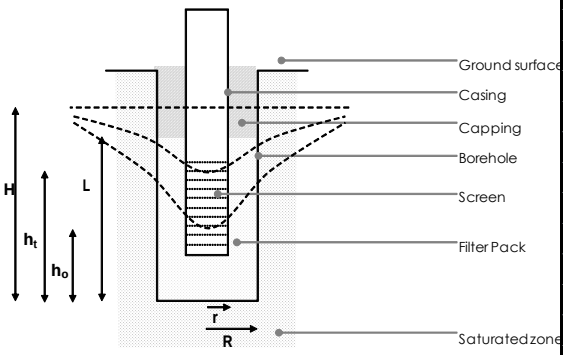
Method ST-13 Revised 7.3.2007

PROJECT DETAILS

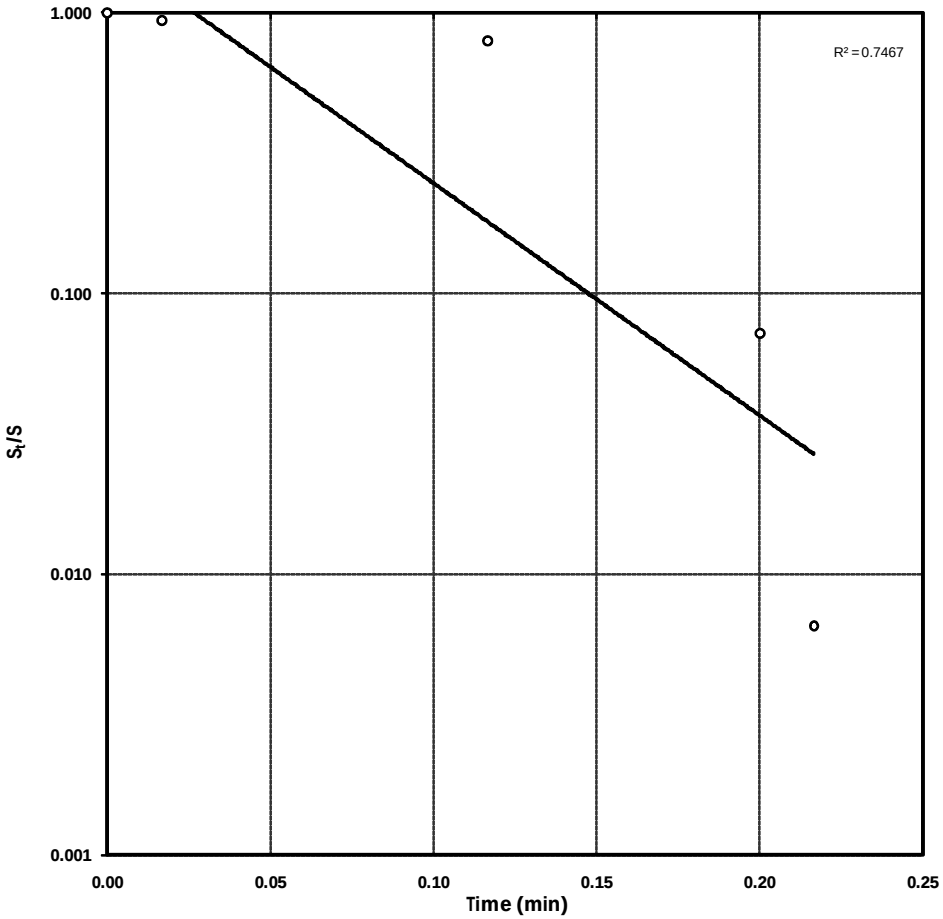
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	GWD	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	12.0	m
h_o - Water level reading at time = 0 (depth)	12.16	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.08	minutes
K_{sat} - Saturated hydraulic conductivity	9.110	m/d



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Single Bore Slug Test (Rising or Falling)

Method ST-13 Revised 7.3.2007

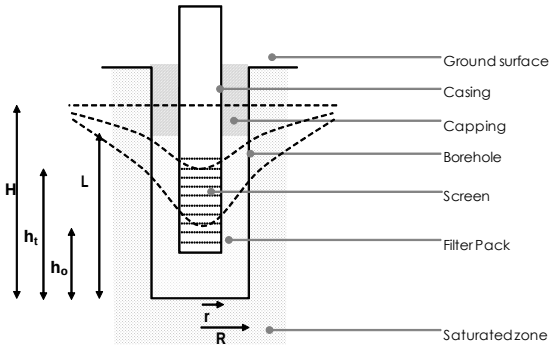
Notes: 1. water level values = direct pressure reading from logger/100 and are relative levels which do not relate to any datum. 2. Water raised by pouring 10 L of water into Piezo.

PROJECT DETAILS

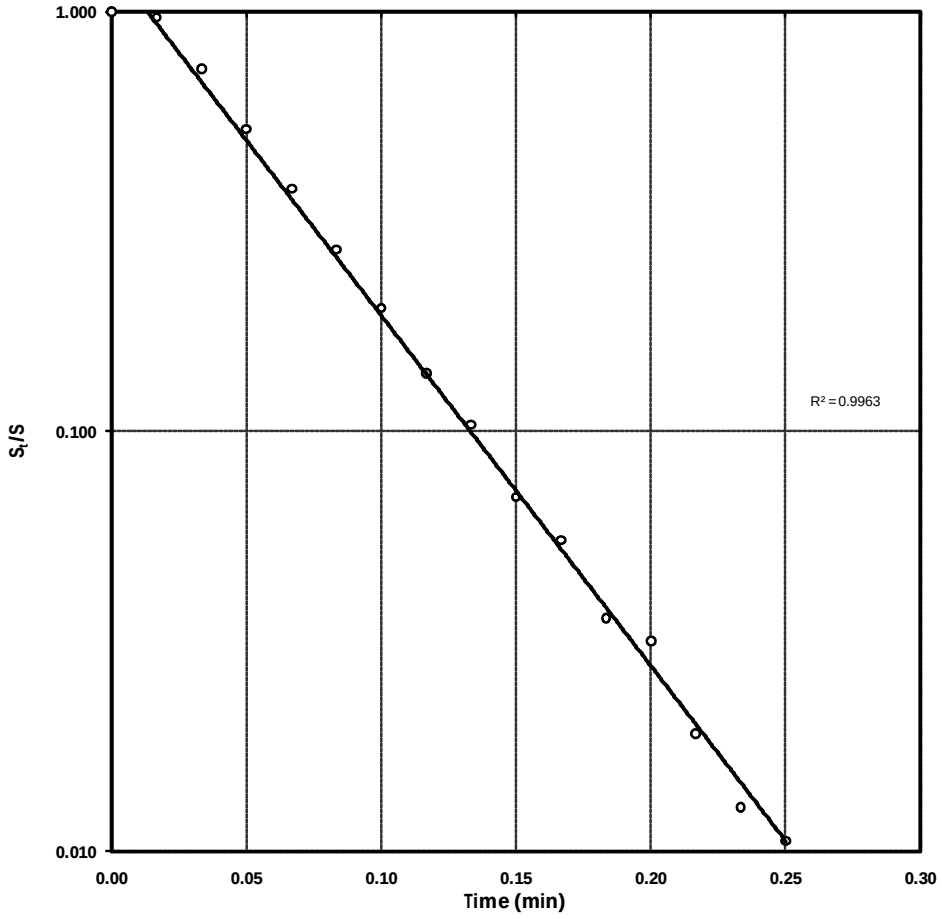
Project	FERN BAY PROJECT	Test Date	1/09/2009
Project Ref	P0902479JS02_V1	Field Testing	B. ROSE AND J. FULTON
Borehole Ref	GWE	Data Analysis	B. ROSE
Method	Hvorslev (1981)	Reviewed	D. MARTENS

FIELD TEST DATA

FACTOR	Enter Data	Unit
H - Initial water level reading (depth)	13.18	m
h_o - Water level reading at time = 0 (depth)	13.65	m
r - Casing radius	0.025	m
R - Bore radius	0.025	m
L - Length of open screen	3.00	m
T_o - Length of characteristic time	0.07	minutes
K_{sat} - Saturated hydraulic conductivity	11.04	m/d



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12 Attachment E – Plans

KEY:

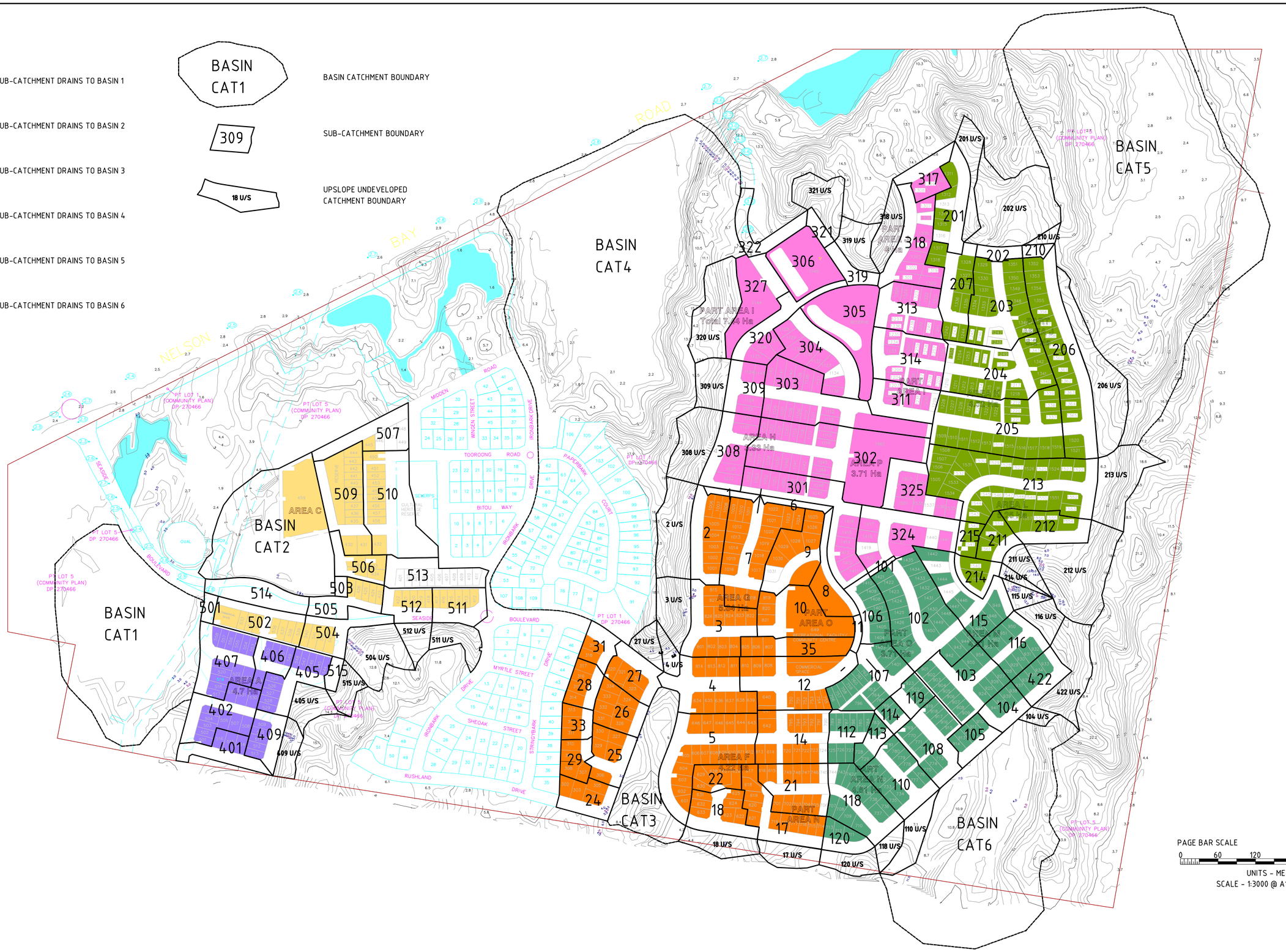
- SUB-CATCHMENT DRAINS TO BASIN 1
- SUB-CATCHMENT DRAINS TO BASIN 2
- SUB-CATCHMENT DRAINS TO BASIN 3
- SUB-CATCHMENT DRAINS TO BASIN 4
- SUB-CATCHMENT DRAINS TO BASIN 5
- SUB-CATCHMENT DRAINS TO BASIN 6

BASIN CAT1 — BASIN CATCHMENT BOUNDARY

309 — SUB-CATCHMENT BOUNDARY

18 U/S — UPSLOPE UNDEVELOPED CATCHMENT BOUNDARY

N W E S



PAGE BAR SCALE

0 60 120 180 240 300

UNITS - METRES

SCALE - 1:3000 @ A1 1:6000 @ A3

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CLIENT/ PROJECT
ASPEN GROUP
FERN BAY SEASIDE VILLAGE

THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified.

TITLE
CONCEPT SITE DRAINAGE PLAN - DRAINS MODELLING SUB-CATCHEMNT BOUNDARIES

PROJECT MANAGER: DMM

DRAWING NUMBER: P0902479JD01_V2

DESIGNED: SL
DRAWN: SL
REVIEWED: DMM

DATUM: mAHD
HORIZONTAL RATIO: 1:3000 @ A1 1:6000 @ A3
VERTICAL RATIO: 1:3000@ A1 1:6000 @ A3

SHEET 1 OF 6 SHEETS

PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	DEVELOPMENT APPLICATION	21.12.2009	SL

KEY:

TYPE 1 GRASS SWALE (FLOW <0.2m3/s)
(APPROXIMATE LOCATION ONLY)

TYPE 2 GRASS SWALE (FLOW 0.2-0.8m3/s)
(APPROXIMATE LOCATION ONLY)

TYPE 3 GRASS SWALE (FLOW >0.8m3/s))
(APPROXIMATE LOCATION ONLY)

PIPE SECTION

PROPOSED ON-SITE STORMWATER DETENTION (OSD)

DESIGN LEVELS

CONVEYANCE SWALE
WITH REVEGETATED BATTER

EXISTING BASIN 4
IWL = RL 1.35
BWL = RL 1.80
TWL = RL 1.81

EXISTING BASIN 5
IWL = RL 2.50
BWL = RL 2.70
TWL = RL 2.76

CONVEYANCE SWALE
WITH REVEGETATED BATTER

PROPOSED BASIN 2
IWL = RL 1.35
BWL = RL 2.00
TWL = RL 2.08

EXISTING BASIN 1
IWL = RL 1.35
BWL = RL 1.80
TWL = RL 1.81

30 m wide corridor for NPWS 4WD access track.
Basin spillway at 3.6 mAHD

PROPOSED BASIN 3
IWL = RL 2.30
BWL = RL 2.50
TWL = RL 3.28

PROPOSED BASIN 6
IWL = RL 2.50
BWL = RL 2.50
TWL = RL 3.12

PAGE BAR SCALE
0 60 120 180 240 300
UNITS - METRES
SCALE - 1:3000 @ A1 1:6000 @ A3

NOTE:
IWL = DESIGN BASIN INVERT LEVEL OR EXISTING MEAN PONDED WATER LEVEL
BWL = ASSUMED LEVEL AT HIGH GROUNDWATER CONDITION WITH 1M SEALEVEL RISE
TWL = PEAK WATER LEVEL DURING CRITICAL STORM EVENT ABOVE GROUND WATER LEVEL WITH 1M SEA LEVEL RISE AND CLIMATE CHANGE EFFECT (20% RAINFALL INTENSITY INCREASE)

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All measurements in mm unless otherwise specified.

TITLE
CONCEPT SITE DRAINAGE PLAN - PROPOSED SWALES AND BASINS

PROJECT MANAGER: DMM
DRAWING NUMBER: P0902479JD01_V2

DESIGNED: SL
DRAWN: SL
REVIEWED: DMM
DATUM: mAHD
HORIZONTAL RATIO: 1:3000 @ A1 1:6000 @ A3
VERTICAL RATIO: 1:3000@ A1 1:6000 @ A3
SHEET 2 OF 6 SHEETS
PAPER SIZE: A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	DEVELOPMENT APPLICATION	21.12.2009	SL



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All measurements in mm unless otherwise specified.

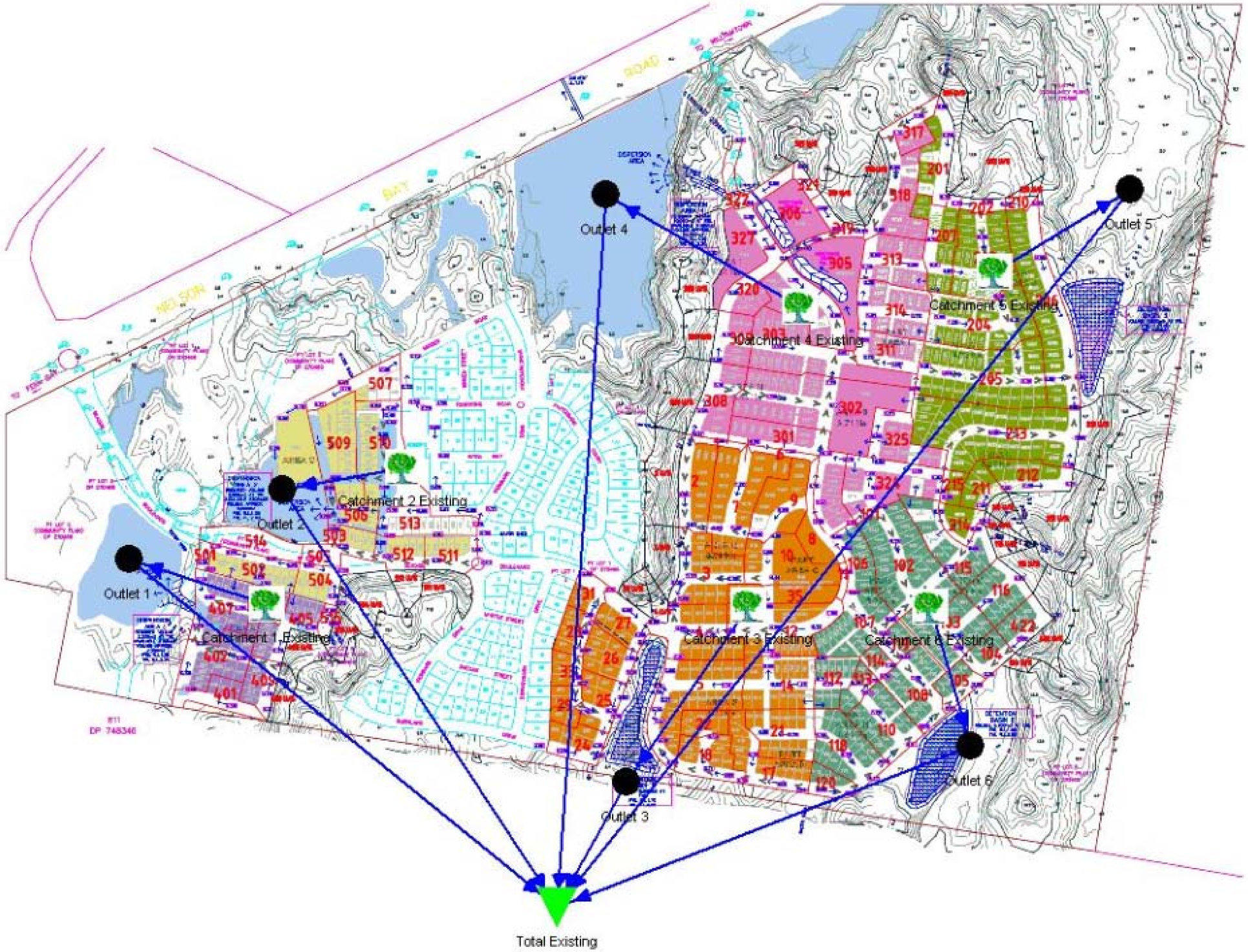
TITLE
CONCEPT SITE DRAINAGE PLAN - DRAINS MODEL LAYOUT

PROJECT MANAGER: DMM

DRAWING NUMBER: P0902479JD01_V2

DESIGNED:	DATUM:	SHEET
SL	mAHD	3
DRAWN:	HORIZONTAL RATIO:	OF 6 SHEETS
SL	NA	
REVIEWED:	VERTICAL RATIO:	PAPER SIZE:
DMM	NA	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	DEVELOPMENT APPLICATION	21.12.2009	SL



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TITLE
MUSIC MODEL SCHEMATIC - EXISTING CONDITIONS

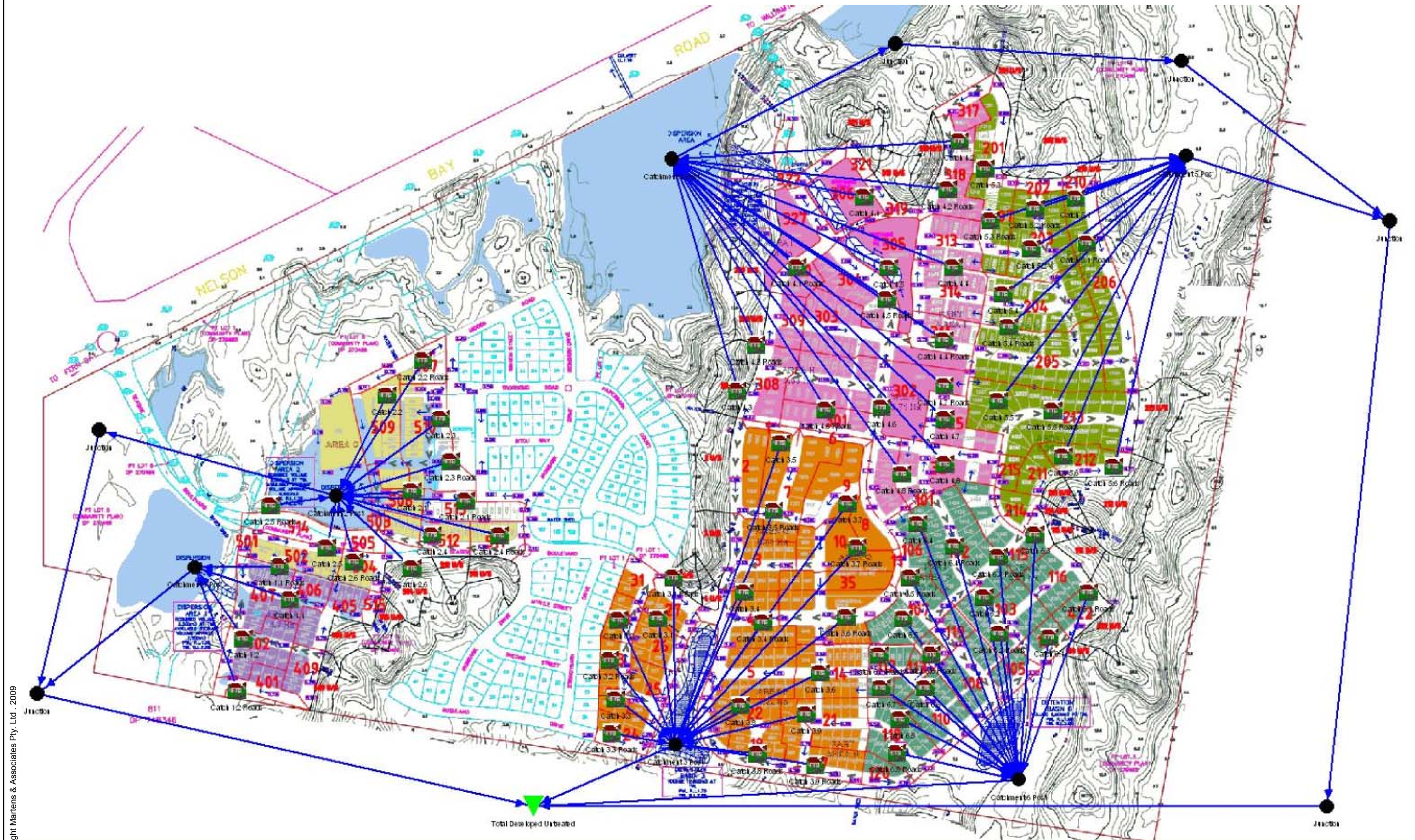
THIS PLAN MUST NOT BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED BY PRINCIPAL CERTIFYING AUTHORITY
All measurements in mm unless otherwise specified.

PROJECT MANAGER: DMM

DRAWING NUMBER: P0902479JD01_V2

DESIGNED:	MGD
DRAWN:	MGD
REVIEWED:	DMM
DATUM:	mAHD
HORIZONTAL RATIO:	NA
VERTICAL RATIO:	NA
SHEET	4 OF 6 SHEETS
PAPER SIZE:	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	ATTACHMENT A	21.12.2009	MGD



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All measurements in mm unless otherwise specified.

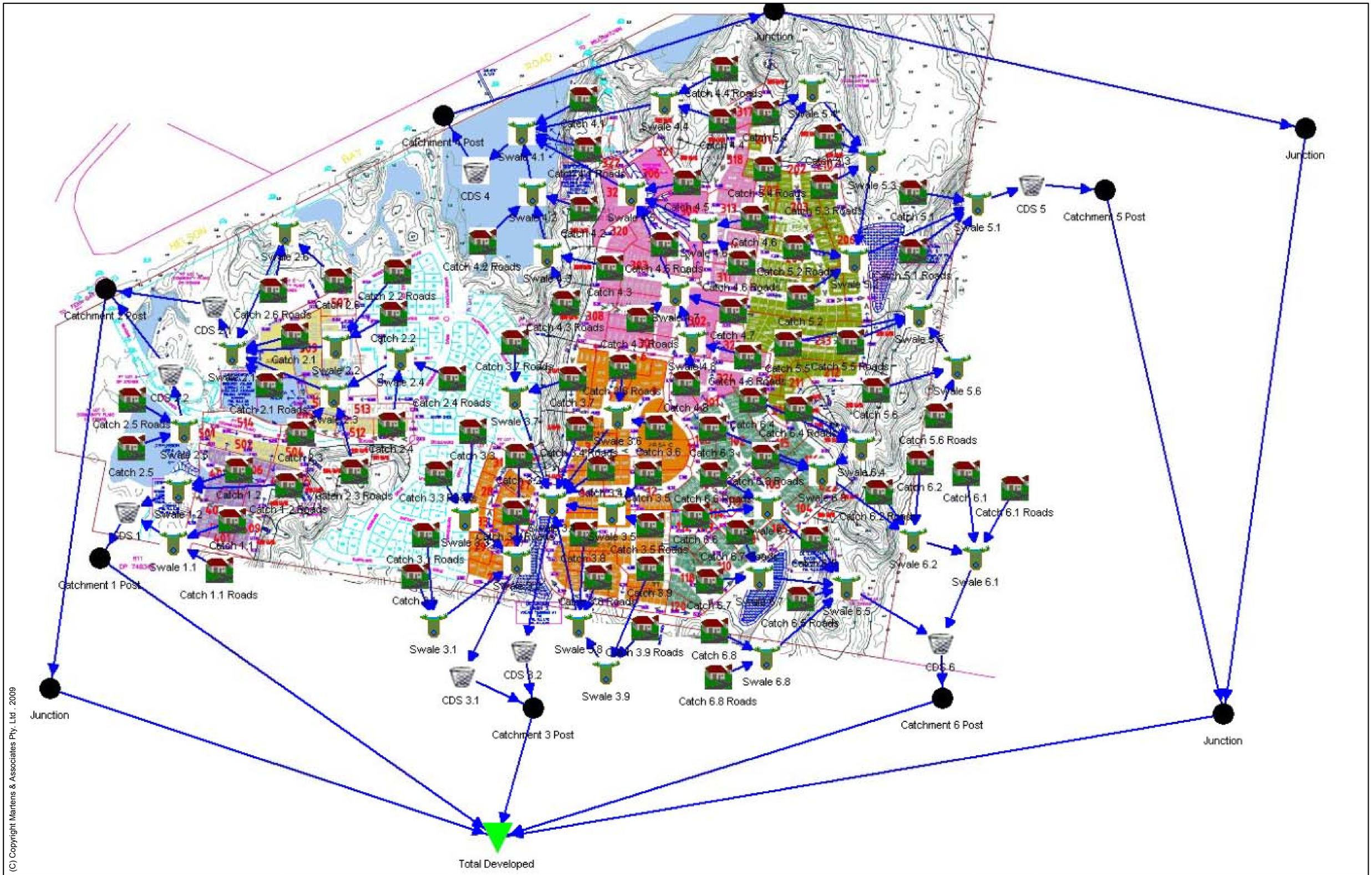
TITLE
MUSIC MODEL SCHEMATIC - PROPOSED CONDITIONS NO TREATMENT

PROJECT MANAGER: DMM

DRAWING NUMBER: P0902479JD01_V2

DESIGNED:	DATUM:	SHEET
MGD	mAHD	5
DRAWN:	HORIZONTAL RATIO:	OF 6 SHEETS
MGD	NA	
REVIEWED:	VERTICAL RATIO:	PAPER SIZE:
DMM	NA	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	ATTACHMENT A	21.12.2009	MGD



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TITLE
MUSIC MODEL SCHEMATIC - PROPOSED CONDITIONS WITH TREATMENT

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All measurements in mm unless otherwise specified.

PROJECT MANAGER: DMM

DRAWING NUMBER: P0902479JD01_V2

DESIGNED:	MGD
DRAWN:	MGD
REVIEWED:	DMM
DATUM:	mAHD
HORIZONTAL RATIO:	NA
VERTICAL RATIO:	NA
SHEET	6 OF 6 SHEETS
PAPER SIZE:	A1 / A3

REV.	DESCRIPTION	DATE	ISSUED
1	ATTACHMENT A	21.12.2009	MGD

13 Attachment F – DRAINS Input and Output Files

DRAINS MODEL INPUT DATA

PIT / NODE DETAILS

Name	Type	Family	Version 9 Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id	Part Full Shock Loss
N 5	Node						2.5		0	388973.4	6363362.834			8
N 1	Node						5		0	389011.759	6363760.783			37
N 2	Node						3.38		0	389003.892	6363610.006			38
N 3	Node						2.95		0	388999.303	6363521.506			39
N 4	Node						2.5		0	388984.465	6363431.437			40
N 6	Node						4.6		0	389112.52	6363743.07			79
N 7	Node						3.73		0	389071.904	6363599.818			81
N 8	Node						4.8		0	389205.62	6363642.715			87
N 9	Node						4.19		0	389111.422	6363594.11			89
N 10	Node						3.6		0	389106.592	6363522.319			96
N 11	Node						5.4		0	389269.311	6363491.144			106
N 12	Node						4		0	389139.792	6363434.864			107
N 14	Node						4.24		0	389106.812	6363363.15			120
N 17	Node						4.14		0	389107.128	6363197.175			141
N 18	Node						3.34		0	389024.931	6363209.189			142
N 21	Node						4.21		0	389120.09	6363269.256			154
N 22	Node						3.94		0	389036.944	6363269.888			155
N 24	Node						3.1		0	388888.673	6363296.76			166
N 25	Node						2		0	388910.171	6363359.04			168
N 26	Node						2.7		0	388930.088	6363412.152			170
N 27	Node						2.6		0	388953.717	6363463.884			172
N 28	Node						3.46		0	388859.588	6363459.249			184
N 29	Node						2.95		0	388832.602	6363318.619			186
N 31	Node						3.08		0	388886.39	6363513.464			193
N 33	Node						3.48		0	388840.378	6363401.924			208
N 35	Node						3.8		0	389138.426	6363487.672			236
N 101	Node						4.85		0	389317.793	6363635.172			353
N 102	Node						3.58		0	389382.438	6363487.217			355
N 103	Node						3.18		0	389431.604	6363433.043			357
N 104	Node						2.78		0	389497.88	6363366.944			359
N 108	Node						2.99		0	389431.149	6363308.306			361
N 105	Node						2.6		0	389437.29	6363310.162			364
N 106	Node						5.4		0	389286.874	6363507.244			380
N 107	Node						4.7		0	389321.086	6363424.732			382
N 110	Node						4.17		0	389307.562	6363196.543			392
N 118	Node						3.61		0	389376.165	6363258.823			396
N 112	Node								0	389282.3	6363364.723			406
N 113	Node						4.53		0	389301.327	6363342.769			413
N 114	Node						4.6		0	389324.928	6363363.443			420
N 115	Node						4.45		0	389437.181	6363534.499			424
N 116	Node						4.23		0	389483.338	6363482.336			429
N 119	Node						4.2		0	389352.92	6363386.861			436
N 120	Node						4.46		0	389294.601	6363183.897			442
N 201	Node						4.7		0	389435.066	6364132.943			494
N 202	Node						4.25		0	389496.721	6364122.946			496
N 203	Node						3.6		0	389511.181	6364023.223			498
N 204	Node						3.15		0	389535.218	6363959.853			500
N 205	Node						2.7		0	389561.986	6363839.122			503
N 206	Node						2.3		0	389645.564	6363850.032			505
N 207	Node						5.47		0	389406.444	6364027.216			524
N 210	Node						3.8		0	389581.107	6364145.593			537
N 211	Node						3.9		0	389531.707	6363668.544			541
N 212	Node						3.2		0	389640.829	6363705.374			543
N 214	Node						4.45		0	389498.512	6363637.562			552
N 215	Node						5.2		0	389424.132	6363706.78			556
N 213	Node						2.8		0	389649.422	6363760.344			560
N 301	Node						3.96		0	389244.65	6363765.979			608
N 302	Node						3.4		0	389258.687	6363854.372			610
N 303	Node						3.16		0	389265.937	6363899.012			614
N 304	Node						2.5		0	389229.839	6363995.362			618
N 305	Node						2.5		0	389240.18	6364008.859			622
N 320	Node						3.42		0	389173.992	6364045.491			626
N 327	Node						3.1		0	389140.247	6364092.056			628
N 306	Node						2		0	389157.983	6364100.857			630
N 308	Node						4.6		0	389069.138	6363878.199			640
N 309	Node						4.17		0	389082.838	6363960.133			644
N 324	Node						4.5		0	389320.208	6363723.869			654
N 325	Node						4.2		0	389331.905	6363788.362			658
N 311	Node						3.3		0	389283.325	6363894.796			666
N 314	Node						3.65		0	389293.209	6363956.575			670
N 313	Node						4.15		0	389295.221	6364014.977			681
N 317	Node						5.47		0	389352.086	6364247.032			695
N 318	Node						4.35		0	389301.24	6364082.111			704
N 319	Node						3.97		0	389251.447	6364082.374			708
N 321	Node						3.97		0	389184.497	6364178.917			714
N 322	Node						3.4		0	389114.571	6364134.121			716
N 401	Node						3.1		0	388183.992	6363347.975			772
N 402	Node						2.99		0	388206.754	6363429.54			774
N 515 U/S	Node						5		0	388475.134	6363441.237			780
N 515	Node						4.5		0	388429.318	6363489.607			782
N 405	Node						3.65		0	388351.863	6363455.78			786
N406	Node						3.3		0	388302.229	6363470.006			790
N 407	Node						2.5		0	388216.554	6363494.349			792
N 408	Node						3.65		0	388314.436	6363516.011			802
N 501	Node						2.7		0	388242.794	6363581.921			831
N 502	Node						2.4		0	388326.256	6363562.32			833
N 504	Node						2.5		0	388434.693	6363545.88			841
N 505	Node						2.5		0	388432.48	6363582.553			843
N 503	Node						2.8		0	388432.164	6363616.064			847
N 506	Node						2.5		0	388431.215	6363638.51			852
N 507	Node						4.34		0	388397.906	6363799.602			861
N 509	Node						5		0	388423.691	6363682.517			867
N 510	Node						3.53		0	388487.172	6363684.035			873
N 511	Node						4.3		0	388587.073	6363562.32			883
N 512	Node						3.2		0	388505.192	6363568.01			886
B3 Outlet	Node						2.7		0	388876.467	6363230.165			926
B6 Outlet	Node						2.7		0	389501.708	6363258.974			976
B5 Outlet	Node						2.7		0	389696.474	6364110.043			981
B4 Outlet	Node						2.7		0	388932.573	6364181.789			1002
B2 Outlet	Node						2.7		0	388377.737	6363631.527			1017
B1 Outlet	Node						2.7		0	388139.055	6363522.948			1022
N 513	Node						3.09		0	388514.993	6363650.207			1030
N 514	Node						2.4		0	388335.951	6363599.437			1038
N27 U/S	Node						2.8		0	388933.201	6363521.725			1074
N4 U/S	Node						2.6		0	388969.803	6363503.151			1082
N 3 U/S	Node						3		0	388950.137	6363584.439			1096
N 2 U/S	Node						3		0	388950.792	6363659.828			1113
N 308 U/S	Node						9		0	388990.125	6363894.516			1122
N 309 U/S	Node						6		0	389003.236	6363982.36			1128
N 327 U/S	Node						6		0	389056.861	6364056.198			1137
N 321 U/S	Node						9.5		0	389167.562	6364213.333			1147
N 319 U/S	Node						8		0	389262.071	6364127.019			1153
N 318 U/S	Node						7		0	389303.48	6364140.348			1160
N 201 U/S	Node						9.5		0	389444.945	6364167.887			1166
N 202 U/S	Node						4.5		0	389501.484	6364187.84			1172
N 210 U/S	Node						5		0	389582.29	6364173.803			1178
N 213 U/S	Node						6.3		0	389707.483	6363748.983			1184
N 212 U/S	Node						4.5		0	389674.288	6363686.142			1191
N 211 U/S	Node						4		0	389559.073	6363633.351			1215
N 214 U/S	Node						4.8		0	389540.63	6363597.074			1221
N 115 U/S	Node						9		0	389528.555	6363573.839			1229
N 116 U/S	Node						10		0	389567.874	6363531.907			1236
N422	Node						3.5		0	389547.198	6363411.52			1243
N 422 U/S	Node						7		0	389625.994	6363428.49			1250
N 104 U/S	Node						3		0	389561.804	6363369.764			1257
N 409 U/S	Node						7		0	388387.016	6363341.229			1276
N 405 U/S	Node						4		0	388407.339	6363408.751			1283
N 504 U/S	Node						3		0	388487.972	6363495.284			1295
N 512 U/S	Node						4		0	388545.005	6363516.262			1301
N 511 U/S	Node						5		0	388621.704	6363520.851			1308
N 409	Node						3.3		0	388336.056	6363393.816			1446
N 18 U/S	Node								0	389021.732	6363179.44			3229
N 17 U/S	Node								0	389102.478	6363176.117			3230
N 110 U/S	Node								0	389340.506	6363183.705			3232
N 118 U/S	Node								0	389405.302	6363235.486			3233
N 120 U/S	Node								0	389319.185	6363165.983			3285

DETENTION BASIN DETAILS

Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL	Crest Length(m)	id
Basin 3	2.5	7000	0	None						388931.204	6363331.295	No			7
	3.5	8652													
Basin 6	2.5	4500	0	None						389508.648	6363316.886	No			349
	3.2	6076													
Basin 5	2.7	15054	0	None						389655.404	6364073.359	No			520
	3	33882													
Basin 4	1.8	52868	0	None						388962.923	6364187.796	No			634
	2	79566													
Basin 1	1.8	27882	0	None						388164.387	6363514.278	No			770
	2	32354													
Basin 2	2	10912	0	None						388412.132	6363637.638	No			857
	2.5	13234													

SUB-CATCHMENT DETAILS

Name	Pit or Node	Total Area (ha)	Paved Area %	Grass Area %	Supp Area %	Paved Time (min)	Grass Time (min)	Supp Time (min)	Paved Length (m)	Grass Length (m)	Supp Length (m)	Paved Slope(%) %	Grass Slope %	Supp Slope %	Paved Rough	Grass Rough	Supp Rough	Lag Time or Factor	Gutter Length (m)	Gutter Slope %	Gutter FlowFactor
Basin Cat3	Basin 3	1.5178	0	100	0		5	5	5										0		
Cat 5	N 5	1.54	49	51	0	2		0	0	295	325	-1	0.7	0.7	-1	0.2	0.2	-1	0		
Cat 1	N 1	0.089	30	70	0	0		0	0	88.99	88.99	-1	0.5	0.5	-1	0.2	0.2	-1	0		
Cat 2	N 2	0.773	45	55	0	2		0	0	149.5	179.5	-1	1.1	1.1	-1	0.2	0.2	-1	0		
Cat 3	N 3	1.012	48	52	0	2		0	0	212	242	-1	0.75	0.75	-1	0.2	0.2	-1	0		
Cat 4	N 4	1.056	56	44	0	2		0	0	197	227	-1	0.9	0.9	-1	0.2	0.2	-1	0		
Cat 6	N 6	0.114	29	71	0	0		0	0	111.5	111.5	-1	1	1	-1	0.2	0.2	-1	0		
Cat 7	N 7	1.41	47	53	0	2		0	0	200	230	-1	1.1	1.1	-1	0.2	0.2	-1	0		
Cat 8	N 8	0.482	45	55	0	2		0	0	185	215	-1	0.8	0.8	-1	0.2	0.2	-1	0		
Cat 9	N 9	0.842	40	60	0	2		0	0	124.3	154.3	-1	0.6	0.6	-1	0.2	0.2	-1	0		
Cat 10	N 10	0.939	54	46	0	2		0	0	102	132	-1	0.8	0.8	-1	0.2	0.2	-1	0		
Cat 11	N 11	0.071	19	81	0	0		0	0	45	45	-1	1	1	-1	0.2	0.2	-1	0		
Cat 12	N 12	1.314	32	68	0	2		0	0	260	290	-1	1	1	-1	0.2	0.2	-1	0		
Cat 14	N 14	0.997	46	54	0	2		0	0	183.5	213.5	0	0.8	0.8	-1	0.2	0.2	-1	0		
Cat 17	N 17	0.84	52	48	0	2		0	0	155	155	-1	1.1	1.1	-1	0.2	0.2	-1	0		
Cat 18	N 18	0.653	45	55	0	2		0	0	160	190	-1	1	1	-1	0.2	0.2	-1	0		
Cat 21	N 21	0.816	45	55	0	5		8	0	95	125	-1	0.7	0.7	-1	0.2	0.2	-1	0		
Cat 22	N 22	0.32	40	60	0	5		8	0										0		
Cat 24	N 24	0.492	46	54	0	2		0	0	118.5	148.5	-1	1	1	-1	0.2	0.2	-1	0		
Cat 25	N 25	0.543	49	51	0	2		0	0	130.5	160.5	-1	0.7	0.7	-1	0.2	0.2	-1	0		
Cat 26	N 26	0.529	55	45	0	2		0	0	54.5	84.5	-1	0.8	0.8	-1	0.2	0.2	0.2	0		
Cat 27	N 27	0.538	45	55	0	2		0	0	134	164	1	0.5	0.5	-1	0.2	0.2	-1	0		
Cat 28	N 28	0.351	48	52	0	2		0	0	46.5	76.5	-1	0.6	0.6	-1	0.2	0.2	0.2	0		
Cat 29	N 29	0.306	55	45	0	2		0	0	32.78	62.78	0	0.6	0.6	-1	0.2	0.2	-1	0		
Cat 31	N 31	0.316	43	57	0	2		0	0	95	125	-1	0.55	0.55	-1	0.2	0.2	-1	0		
Cat 33	N 33	0.26	53	47	0	2		0	0	48.4	78.4	0	0.6	0.6	-1	0.2	0.2	-1	0		
Cat 35	N 35	0.545	57	43	0	2		0	0	29.5	122.5	-1	0.6	0.6	-1	0.2	0.2	-1	0		
Basin Cat6	Basin 6	6.74	0	100	0		5	5	5										0		

Cat 101	N 101	0.035	43	57	0	2	0	0	50	50	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 102	N 102	1.691	22	75	0	2	0	0	248	278	-1	0.7	0.7	-1	0.2	0.2	0.2	0	
Cat 103	N 103	1.026	55	45	0	2	0	0	171	201	0	0.5	0.5	-1	0.2	0.2	0	0	
Cat 104	N 104	0.369	47	53	0	2	0	0	104.4	134.4	0	0.7	0.7	-1	0.2	0.2	0	0	
Cat 108	N 108	0.87	42	58	0	2	0	0	149	179	-1	0.8	0.8	0	0.2	0.2	0	0	
Cat 105	N 105	0.365	47	53	0	2	0	0	83	113	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 106	N 106	0.489	48	52	0	2	0	0	100	130	0	1	1	-1	0.2	0.2	0	0	
Cat 107	N 107	0.938	45	55	0	2	0	0	97	127	-1	0.95	0.95	-1	0.2	0.2	-1	0	
Cat 110	N 110	0.851	48	52	0	2	0	0	155	185	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 118	N 118	0.95	47	53	0	2	0	0	152	182	-1	0.7	0.7	-1	0.2	0.2	0	0	
Cat 112	N 112	0.473	50	50	0	2	0	0	57	87	0	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 113	N 113	0.256	62	38	0	2	0	0	100	130	0	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 114	N 114	0.178	47	53	0	2	0	0	36	66	-1	1.1	1.1	-1	0.2	0.2	0	0	
Cat 115	N 115	0.971	45	55	0	2	0	0	99.25	129.25	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 116	N 116	0.672	54	46	0	2	0	0	150	180	0	0.7	0.7	-1	0.2	0.2	0	0	
Cat 119	N 119	0.271	46	54	0	2	0	0	48	78	-1	0.8	0.8	0	0.2	0.2	0	0	
Cat 120	N 120	0.311	45	55	0	2	0	0	80	110	-1	0.9	0.9	-1	0.2	0.2	-1	0	
Cat 201	N 201	0.68	43	57	0	2	0	0	166	196	-1	0.8	0.8	0	0.2	0.2	-1	0	
Cat 202	N 202	0.156	29	71	0	0	0	0	74	104	0	0.7	0.7	-1	0.2	0.2	0	0	
Cat 203	N 203	1.274	52	48	0	2	0	0	190	220	0	0.5	0.5	-1	0.2	0.2	0	0	
Cat 204	N 204	1.429	37	63	0	2	0	0	200	230	0	0.8	0.8	0	0.2	0.2	0	0	
Cat 205	N 205	1.946	51	49	0	2	0	0	330	360	0	0.6	0.6	-1	0.2	0.2	-1	0	
Cat 206	N 206	1.774	43	57	0	2	0	0	372	402	-1	0.5	0.5	-1	0.2	0.2	0	0	
Basin Cat5	Basin 5	16.46	0	100	0	5	5	5										0	
Cat 207	N 207	0.802	40	60	0	2	0	0	155	185	0	0.7	0.7	-1	0.2	0.2	0	0	
Cat 210	N 210	0.091	28	72	0	0	0	0	41.9	41.9	0	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 211	N 211	0.354	52	48	0	2	0	0	54	84	-1	1	1	-1	0.2	0.2	-1	0	
Cat 212	N 212	0.628	47	53	0	2	0	0	127	157	0	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 214	N 214	0.328	43	57	0	2	0	0	105	135	0	0.8	0.8	0	0.2	0.2	0	0	
Cat 215	N 215	0.195	49	51	0	2	0	0	25	55	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 213	N 213	2.468	53	47	0	2	0	0	320	350	0	1	1	0	0.2	0.2	0	0	
Cat 301	N 301	1.29	47	53	0	2	0	0	236	266	-1	1.1	1.1	-1	0.2	0.2	-1	0	
Cat 302	N 302	2.334	0	100	0	2	0	0	212	242	-1	0.6	0.6	-1	0.2	0.2	-1	0	
Cat 303	N 303	1.473	50	50	0	2	0	0	195	225	-1	0.55	0.55	-1	0.2	0.2	-1	0	
Cat 304	N 304	0.998	45	55	0	2	0	0	177	207	-1	1	1	-1	0.2	0.2	-1	0	
Cat 305	N 305	1.091	0	100	0	5	8	0	199	199	-1	1	1	-1	0.2	0.2	-1	0	
Cat 320	N 320	0.606	43	57	0	2	0	0	222.5	232.5	-1	0.5	0.5	-1	0.2	0.2	0	0	
Cat 327	N 327	0.81	52	48	0	2	0	0	76.517	106.517	-1	0.55	0.55	-1	0.2	0.2	-1	0	
Cat 306	N 306	0.817	0	100	0	0	0	0	92.7	92.7	-1	-1	1	-1	-1	0.2	-1	0	
Basin Cat4	Basin 4	21.37	30	70	0	5	5	5										0	
Cat 308	N 308	0.748	44.8	55.2	0	2	0	0	175	205	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 309	N 309	0.506	45	55	0	2	0	0	122	152	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 324	N 324	1.121	41	59	0	2	0	0	130	160	0	0.9	0.9	-1	0.2	0.2	0	0	
Cat 325	N 325	0.721	44	56	0	2	0	0	120	150	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 311	N 311	0.598	40	60	0	2	0	0	144	174	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 314	N 314	0.953	45.2	54.8	0	2	0	0	178	208	-1	0.65	0.65	-1	0.2	0.2	0	0	
Cat 313	N 313	0.789	48.3	51.7	0	2	0	0	150	180	0	1.8	1.8	-1	0.2	0.2	-1	0	
Cat 317	N 317	0.421	41	59	0	2	0	0	90	120	0	0.9	0.9	-1	0.2	0.2	0	0	
Cat 318	N 318	0.926	48	52	0	2	0	0	175	205	0	0.9	0.9	-1	0.2	0.2	0	0	
Cat 319	N 319	0.23	27	73	0	2	0	0	105	135	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 321	N 321	0.124	29	71	0	0	0	0	60	60	-1	0.5	0.5	-1	0.2	0.2	0	0	
Cat 322	N 322	0.414	30	70	0	0	0	0	210	210	-1	0.6	0.6	-1	0.2	0.2	-1	0	
Basin Cat1	Basin 1	5.87	0	100	0	5	5	5										0	
Cat 401	N 401	0.479	38	62	0	2	0	0	133	163	-1	1.5	1.5	-1	0.2	0.2	-1	0	
Cat 402	N 402	0.832	50	50	0	2	0	0	170	200	0	0.85	0.85	-1	0.2	0.2	0	0	
Cat 515 U/S	N 515 U/S	0.271	0	100	0	5	5	5										0	
Cat 515	N 515	0.1108	29.2	70.8	0	2	0	0	54	84	-1	2.4	2.4	-1	0.2	0.2	-1	0	
Cat 405	N 405	0.638	33	67	0	2	0	0	170	170	-1	0.85	0.85	0	0.2	0.2	-1	0	
Cat 406	N406	0.365	49	51	0	2	0	0	96	126	-1	1	1	-1	0.2	0.2	-1	0	
Cat 407	N 407	0.911	48	52	0	2	0	0	195	195	-1	0.8	0.8	-1	0.2	0.2	-1	0	
Cat 501	N 501	0.094	29	71	0	0	0	0	45.7	45.7	-1	2	2	-1	0.2	0.2	-1	0	
Cat 502	N 502	0.687	48	52	0	2	0	0	143.9	173.9	0	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 504	N 504	0.588	41	59	0	2	0	0	190	220	-1	2.4	2.4	-1	0.2	0.2	0	0	
Cat 505	N 505	0.48	29	71	0	2	0	0	140	170	-1	0.5	0.5	-1	0.2	0.2	0	0	
Cat 503	N 503	0.064	0	100	0	0	0	0	30	30	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 506	N 506	0.388	45	55	0	2	0	0	71	101	0	0.7	0.7	-1	0.2	0.2	-1	0	
Basin Cat2	Basin 2	3.3	15	85	0	5	0	0										0	
Cat 507	N 507	0.607	42	58	0	2	0	0	171	201	0	2	2	-1	0.2	0.2	-1	0	
Cat 509	N 509	1.052	54	46	0	2	0	0	162	192	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 510	N 510	1.413	49	51	0	2	0	0	196	196	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 511	N 511	0.493	42	58	0	2	0	0	130	160	-1	1.6	1.6	-1	0.2	0.2	-1	0	
Cat 512	N 512	0.425	39	61	0	2	0	0	100	130	-1	1.6	1.6	-1	0.2	0.2	-1	0	
Cat 513	N 513	0.655	45	55	0	2	0	0	110	140	-1	0.5	0.5	-1	0.2	0.2	-1	0	
Cat 514	N 514	0.57	48	52	0	2	0	0	165	165	-1	1.6	1.6	-1	0.2	0.2	-1	0	
Cat27 U/S	N27 U/S	0.226	0	100	0	5	8	0										0	
Cat 4 U/S	N4 U/S	0.173	0	100	0	5	5	0										0	
Cat3 U/S	N 3 U/S	0.53	0	100	0	5	8	0										0	
Cat 2 U/S	N 2 U/S	0.822	0	100	0	5	8	5										0	
Cat 308 U/S	N 308 U/S	0.701	0	100	0	5	8	5										0	
Cat 309 U/S	N 309 U/S	0.4	0	100	0	5	6	5										0	
Cat 327 U/S	N 327 U/S	0.914	52	48	0	2	0	0	76.5	106.5	-1	0.5	0.5	0	0.2	0.2	-1	0	
Cat 321 U/S	N 321 U/S	0.548	0	100	0	5	7	0										0	
Cat 319 U/S	N 319 U/S	0.403	0	100	0	5	5	5										0	
Cat 318 U/S	N 318 U/S	0.416	0	100	0	5	5	5										0	
Cat 201 U/S	N 201 U/S	0.412	0	100	0	5	5	5										0	
Cat 202 U/S	N 202 U/S	1.491	0	100	0	5	10	5										0	
Cat 210 U/S	N 210 U/S	0.082	0	100	0	5	2	5										0	
Cat 213 U/S	N 213 U/S	0.811	0	100	0	5	7	5										0	
Cat 212 U/S	N 212 U/S	1.395	0	100	0	5	10	5										0	
Cat 211 U/S	N 211 U/S	0.245	0	100	0	5	3	5										0	
Cat 214 U/S	N 214 U/S	0.105	0	100	0	5	3	5										0	
Cat 115 U/S	N 115 U/S	0.183	0	100	0	5	3	5										0	
Cat 116 U/S	N 116 U/S	0.285	0	100	0	5	5	5										0	
Cat 422	N422	0.431	47.3	52.7	0	2	0	0	115	145	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 422 U/S	N 422 U/S	0.795	0	100	0	5	8	5										0	
Cat 104 U/S	N 104 U/S	0.116	0	100	0	5	3	5										0	
Cat 409 U/S	N 409 U/S	0.277	0	100	0	5	5	5										0	
Cat 405 U/S	N 405 U/S	0.365	0	100	0	5	5	5										0	
Cat 504 U/S	N 504 U/S	0.751	0	100	0	5	6	5										0	
Cat 512 U/S	N 512 U/S	0.252	0	100	0	5	5	5										0	
Cat 511 U/S	N 511 U/S	0.359	0	100	0	5	5	5										0	
Cat 409	N 409	0.427	44	56	0	2	0	0	120	150	-1	0.7	0.7	-1	0.2	0.2	-1	0	
Cat 18 U/S	N 18 U/S	0.3844	0	100	0	5	3	5										0	
CAT 17 U/S	N 17 U/S	0.3364	0	100	0	5	3	5										0	
CAT 110 U/S	N 110 U/S	0.4049	0	100	0	5	3	5										0	
Cat 118 U/S	N 118 U/S	0.95	0	100	0	5	3	5										0	
CAT 120 U/S	N 120 U/S	0.3115	0	100	0	5	3	5										0	

PIPE DETAILS

Name	From	To	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Type	Dia (mm)	I.D. (mm)	Rough	Pipe Is	No. Pipes	Chg From	At Chg	Chg (m)	Rl (m)	Chg (m)	RL (m)	etc (m)

DETAILS of SERVICES CROSSING PIPES

Pipe	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	Chg (m)	Bottom Elev (m)	Height of Service (m)	etc etc

CHANNEL DETAILS

Name	From	To	Type	Length (m)	U/S IL (m)	D/S IL (m)	Slope (%)	Base Width (m)	L.B. Slope (1:?)	R.B. Slope (1:?)	Manning n	Depth (m)	Roofed

OVERFLOW ROUTE DETAILS

Name	From	To	Travel Time (min)	Spill Level (m)	Crest Length (m)	Weir Coeff. C	Cross Section	Safe Depth Major Storms (m)	SafeDepth Minor Storms (m)	Safe DxV (sq.m/sec)	Bed Slope (%)	D/S Area Contributing %	id
OF Basin 3	Basin 3	B3 Outlet	5	3.5	10	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	927
OF 5	N 5	Basin 3	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	75
OF 1	N 1	N 2	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	64
OF 2	N 2	N 3	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	66
OF 3	N 3	N 4	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	68
OF 4	N 4	N 5	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	70
OF 6	N 6	N 7	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	83
OF 7	N 7	N 2	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	85
OF 8	N 8	N 9	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	91
OF 9	N 9	N 7	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	94
OF 10	N 10	N 3	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	100
OF 11	N 11	N 12	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	110
OF 12	N 12	N 4	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	114
OF 14	N 14	N 5	5				Grassed Swale	0.5	0.4	1	1	0	123
OF 17	N 17	N 18	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	147
OF 18	N 18	Basin 3	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	148
OF 21	N 21	N 17	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	158
OF22	N 22	N 18	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1882
OF 24	N 24	N 25	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	174
OF 25	N 25	N 26	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	215
OF 26	N 26	Basin 3	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	178
OF 27	N 27	N 26	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	177
OF 28	N 28	N 31	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	204
OF29	N 29	N 24	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1818
OF 31	N 31	N 27	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	200
OF 30	N 33	N 28	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	211
OF35	N 35	N 12	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	2634
OF Basin 6	Basin 6	B6 Outlet	5	3.2	18	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	978
OF 101	N 101	N 102	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	366
OF 102	N 102	N 103	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	368
OF 103	N 103	N 104	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	370
OF 104	N 104	N 105	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	375
OF108	N 108	Basin 6	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	388
OF 105	N 105	Basin 6	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	377
OF106	N 106	N 107	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	2004
OF 107	N 107	N 119	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	386
OF 110	N 110	N 118	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	399
OF 118	N 118	N 108	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	401
OF 112	N 112	N 113	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	416
OF 113	N 113	N 118	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	418
OF 114	N 114	N 113	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	422
OF 115	N 115	N 102	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	426
OF 116	N 116	N 103	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	431
OF 119	N 119	N 108	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	440
OF 120	N 120	N 110	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	444
OF201	N 201	N 202	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	510
OF202	N 202	N 203	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	512
OF 203	N 203	N 204	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	514
OF 204	N 204	N 205	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	516
OF 205	N 205	N 206	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3020
OF206	N 206	Basin 5	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3111
OF Basin 5	Basin 5	B5 Outlet	5	3	10	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	983
OF 207	N 207	N 203	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	526
OF 210	N 210	Basin 5	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	539
OF 211	N 211	N 212	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	545
OF 212	N 212	N 213	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	562
OF 214	N 214	N 211	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	554
OF 215	N 215	N 213	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	558
OF 213	N 213	N 206	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	547
OF 301	N 301	N 302	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	612
OF 302	N 302	N 303	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	616
OF 303	N 303	N 304	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	620
OF 304	N 304	N 305	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	624
OF 305	N 305	N 306	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	632

OF 320	N 320	N 304	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	650
OF 326	N 327	N 306	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	722
OF 306	N 306	Basin 4	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	636
OF Basin 4	Basin 4	B4 Outlet	5	2	10	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1004
OF 308	N 308	N 309	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	646
OF 309	N 309	N 320	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	648
OF 324	N 324	N 325	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	660
OF 325	N 325	N 311	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3305
OF 311	N 311	N 303	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	677
OF 314	N 314	N 313	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	687
OF 313	N 313	N 305	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	685
OF 317	N 317	N 318	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	706
OF 318	N 318	N 319	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	710
OF 319	N 319	N 320	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	712
OF 321	N 321	N 322	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	718
OF 322	N 322	N 327	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	720
OF Basin 1	Basin 1	B1 Outlet	5	2	10	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1024
OF 401	N 401	N 402	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	776
OF 402	N 402	Basin 1	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	778
OF 515 U/S	N 515 U/S	N 515	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	784
OF 515	N 515	N 504	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	788
OF 405	N 405	N406	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	794
OF 406	N406	N 407	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	795
OF 407	N 407	Basin 1	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	798
OF 408	N 408	N406	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	803
OF 501	N 501	N 502	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	835
OF 502	N 502	N 514	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	924
OF 504	N 504	N 505	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	845
OF 505	N 505	N 503	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	850
OF 503	N 503	N 506	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	854
OF 506	N 506	Basin 2	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	859
OFBasin 2	Basin 2	B2 Outlet	5	2.5	10	2	Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1019
OF 507	N 507	N 509	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	865
OF 509	N 509	N 506	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	871
OF 510	N 510	N 509	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	875
OF 511	N 511	N 512	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	889
OF 512	N 512	N 505	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	891
OF513	N 513	N 510	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	2840
OF 514	N 514	Basin 2	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1044
OF 27 U/S	N27 U/S	N 27	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1080
OF 4 U/S	N4 U/S	N 4	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1092
OF 3 U/S	N 3 U/S	N 3	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1111
OF 2 U/S	N 2 U/S	N 2	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1120
OF 308 U/S	N 308 U/S	N 308	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1126
OF 309 U/S	N 309 U/S	N 309	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1134
OF 327 U/S	N 327 U/S	N 327	2				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1141
OF 321 U/S	N 321 U/S	N 321	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1151
OF 319 U/S	N 319 U/S	N 319	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1158
OF 318 U/S	N 318 U/S	N 318	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1164
OF 201 U/S	N 201 U/S	N 201	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1170
OF 202 U/S	N 202 U/S	N 202	2				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1176
OF 210 U/S	N 210 U/S	N 210	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1182
OF 213 U/S	N 213 U/S	N 213	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1189
OF 212 U/S	N 212 U/S	N 212	2				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1195
OF 211 U/S	N 211 U/S	N 211	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1219
OF 214 U/S	N 214 U/S	N 214	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1227
OF 115 U/S	N 115 U/S	N 115	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1234
OF 116 U/S	N 116 U/S	N 116	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1241
OF 422	N422	N 104	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1247
OF 422 U/S	N 422 U/S	N422	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1255
OF 104 U/S	N 104 U/S	N 104	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1261
OF 409 U/S	N 409 U/S	N 409	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1281
OF 405 U/S	N 405 U/S	N 405	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1288
OF 504 U/S	N 504 U/S	N 504	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1299
OF 512 U/S	N 512 U/S	N 512	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1306
OF 511 U/S	N 511 U/S	N 511	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	1312
OF 409	N 409	N 405	5				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	809
OF 18 U/S	N 18 U/S	N 18	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3234
OF 17U/S	N 17 U/S	N 17	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3235
OF 110 U/S	N 110 U/S	N 110	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3237
OF 118 U/S	N 118 U/S	N 118	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3238
OF 120 U/S	N 120 U/S	N 120	1				Dummy used to model flows across road crown	0.2	0.05	0.6	1	0	3262

DRAINS MODEL RESULTS (WITHOUT CLIMATE CHANGE)

DRAINS results prepared 21 December, 2009 from Version 2009.09

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Basin Cat3	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 5	0.139	0.139	0	72.47	74.68	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 1	0.008	0.008	0	29.63	29.63	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 2	0.093	0.093	0	39.07	41.37	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 3	0.107	0.107	0	53.28	55.52	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 4	0.138	0.138	0	48.46	50.58	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 6	0.01	0.01	0	27.56	27.56	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 7	0.16	0.16	0	46.14	48	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 8	0.051	0.051	0	48.35	50.72	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 9	0.087	0.087	0	41.8	45.31	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 10	0.147	0.147	0	29.93	32.6	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 11	0.006	0.006	0	14.69	14.69	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 12	0.09	0.09	0	55.17	56.77	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 14	0.108	0.108	0	48.12	50.51	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 17	0.116	0.116	0	39.88	37.88	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 18	0.076	0.076	0	41.73	44.05	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 21	0.101	0.101	0	37.34	46.13	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 22	0.079	0.079	0	5	8	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 24	0.064	0.064	0	30.58	32.73	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 25	0.069	0.069	0	41.13	44.3	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 26	0.105	0.105	0	19.62	22.92	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 27	0.059	0.059	0	45.98	49.64	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 28	0.061	0.061	0	19.46	23.54	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 29	0.068	0.068	0	16.16	20.91	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 31	0.038	0.038	0	34.71	38.57	0	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
Cat 33	0.049	0.049	0	19.89	23.89	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 35	0.131	0.131	0	15.29	31.23	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Basin Cat6	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 101	0.005	0.005	0	19.41	17.41	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 102	0.075	0.075	0	59.52	61.6	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 103	0.124	0.124	0	52.9	56.09	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 104	0.048	0.048	0	34.2	37.47	0	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
Cat 108	0.093	0.093	0	42.7	45.44	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 105	0.052	0.052	0	27.69	30.92	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 106	0.071	0.071	0	27.81	30.21	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 107	0.127	0.127	0	27.74	30.26	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 110	0.1	0.1	0	45.38	48.24	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 118	0.11	0.11	0	44.88	47.77	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 112	0.081	0.081	0	21.71	25.4	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Cat 113	0.045	0.045	0	35.35	39.04	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 114	0.036	0.036	0	14.49	17.96	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 115	0.124	0.124	0	30.6	33.51	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 116	0.09	0.09	0	44.54	47.46	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 119	0.047	0.047	0	18.33	21.85	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 120	0.045	0.045	0	24.4	27.12	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Cat 201	0.071	0.071	0	45.43	47.98	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 202	0.015	0.015	0	23.05	28.27	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Cat 203	0.14	0.14	0	56.23	59.21	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 204	0.12	0.12	0	50.57	52.82	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 205	0.169	0.169	0	80.94	83.17	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 206	0.117	0.117	0	91.59	93.86	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Basin Cat5	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 207	0.078	0.078	0	45.38	48.24	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 210	0.01	0.01	0	17.33	17.33	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 211	0.069	0.069	0	18.39	21.36	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 212	0.073	0.073	0	44.58	48.36	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 214	0.04	0.04	0	30.42	33.05	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 215	0.041	0.041	0	14.71	20.4	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 213	0.252	0.252	0	62.22	63.55	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 301	0.137	0.137	0	50.75	52.38	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 302	0	0	0	36.41	37.25	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 303	0.157	0.157	0	55.53	58.32	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 304	0.112	0.112	0	44.21	46.37	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 305	0	0	0	33.42	36.42	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 320	0.051	0.051	0	61.61	61.21	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 327	0.126	0.126	0	28.3	32.08	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 306	0	0	0	0	17.97	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Basin Cat4	3.953	3.953	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 308	0.073	0.073	0	53.62	56.76	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 309	0.057	0.057	0	43.57	47.43	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 324	0.124	0.124	0	36.06	38.58	0	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
Cat 325	0.08	0.08	0	43.16	47.06	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 311	0.056	0.056	0	47.92	51.44	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 314	0.098	0.098	0	50.2	52.92	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 313	0.111	0.111	0	29.6	30.79	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 317	0.053	0.053	0	27.01	29.72	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 318	0.109	0.109	0	45.27	47.58	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 319	0.016	0.016	0	39.99	44.17	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 321	0.012	0.012	0	22.49	22.49	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Cat 322	0.027	0.027	0	54.52	54.52	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Basin Cat1	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 401	0.054	0.054	0	29.12	30.64	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 402	0.102	0.102	0	45.26	47.69	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 515 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 515	0.014	0.014	0	14.6	16.43	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 405	0.051	0.051	0	45.26	43.26	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 406	0.055	0.055	0	27.19	29.65	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 407	0.1	0.1	0	49.83	47.83	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 501	0.013	0.013	0	12.04	12.04	0	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
Cat 502	0.078	0.078	0	47.9	51.42	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 504	0.068	0.068	0	35.87	36.99	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 505	0.033	0.033	0	47.15	50.73	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 503	0	0	0	10.16	10.16	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 506	0.056	0.056	0	24.49	27.78	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Basin Cat2	0.305	0.305	0	5	0	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 507	0.072	0.072	0	35.58	37	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 509	0.136	0.136	0	46.55	49.33	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 510	0.144	0.144	0	57.25	55.25	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 511	0.062	0.062	0	28.24	29.72	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 512	0.054	0.054	0	23.55	25.23	0	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
Cat 513	0.077	0.077	0	41.07	45.15	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 514	0.075	0.075	0	35.07	33.07	0	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
Cat27 U/S	0	0	0	5	8	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 4 U/S	0	0	0	5	5	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat3 U/S	0	0	0	5	8	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 2 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 308 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 309 U/S	0	0	0	5	6	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 327 U/S	0.14	0.14	0	29.06	33	0	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
Cat 321 U/S	0	0	0	5	7	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 319 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 318 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 201 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 202 U/S	0	0	0	5	10	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 210 U/S	0	0	0	5	2	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 213 U/S	0	0	0	5	7	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 212 U/S	0	0	0	5	10	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 211 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 214 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 115 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 116 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 422	0.055	0.055	0	36.13	39.22	0	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
Cat 422 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 104 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 409 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 405 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 504 U/S	0	0	0	5	6	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 512 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 511 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 409	0.05	0.05	0	39.21	42.54	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 18 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 17 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 110 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 118 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 120 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1

Outflow Volumes for Total Catchment (36.7 impervious + 103 pervious = 140 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1	27220.26	6789.71 (24.9%)	6789.71 (94.9%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, average 179 mm/h, Zone 1	41644.67	10582.11 (25.4%)	10582.11 (96.6%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, average 150 mm/h, Zone 1	52346.65	13395.88 (25.6%)	13395.88 (97.3%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1	60954.77	15659.18 (25.7%)	15659.18 (97.7%)	0.00 (0.0%)
AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1	68050.64	17524.85 (25.8%)	17524.85 (97.9%)	0.00 (0.0%)
AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1	73983.27	19082.04 (25.8%)	19082.04 (98.1%)	0.00 (0.0%)
AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1	88989.3	23023.14 (25.9%)	23023.14 (98.4%)	0.00 (0.0%)
AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1	101901.47	26416.25 (25.9%)	26416.25 (98.6%)	0.00 (0.0%)
AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1	119350.36	30997.87 (26.0%)	30997.87 (98.8%)	0.00 (0.0%)
AR&R 100 year, 2 hours storm, average 47.3 mm/h, Zone 1	132053.16	34327.81 (26.0%)	34327.81 (98.9%)	0.00 (0.0%)
AR&R 100 year, 3 hours storm, average 36.6 mm/h, Zone 1	153271.06	39900.79 (26.0%)	39900.79 (99.0%)	0.00 (0.0%)
AR&R 100 year, 4.5 hours storm, average 28.3 mm/h, Zone 1	177769.23	46320.16 (26.1%)	46320.16 (99.1%)	0.00 (0.0%)
AR&R 100 year, 6 hours storm, average 23.6 mm/h, Zone 1	197660.98	51549.99 (26.1%)	51549.99 (99.2%)	0.00 (0.0%)
AR&R 100 year, 9 hours storm, average 18.2 mm/h, Zone 1	228650.17	59684.39 (26.1%)	59684.39 (99.3%)	0.00 (0.0%)
AR&R 100 year, 12 hours storm, average 15.2 mm/h, Zone 1	254614.11	66533.09 (26.1%)	66533.09 (99.4%)	0.00 (0.0%)
AR&R 100 year, 18 hours storm, average 12.1 mm/h, Zone 1	304029.34	79473.36 (26.1%)	79473.36 (99.4%)	0.00 (0.0%)
AR&R 100 year, 24 hours storm, average 10.3 mm/h, Zone 1	345069.09	90305.17 (26.2%)	90305.17 (99.5%)	0.00 (0.0%)
AR&R 100 year, 30 hours storm, average 9.09 mm/h, Zone 1	380664.84	99698.89 (26.2%)	99698.89 (99.6%)	0.00 (0.0%)
AR&R 100 year, 36 hours storm, average 8.17 mm/h, Zone 1	410565.19	107567.17 (26.2%)	107567.17 (99.6%)	0.00 (0.0%)
AR&R 100 year, 48 hours storm, average 6.86 mm/h, Zone 1	459645.47	120434.59 (26.2%)	120434.59 (99.7%)	0.00 (0.0%)
AR&R 100 year, 72 hours storm, average 5.27 mm/h, Zone 1	529664.25	138844.50 (26.2%)	138844.50 (99.7%)	0.00 (0.0%)
AR&R 50 year, 1 hour storm, average 65 mm/h, Zone 1	90734.2	23476.25 (25.9%)	23476.25 (98.4%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, average 43.4 mm/h, Zone 1	60582.52	15528.64 (25.6%)	15528.64 (97.5%)	0.00 (0.0%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF Basin 3	0	0	0.362	0	0	0	0	
OF 5	1.142	1.142	0.362	0.079	0.07	30.34	0.87	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 1	0.008	0.008	0.362	0.012	0	5.8	0.23	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1

OF 2	0.387	0.387	0.362	0.051	0.03	21.41	0.66	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 3	0.616	0.616	0.362	0.061	0.05	25.19	0.74	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 4	0.899	0.899	0.362	0.072	0.06	28.74	0.81	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 6	0.01	0.01	0.362	0.012	0	6.23	0.26	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 7	0.301	0.301	0.362	0.047	0.03	19.83	0.6	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 8	0.051	0.051	0.362	0.024	0.01	11.33	0.37	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 9	0.134	0.134	0.362	0.034	0.02	15.11	0.49	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 10	0.147	0.147	0.362	0.035	0.02	15.42	0.51	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 11	0.006	0.006	0.362	0.011	0	5.37	0.2	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 12	0.204	0.204	0.362	0.04	0.02	17.31	0.55	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 14	0.108	0.108	1.072	0.169	0.16	1.35	0.94	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 17	0.216	0.216	0.362	0.041	0.02	17.63	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 18	0.306	0.306	0.362	0.047	0.03	19.83	0.61	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 21	0.101	0.101	0.362	0.03	0.01	13.85	0.45	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF22	0.079	0.079	0.362	0.028	0.01	12.9	0.41	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
OF 24	0.125	0.125	0.362	0.033	0.02	14.79	0.48	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 25	0.189	0.189	0.362	0.039	0.02	17	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 26	0.446	0.446	0.362	0.055	0.04	22.67	0.67	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 27	0.196	0.196	0.362	0.039	0.02	17	0.55	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 28	0.105	0.105	0.362	0.03	0.01	13.85	0.47	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF29	0.068	0.068	0.362	0.026	0.01	12.27	0.4	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 31	0.139	0.139	0.362	0.034	0.02	15.11	0.5	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
OF 30	0.049	0.049	0.362	0.023	0.01	11.01	0.38	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF35	0.131	0.131	0.362	0.033	0.02	14.79	0.5	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF Basin 6	0	0	0.362	0	0	0	0	
OF 101	0.005	0.005	0.362	0.01	0	4.94	0.22	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 102	0.196	0.196	0.362	0.039	0.02	17	0.55	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 103	0.409	0.409	0.362	0.053	0.03	22.04	0.65	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 104	0.492	0.492	0.362	0.056	0.04	23.3	0.7	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF108	0.706	0.706	0.362	0.065	0.05	26.45	0.77	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 105	0.514	0.514	0.362	0.057	0.04	23.61	0.71	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF106	0.071	0.071	0.362	0.026	0.01	12.27	0.42	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 107	0.193	0.193	0.362	0.039	0.02	17	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 110	0.14	0.14	0.362	0.034	0.02	15.11	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 118	0.395	0.395	0.362	0.052	0.03	21.72	0.65	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 112	0.081	0.081	0.362	0.028	0.01	12.9	0.42	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
OF 113	0.153	0.153	0.362	0.036	0.02	15.74	0.51	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
OF 114	0.036	0.036	0.362	0.021	0.01	10.38	0.33	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 115	0.124	0.124	0.362	0.033	0.02	14.79	0.47	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 116	0.09	0.09	0.362	0.029	0.01	13.22	0.44	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 119	0.225	0.225	0.362	0.042	0.02	17.94	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 120	0.045	0.045	0.362	0.023	0.01	11.01	0.35	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
OF201	0.071	0.071	0.362	0.026	0.01	12.27	0.42	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF202	0.079	0.079	0.362	0.028	0.01	12.9	0.42	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 203	0.296	0.296	0.362	0.046	0.03	19.52	0.61	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 204	0.41	0.41	0.362	0.053	0.03	22.04	0.66	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 205	0.572	0.572	0.362	0.06	0.04	24.56	0.73	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF206	1.079	1.079	0.362	0.077	0.07	29.94	0.86	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 5	0	0	0.362	0	0	0	0	
OF 207	0.078	0.078	0.362	0.027	0.01	12.59	0.44	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 210	0.01	0.01	0.362	0.012	0	6.23	0.26	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 211	0.1	0.1	0.362	0.03	0.01	13.85	0.45	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 212	0.163	0.163	0.362	0.037	0.02	16.05	0.52	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 214	0.04	0.04	0.362	0.021	0.01	10.38	0.36	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 215	0.041	0.041	0.362	0.022	0.01	10.7	0.34	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 213	0.419	0.419	0.362	0.053	0.04	22.04	0.67	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 301	0.137	0.137	0.362	0.034	0.02	15.11	0.5	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 302	0.137	0.137	0.362	0.034	0.02	15.11	0.5	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 303	0.546	0.546	0.362	0.059	0.04	24.24	0.71	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 304	0.981	0.981	0.362	0.074	0.06	29.34	0.83	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 305	1.143	1.143	0.362	0.079	0.07	30.34	0.87	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 320	0.349	0.349	0.362	0.049	0.03	20.78	0.63	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 326	0.294	0.294	0.362	0.046	0.03	19.52	0.61	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 306	1.318	1.318	0.362	0.083	0.08	31.07	0.91	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 4	0	0	0.362	0	0	0	0	
OF 308	0.073	0.073	0.362	0.027	0.01	12.59	0.41	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 309	0.124	0.124	0.362	0.033	0.02	14.79	0.47	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 324	0.124	0.124	0.362	0.033	0.02	14.79	0.48	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
OF 325	0.204	0.204	0.362	0.04	0.02	17.31	0.55	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 311	0.26	0.26	0.362	0.044	0.03	18.89	0.58	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 314	0.098	0.098	0.362	0.03	0.01	13.53	0.46	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 313	0.194	0.194	0.362	0.039	0.02	17	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 317	0.053	0.053	0.362	0.024	0.01	11.33	0.38	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 318	0.159	0.159	0.362	0.037	0.02	16.05	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 319	0.174	0.174	0.362	0.037	0.02	16.37	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 321	0.012	0.012	0.362	0.013	0	6.66	0.27	AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1
OF 322	0.035	0.035	0.362	0.02	0.01	10.07	0.35	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 1	0	0	0.362	0	0	0	0	
OF 401	0.054	0.054	0.362	0.024	0.01	11.33	0.39	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 402	0.154	0.154	0.362	0.036	0.02	15.74	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 515 U/S	0	0	0.362	0	0	0	0	
OF 515	0.014	0.014	0.362	0.014	0	7.09	0.28	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 405	0.102	0.102	0.362	0.03	0.01	13.85	0.45	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 406	0.141	0.141	0.362	0.035	0.02	15.42	0.49	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 407	0.241	0.241	0.362	0.043	0.02	18.26	0.58	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 408	0	0	0.362	0	0	0	0	
OF 501	0.013	0.013	0.362	0.014	0	7.09	0.26	AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1
OF 502	0.082	0.082	0.362	0.028	0.01	12.9	0.43	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 504	0.078	0.078	0.362	0.027	0.01	12.59	0.43	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 505	0.219	0.219	0.362	0.041	0.02	17.63	0.57	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 503	0.219	0.219	0.362	0.041	0.02	17.63	0.57	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 506	0.657	0.657	0.362	0.063	0.05	25.82	0.75	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OFBasin 2	0	0	0.362	0	0	0	0	
OF 507	0.072	0.072	0.362	0.026	0.01	12.27	0.42	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 509	0.413	0.413	0.362	0.053	0.03	22.04	0.66	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 510	0.216	0.216	0.362	0.041	0.02	17.63	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 511	0.062	0.062	0.362	0.025	0.01	11.96	0.39	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 512	0.11	0.11	0.362	0.031	0.01	14.16	0.46	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF513	0.077	0.077	0.362	0.027	0.01	12.59	0.43	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 514	0.154	0.154	0.362	0.036	0.02	15.74	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 27 U/S	0	0	0.362	0	0	0	0	
OF 4 U/S	0	0	0.362	0	0	0	0	
OF 3 U/S	0	0	0.362	0	0	0	0	
OF 2 U/S	0	0	0.362	0	0	0	0	
OF 308 U/S	0	0	0.362	0	0	0	0	
OF 309 U/S	0	0	0.362	0	0	0	0	
OF 327 U/S	0.14	0.14	0.362	0.034	0.02	15.11	0.51	AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1
OF 321 U/S	0	0	0.362	0	0	0	0	
OF 319 U/S	0	0	0.362	0	0	0	0	
OF 318 U/S	0	0	0.362	0	0	0	0	
OF 201 U/S	0	0	0.362	0	0	0	0	
OF 202 U/S	0	0	0.362	0	0	0	0	
OF 210 U/S	0	0	0.362	0	0	0	0	
OF 213 U/S	0	0	0.362	0	0	0	0	
OF 212 U/S	0	0	0.362	0	0	0	0	
OF 211 U/S	0	0	0.362	0	0	0	0	
OF 214 U/S	0	0	0.362	0	0	0	0	
OF 115 U/S	0	0	0.362	0	0	0	0	
OF 116 U/S	0	0	0.362	0	0	0	0	
OF 422	0.055	0.055	0.362	0.024	0.01	11.33	0.4	AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1
OF 422 U/S	0	0	0.362	0	0	0	0	
OF 104 U/S	0	0	0.362	0	0	0	0	
OF 409 U/S	0	0	0.362	0	0	0	0	
OF 405 U/S	0	0	0.362	0	0	0	0	
OF 504 U/S	0	0	0.362	0	0	0	0	
OF 512 U/S	0	0	0.362	0	0	0	0	
OF 511 U/S	0	0	0.362	0	0	0	0	
OF 409	0.05	0.05	0.362	0.024	0.01	11.33	0.36	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 18 U/S	0	0	0.362	0	0	0	0	
OF 17U/S	0	0	0.362	0	0	0	0	
OF 110 U/S	0	0	0.362	0	0	0	0	
OF 118 U/S	0	0	0.362	0	0	0	0	
OF 120 U/S	0	0	0.362	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin 3	3.09	4419.7	0	0	0
Basin 6	2.98	2415.9	0	0	0
Basin 5	2.73	509.3	0	0	0
Basin 4	1.81	274.3	0	0	0
Basin 1	1.8	0	0	0	0
Basin 2	2.04	426.6	0	0	0

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Basin 3	5773.45	2400.86	3356.88	0.3
N 5	3717.72	3717.73	0	0
N 1	19.22	19.22	0	0
N 2	1169.29	1169.29	0	0
N 3	1884.01	1884.01	0	0
N 4	2845.4	2845.4	0	0
N 6	23.8	23.8	0	0
N 7	899.61	899.61	0	0
N 8	156.17	156.17	0	0
N 9	398.66	398.66	0	0
N 10	365.08	365.08	0	0
N 11	9.71	9.71	0	0
N 12	536.13	536.13	0	0
N 14	330.21	330.21	0	0
N 17	578.88	578.88	0	0
N 18	882.61	882.61	0	0
N 21	264.38	264.38	0	0
N 22	92.16	92.16	0	0
N 24	284.13	284.13	0	0
N 25	475.7	475.7	0	0
N 26	1177.85	1177.85	0	0
N 27	492.67	492.67	0	0
N 28	220.52	220.52	0	0
N 29	121.18	121.18	0	0
N 31	318.36	318.36	0	0
N 33	99.22	99.22	0	0
N 35	223.67	223.67	0	0
Basin 6	3539.98	1711.61	1821.36	0.2
N 101	10.84	10.84	0	0
N 102	593.29	593.29	0	0
N 103	1260.86	1260.86	0	0
N 104	1532.25	1532.25	0	0
N 108	1886.9	1886.9	0	0
N 105	1654.9	1654.9	0	0
N 106	169	169	0	0
N 107	472.91	472.91	0	0
N 110	394.87	394.87	0	0
N 118	1061.14	1061.14	0	0
N 112	170.28	170.28	0	0
N 113	344.79	344.79	0	0

N 114	60.24	60.24	0	0
N 115	314.6	314.6	0	0
N 116	261.27	261.27	0	0
N 119	562.67	562.67	0	0
N 120	100.76	100.76	0	0
N 201	210.53	210.53	0	0
N 202	243.1	243.1	0	0
N 203	951.06	951.06	0	0
N 204	1331.75	1331.75	0	0
N 205	2044.31	2044.3	0	0
N 206	4039.47	4039.46	0	0
Basin 5	4042.07	4045.97	0	-0.1
N 207	230.98	230.98	0	0
N 210	18.35	18.35	0	0
N 211	234.09	234.09	0	0
N 212	446.6	446.6	0	0
N 214	101.55	101.55	0	0
N 215	68.8	68.8	0	0
N 213	1457.19	1457.19	0	0
N 301	436.54	436.54	0	0
N 302	436.54	436.54	0	0
N 303	1698.37	1698.37	0	0
N 304	3103.34	3103.34	0	0
N 305	3685.99	3685.98	0	0
N 320	1081.85	1081.85	0	0
N 327	760.78	760.78	0	0
N 306	4441.08	4441.08	0	0
Basin 4	9044.16	9004.13	0	0.4
N 308	241.27	241.27	0	0
N 309	405.22	405.22	0	0
N 324	330.92	330.92	0	0
N 325	559.33	559.33	0	0
N 311	731.56	731.56	0	0
N 314	310.14	310.14	0	0
N 313	584.53	584.53	0	0
N 317	124.28	124.28	0	0
N 318	444.3	444.3	0	0
N 319	489.02	489.02	0	0
N 321	25.89	25.89	0	0
N 322	115.32	115.32	0	0
Basin 1	1161.05	1161.05	0	0
N 401	131.05	131.05	0	0
N 402	430.57	430.57	0	0
N 515 U/S	0	0	0	0
N 515	23.29	23.29	0	0
N 405	286.86	286.86	0	0
N406	415.63	415.63	0	0
N 407	730.48	730.48	0	0
N 408	0	0	0	0
N 501	19.63	19.63	0	0
N 502	257.05	257.05	0	0
N 504	196.87	196.87	0	0
N 505	565.52	565.52	0	0
N 503	565.52	565.52	0	0
N 506	1994.38	1994.38	0	0
Basin 2	2803.71	2802.96	0	0
N 507	183.56	183.56	0	0
N 509	1303.3	1303.3	0	0
N 510	710.73	710.73	0	0
N 511	149.08	149.08	0	0
N 512	268.42	268.42	0	0
B3 Outlet	0	0	0	0
B6 Outlet	0	0	0	0
B5 Outlet	0	0	0	0
B4 Outlet	0	0	0	0
B2 Outlet	0	0	0	0
B1 Outlet	0	0	0	0
N 513	212.22	212.22	0	0
N 514	454.05	454.05	0	0
N27 U/S	0	0	0	0
N4 U/S	0	0	0	0
N 3 U/S	0	0	0	0
N 2 U/S	0	0	0	0
N 308 U/S	0	0	0	0
N 309 U/S	0	0	0	0
N 327 U/S	342.2	342.2	0	0
N 321 U/S	0	0	0	0
N 319 U/S	0	0	0	0
N 318 U/S	0	0	0	0
N 201 U/S	0	0	0	0
N 202 U/S	0	0	0	0
N 210 U/S	0	0	0	0
N 213 U/S	0	0	0	0
N 212 U/S	0	0	0	0
N 211 U/S	0	0	0	0
N 214 U/S	0	0	0	0
N 115 U/S	0	0	0	0
N 116 U/S	0	0	0	0
N422	146.78	146.78	0	0
N 422 U/S	0	0	0	0
N 104 U/S	0	0	0	0
N 409 U/S	0	0	0	0
N 405 U/S	0	0	0	0
N 504 U/S	0	0	0	0
N 512 U/S	0	0	0	0
N 511 U/S	0	0	0	0
N 409	135.27	135.27	0	0
N 18 U/S	0	0	0	0
N 17 U/S	0	0	0	0
N 110 U/S	0	0	0	0
N 118 U/S	0	0	0	0
N 120 U/S	0	0	0	0

Run Log for P0902479DRN01V05.drn run at 12:40:12 on 21/12/2009
The maximum flow exceeded the safe value in the following overflow routes: OF206, OF 205, OF 509, OF 506, OF 306, OF 305, OF 304, OF 303, OF 213, OF 204, OF 118, OF108, OF 105, OF 104, OF 103, OF 26, OF 5, OF 4, OF 3, OF 2

DRAINS MODEL RESULTS (WITH CLIMATE CHANGE)

DRAINS results prepared 21 December, 2009 from Version 2009.09

PIT / NODE DETAILS

Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Version 8 Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
Basin Cat3	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 5	0.178	0.178	0	61.34	62.89	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 1	0.01	0.01	0	31.98	31.98	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 2	0.116	0.116	0	36.46	38.46	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 3	0.134	0.134	0	49.67	51.61	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 4	0.174	0.174	0	45.19	47.02	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 6	0.012	0.012	0	29.74	29.74	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 7	0.201	0.201	0	43.04	44.63	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 8	0.064	0.064	0	45.09	47.15	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 9	0.108	0.108	0	39	42.13	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 10	0.18	0.18	0	32.14	35.19	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 11	0.006	0.006	0	17.25	17.25	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 12	0.113	0.113	0	51.43	52.77	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 14	0.135	0.135	0	44.88	46.96	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 17	0.144	0.144	0	37.22	35.22	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 18	0.095	0.095	0	38.94	40.95	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 21	0.125	0.125	0	35.07	43.45	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 22	0.085	0.085	0	5	8	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 24	0.08	0.08	0	32.85	35.32	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 25	0.086	0.086	0	38.38	41.18	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 26	0.12	0.12	0	22.7	26.93	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 27	0.074	0.074	0	42.88	46.15	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 28	0.07	0.07	0	22.51	27.65	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 29	0.074	0.074	0	18.63	24.56	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 31	0.047	0.047	0	34.32	38.11	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 33	0.057	0.057	0	23.01	28.06	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 35	0.14	0.14	0	17.61	36.68	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Basin Cat6	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 101	0.006	0.006	0	22.46	20.46	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 102	0.095	0.095	0	55.47	57.26	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 103	0.157	0.157	0	49.32	52.14	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 104	0.06	0.06	0	33.82	37.02	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 108	0.116	0.116	0	39.84	42.24	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 105	0.063	0.063	0	29.73	33.37	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 106	0.087	0.087	0	29.86	32.61	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 107	0.156	0.156	0	29.78	32.65	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 110	0.125	0.125	0	42.33	44.85	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 118	0.138	0.138	0	41.86	44.41	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 112	0.096	0.096	0	24.13	28.52	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 113	0.056	0.056	0	33.01	36.29	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 114	0.038	0.038	0	16.67	21.1	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 115	0.154	0.154	0	32.87	36.17	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 116	0.113	0.113	0	41.55	44.12	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 119	0.053	0.053	0	21.18	25.66	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 120	0.054	0.054	0	27.15	30.45	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 201	0.09	0.09	0	42.38	44.61	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 202	0.018	0.018	0	25.88	31.74	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 203	0.176	0.176	0	52.41	55.05	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 204	0.151	0.151	0	47.15	49.1	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 205	0.214	0.214	0	75.3	77.23	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 206	0.15	0.15	0	85.19	87.16	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Basin Cat5	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 207	0.098	0.098	0	42.33	44.85	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 210	0.011	0.011	0	20.35	20.35	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 211	0.078	0.078	0	21.25	25.09	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 212	0.091	0.091	0	41.59	44.96	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 214	0.05	0.05	0	32.67	35.67	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 215	0.044	0.044	0	16.93	23.96	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 213	0.324	0.324	0	57.98	59.08	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 301	0.173	0.173	0	47.32	48.7	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 302	0	0	0	36.41	37.25	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 303	0.198	0.198	0	51.76	54.22	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 304	0.14	0.14	0	41.24	43.11	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 305	0	0	0	33.42	36.42	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 320	0.065	0.065	0	57.42	56.9	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 327	0.154	0.154	0	30.39	34.62	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 306	0	0	0	0	17.97	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Basin Cat4	4.275	4.275	0	5	5	5	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 308	0.092	0.092	0	49.99	52.76	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 309	0.072	0.072	0	40.65	44.1	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 324	0.155	0.155	0	35.66	38.12	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 325	0.1	0.1	0	40.26	43.75	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 311	0.071	0.071	0	44.69	47.82	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 314	0.124	0.124	0	46.81	49.2	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 313	0.136	0.136	0	31.79	33.23	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 317	0.065	0.065	0	28.99	32.08	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 318	0.136	0.136	0	42.23	44.23	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 319	0.02	0.02	0	37.32	41.07	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 321	0.014	0.014	0	25.25	25.25	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 322	0.034	0.034	0	50.68	50.68	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Basin Cat1	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 401	0.066	0.066	0	31.27	33.07	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 402	0.128	0.128	0	42.22	44.34	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 515 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 515	0.015	0.015	0	16.8	19.3	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 405	0.065	0.065	0	42.22	40.22	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 406	0.067	0.067	0	29.19	32	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 407	0.126	0.126	0	46.47	44.47	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 501	0.013	0.013	0	14.15	14.15	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 502	0.098	0.098	0	44.67	47.8	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 504	0.084	0.084	0	33.49	34.38	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 505	0.042	0.042	0	43.97	47.16	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 503	0	0	0	10.16	10.16	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 506	0.067	0.067	0	27.25	31.19	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Basin Cat2	0.33	0.33	0	5	0	0	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
Cat 507	0.089	0.089	0	33.22	34.4	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 509	0.171	0.171	0	43.41	45.86	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 510	0.182	0.182	0	53.36	51.36	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 511	0.076	0.076	0	30.32	32.08	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 512	0.065	0.065	0	26.2	28.32	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 513	0.096	0.096	0	38.32	41.97	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 514	0.094	0.094	0	34.68	32.68	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat27 U/S	0	0	0	5	8	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 4 U/S	0	0	0	5	5	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat3 U/S	0	0	0	5	8	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 2 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 308 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 309 U/S	0	0	0	5	6	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 327 U/S	0.171	0.171	0	31.21	35.62	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 321 U/S	0	0	0	5	7	0	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 319 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 318 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 201 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 202 U/S	0	0	0	5	10	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 210 U/S	0	0	0	5	2	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 213 U/S	0	0	0	5	7	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 212 U/S	0	0	0	5	10	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 211 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 214 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 115 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 116 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 422	0.069	0.069	0	35.72	38.75	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 422 U/S	0	0	0	5	8	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 104 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 409 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 405 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 504 U/S	0	0	0	5	6	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 512 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 511 U/S	0	0	0	5	5	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 409	0.062	0.062	0	36.59	39.55	0	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
Cat 18 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 17 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 110 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
Cat 118 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1
CAT 120 U/S	0	0	0	5	3	5	AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1

Outflow Volumes for Total Catchment (36.7 impervious + 103 pervious = 140 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 234 mm/h, Zone 1	27220.26	6789.71 (24.9%)	6789.71 (94.9%)	0.00 (0.0%)
AR&R 100 year, 10 minutes storm, average 179 mm/h, Zone 1	41644.67	10582.11 (25.4%)	10582.11 (96.6%)	0.00 (0.0%)
AR&R 100 year, 15 minutes storm, average 150 mm/h, Zone 1	52346.65	13395.88 (25.6%)	13395.88 (97.3%)	0.00 (0.0%)
AR&R 100 year, 20 minutes storm, average 131 mm/h, Zone 1	60954.77	15659.18 (25.7%)	15659.18 (97.7%)	0.00 (0.0%)
AR&R 100 year, 25 minutes storm, average 117 mm/h, Zone 1	68050.64	17524.85 (25.8%)	17524.85 (97.9%)	0.00 (0.0%)
AR&R 100 year, 30 minutes storm, average 106 mm/h, Zone 1	73983.27	19082.04 (25.8%)	19082.04 (98.1%)	0.00 (0.0%)
AR&R 100 year, 45 minutes storm, average 85 mm/h, Zone 1	88989.3	23023.14 (25.9%)	23023.14 (98.4%)	0.00 (0.0%)
AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1	122281.69	31778.98 (26.0%)	31778.98 (98.8%)	0.00 (0.0%)
AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1	143639.22	37389.62 (26.0%)	37389.62 (99.0%)	0.00 (0.0%)
AR&R 100 year, 2 hours storm, average 47.3 mm/h, Zone 1	157067.81	40911.92 (26.0%)	40911.92 (99.1%)	0.00 (0.0%)
AR&R 100 year, 3 hours storm, average 36.6 mm/h, Zone 1	183925.3	47969.09 (26.1%)	47969.09 (99.2%)	0.00 (0.0%)
AR&R 100 year, 4.5 hours storm, average 28.3 mm/h, Zone 1	177769.23	46320.16 (26.1%)	46320.16 (99.1%)	0.00 (0.0%)
AR&R 100 year, 6 hours storm, average 23.6 mm/h, Zone 1	197660.98	51549.99 (26.1%)	51549.99 (99.2%)	0.00 (0.0%)
AR&R 100 year, 9 hours storm, average 18.2 mm/h, Zone 1	228650.17	59684.39 (26.1%)	59684.39 (99.3%)	0.00 (0.0%)
AR&R 100 year, 12 hours storm, average 15.2 mm/h, Zone 1	254614.11	66533.09 (26.1%)	66533.09 (99.4%)	0.00 (0.0%)
AR&R 100 year, 18 hours storm, average 12.1 mm/h, Zone 1	304029.34	79473.36 (26.1%)	79473.36 (99.4%)	0.00 (0.0%)
AR&R 100 year, 24 hours storm, average 10.3 mm/h, Zone 1	345069.09	90305.17 (26.2%)	90305.17 (99.5%)	0.00 (0.0%)
AR&R 100 year, 30 hours storm, average 9.09 mm/h, Zone 1	380664.84	99698.89 (26.2%)	99698.89 (99.6%)	0.00 (0.0%)
AR&R 100 year, 36 hours storm, average 8.17 mm/h, Zone 1	410565.19	107567.17 (26.2%)	107567.17 (99.6%)	0.00 (0.0%)
AR&R 100 year, 48 hours storm, average 6.86 mm/h, Zone 1	459645.47	120434.59 (26.2%)	120434.59 (99.7%)	0.00 (0.0%)
AR&R 100 year, 72 hours storm, average 5.27 mm/h, Zone 1	529664.25	138844.50 (26.2%)	138844.50 (99.7%)	0.00 (0.0%)
AR&R 50 year, 1 hour storm, average 65 mm/h, Zone 1	90734.2	23476.25 (25.9%)	23476.25 (98.4%)	0.00 (0.0%)
AR&R 5 year, 1 hour storm, average 43.4 mm/h, Zone 1	60582.52	15528.64 (25.6%)	15528.64 (97.5%)	0.00 (0.0%)

PIPE DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Max U/S HGL (m)	Max D/S HGL (m)	Due to Storm

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF Basin 3	0	0	0.362	0	0	0	0	
OF 5	1.437	1.437	0.362	0.085	0.08	31.42	0.94	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 1	0.01	0.01	0.362	0.012	0	6.23	0.25	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1

OF 2	0.484	0.484	0.362	0.056	0.04	23.3	0.69	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 3	0.77	0.77	0.362	0.067	0.05	27.39	0.78	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 4	1.129	1.129	0.362	0.078	0.07	30.14	0.88	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 6	0.012	0.012	0.362	0.014	0	7.09	0.24	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 7	0.377	0.377	0.362	0.051	0.03	21.41	0.64	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 8	0.064	0.064	0.362	0.025	0.01	11.96	0.4	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 9	0.167	0.167	0.362	0.037	0.02	16.05	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 10	0.18	0.18	0.362	0.038	0.02	16.68	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 11	0.006	0.006	0.362	0.011	0	5.37	0.21	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 12	0.235	0.235	0.362	0.043	0.02	18.26	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 14	0.135	0.135	1.072	0.184	0.18	1.48	1	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 17	0.267	0.267	0.362	0.044	0.03	18.89	0.59	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 18	0.381	0.381	0.362	0.051	0.03	21.41	0.65	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 21	0.125	0.125	0.362	0.033	0.02	14.79	0.48	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF22	0.085	0.085	0.362	0.029	0.01	13.22	0.42	AR&R 100 year, 1.5 hours storm, average 57 mm/h, Zone 1
OF 24	0.152	0.152	0.362	0.036	0.02	15.74	0.5	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 25	0.237	0.237	0.362	0.043	0.02	18.26	0.57	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 26	0.551	0.551	0.362	0.059	0.04	24.24	0.72	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 27	0.243	0.243	0.362	0.043	0.02	18.26	0.58	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 28	0.124	0.124	0.362	0.033	0.02	14.79	0.47	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF29	0.074	0.074	0.362	0.027	0.01	12.59	0.41	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 31	0.17	0.17	0.362	0.037	0.02	16.37	0.52	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 30	0.057	0.057	0.362	0.024	0.01	11.64	0.38	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF35	0.14	0.14	0.362	0.034	0.02	15.11	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 6	0	0	0.362	0	0	0	0	
OF 101	0.006	0.006	0.362	0.011	0	5.37	0.22	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 102	0.246	0.246	0.362	0.043	0.02	18.26	0.59	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 103	0.515	0.515	0.362	0.057	0.04	23.61	0.71	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 104	0.617	0.617	0.362	0.061	0.05	25.19	0.74	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF108	0.879	0.879	0.362	0.071	0.06	28.54	0.81	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 105	0.645	0.645	0.362	0.063	0.05	25.82	0.74	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF106	0.087	0.087	0.362	0.029	0.01	13.22	0.43	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 107	0.239	0.239	0.362	0.043	0.02	18.26	0.57	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 110	0.176	0.176	0.362	0.037	0.02	16.37	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 118	0.493	0.493	0.362	0.056	0.04	23.3	0.7	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 112	0.096	0.096	0.362	0.03	0.01	13.53	0.45	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 113	0.184	0.184	0.362	0.038	0.02	16.68	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 114	0.038	0.038	0.362	0.021	0.01	10.38	0.35	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 115	0.154	0.154	0.362	0.036	0.02	15.74	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 116	0.113	0.113	0.362	0.031	0.01	14.16	0.47	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 119	0.279	0.279	0.362	0.045	0.03	19.2	0.6	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 120	0.054	0.054	0.362	0.024	0.01	11.33	0.39	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF201	0.09	0.09	0.362	0.029	0.01	13.22	0.44	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF202	0.1	0.1	0.362	0.03	0.01	13.85	0.44	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 203	0.373	0.373	0.362	0.05	0.03	21.09	0.65	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 204	0.516	0.516	0.362	0.058	0.04	23.93	0.69	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 205	0.726	0.726	0.362	0.066	0.05	26.76	0.77	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF206	1.369	1.369	0.362	0.084	0.08	31.18	0.93	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 5	0	0	0.362	0	0	0	0	
OF 207	0.098	0.098	0.362	0.03	0.01	13.53	0.46	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 210	0.011	0.011	0.362	0.013	0	6.66	0.25	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 211	0.117	0.117	0.362	0.032	0.02	14.48	0.47	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 212	0.204	0.204	0.362	0.04	0.02	17.31	0.55	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 214	0.05	0.05	0.362	0.023	0.01	11.01	0.38	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 215	0.044	0.044	0.362	0.022	0.01	10.7	0.37	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 213	0.531	0.531	0.362	0.058	0.04	23.93	0.71	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 301	0.173	0.173	0.362	0.037	0.02	16.37	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 302	0.173	0.173	0.362	0.037	0.02	16.37	0.53	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 303	0.686	0.686	0.362	0.065	0.05	26.45	0.75	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 304	1.23	1.23	0.362	0.08	0.07	30.71	0.9	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 305	1.431	1.431	0.362	0.085	0.08	31.42	0.94	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 320	0.438	0.438	0.362	0.054	0.04	22.35	0.68	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 326	0.365	0.365	0.362	0.05	0.03	21.09	0.64	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 306	1.643	1.643	0.362	0.09	0.09	32.02	0.99	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 4	0	0	0.362	0	0	0	0	
OF 308	0.092	0.092	0.362	0.029	0.01	13.22	0.46	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 309	0.157	0.157	0.362	0.036	0.02	15.74	0.52	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 324	0.155	0.155	0.362	0.036	0.02	15.74	0.51	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 325	0.255	0.255	0.362	0.043	0.03	18.57	0.59	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 311	0.326	0.326	0.362	0.048	0.03	20.15	0.63	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 314	0.124	0.124	0.362	0.033	0.02	14.79	0.47	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 313	0.242	0.242	0.362	0.043	0.02	18.26	0.58	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 317	0.065	0.065	0.362	0.025	0.01	11.96	0.41	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 318	0.2	0.2	0.362	0.039	0.02	17	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 319	0.218	0.218	0.362	0.041	0.02	17.63	0.56	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 321	0.014	0.014	0.362	0.014	0	7.09	0.28	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 322	0.045	0.045	0.362	0.022	0.01	10.7	0.37	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF Basin 1	0	0	0.362	0	0	0	0	
OF 401	0.066	0.066	0.362	0.025	0.01	11.96	0.41	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 402	0.193	0.193	0.362	0.039	0.02	17	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 515 U/S	0	0	0.362	0	0	0	0	
OF 515	0.015	0.015	0.362	0.015	0	7.52	0.26	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 405	0.127	0.127	0.362	0.033	0.02	14.79	0.48	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 406	0.176	0.176	0.362	0.037	0.02	16.37	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 407	0.302	0.302	0.362	0.047	0.03	19.83	0.6	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 408	0	0	0.362	0	0	0	0	
OF 501	0.013	0.013	0.362	0.014	0	7.09	0.26	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 502	0.104	0.104	0.362	0.03	0.01	13.85	0.46	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 504	0.097	0.097	0.362	0.03	0.01	13.53	0.45	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 505	0.273	0.273	0.362	0.044	0.03	18.89	0.61	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 503	0.273	0.273	0.362	0.044	0.03	18.89	0.61	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 506	0.821	0.821	0.362	0.069	0.05	28.02	0.79	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OFBasin 2	0	0	0.362	0	0	0	0	
OF 507	0.089	0.089	0.362	0.029	0.01	13.22	0.44	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 509	0.518	0.518	0.362	0.058	0.04	23.93	0.7	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 510	0.273	0.273	0.362	0.045	0.03	19.2	0.59	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 511	0.076	0.076	0.362	0.027	0.01	12.59	0.42	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 512	0.136	0.136	0.362	0.034	0.02	15.11	0.49	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF513	0.096	0.096	0.362	0.03	0.01	13.53	0.45	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 514	0.193	0.193	0.362	0.039	0.02	17	0.54	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 27 U/S	0	0	0.362	0	0	0	0	
OF 4 U/S	0	0	0.362	0	0	0	0	
OF 3 U/S	0	0	0.362	0	0	0	0	
OF 2 U/S	0	0	0.362	0	0	0	0	
OF 308 U/S	0	0	0.362	0	0	0	0	
OF 309 U/S	0	0	0.362	0	0	0	0	
OF 327 U/S	0.171	0.171	0.362	0.037	0.02	16.37	0.52	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 321 U/S	0	0	0.362	0	0	0	0	
OF 319 U/S	0	0	0.362	0	0	0	0	
OF 318 U/S	0	0	0.362	0	0	0	0	
OF 201 U/S	0	0	0.362	0	0	0	0	
OF 202 U/S	0	0	0.362	0	0	0	0	
OF 210 U/S	0	0	0.362	0	0	0	0	
OF 213 U/S	0	0	0.362	0	0	0	0	
OF 212 U/S	0	0	0.362	0	0	0	0	
OF 211 U/S	0	0	0.362	0	0	0	0	
OF 214 U/S	0	0	0.362	0	0	0	0	
OF 115 U/S	0	0	0.362	0	0	0	0	
OF 116 U/S	0	0	0.362	0	0	0	0	
OF 422	0.069	0.069	0.362	0.026	0.01	12.27	0.41	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 422 U/S	0	0	0.362	0	0	0	0	
OF 104 U/S	0	0	0.362	0	0	0	0	
OF 409 U/S	0	0	0.362	0	0	0	0	
OF 405 U/S	0	0	0.362	0	0	0	0	
OF 504 U/S	0	0	0.362	0	0	0	0	
OF 512 U/S	0	0	0.362	0	0	0	0	
OF 511 U/S	0	0	0.362	0	0	0	0	
OF 409	0.062	0.062	0.362	0.025	0.01	11.96	0.39	AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1
OF 18 U/S	0	0	0.362	0	0	0	0	
OF 17U/S	0	0	0.362	0	0	0	0	
OF 110 U/S	0	0	0.362	0	0	0	0	
OF 118 U/S	0	0	0.362	0	0	0	0	
OF 120 U/S	0	0	0.362	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin 3	3.28	5952.7	0	0	0
Basin 6	3.12	3189.8	0	0	0
Basin 5	2.76	1067	0	0	0
Basin 4	1.81	485.7	0	0	0
Basin 1	1.8	0	0	0	0
Basin 2	2.08	884	0	0	0

CONTINUITY CHECK for AR&R 100 year, 1 hour storm, average 73 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Change (cu.m)	Difference %
Basin 3	6948.43	2484.18	4436.38	0.4
N 5	4472.6	4472.6	0	0
N 1	23.12	23.12	0	0
N 2	1406.39	1406.39	0	0
N 3	2266.17	2266.17	0	0
N 4	3422.83	3422.83	0	0
N 6	28.63	28.63	0	0
N 7	1082.03	1082.03	0	0
N 8	187.84	187.84	0	0
N 9	479.5	479.5	0	0
N 10	439.11	439.11	0	0
N 11	11.68	11.68	0	0
N 12	644.84	644.84	0	0
N 14	397.16	397.16	0	0
N 17	696.26	696.26	0	0
N 18	1061.59	1061.58	0	0
N 21	317.99	317.99	0	0
N 22	110.85	110.85	0	0
N 24	341.74	341.74	0	0
N 25	572.16	572.16	0	0
N 26	1416.69	1416.69	0	0
N 27	592.57	592.57	0	0
N 28	265.24	265.24	0	0
N 29	145.75	145.75	0	0
N 31	382.91	382.91	0	0
N 33	119.33	119.33	0	0
N 35	269.02	269.02	0	0
Basin 6	4259.57	1827.78	2417.98	0.3
N 101	13.03	13.03	0	0
N 102	713.6	713.6	0	0
N 103	1516.54	1516.54	0	0
N 104	1843.26	1843.26	0	0
N 108	2269.52	2269.51	0	0
N 105	1991.35	1991.35	0	0
N 106	203.27	203.27	0	0
N 107	568.81	568.81	0	0
N 110	474.94	474.94	0	0
N 118	1276.32	1276.32	0	0
N 112	204.81	204.81	0	0
N 113	414.71	414.71	0	0

N 114	72.45	72.45	0	0
N 115	378.4	378.4	0	0
N 116	314.25	314.25	0	0
N 119	676.76	676.76	0	0
N 120	121.2	121.2	0	0
N 201	253.22	253.22	0	0
N 202	292.4	292.4	0	0
N 203	1143.92	1143.92	0	0
N 204	1601.8	1601.8	0	0
N 205	2460.8	2460.81	0	0
N 206	4867.98	4867.97	0	0
Basin 5	4879.07	4886.89	39.48	-1
N 207	277.81	277.81	0	0
N 210	22.07	22.07	0	0
N 211	281.55	281.55	0	0
N 212	537.16	537.16	0	0
N 214	122.14	122.14	0	0
N 215	82.75	82.75	0	0
N 213	1752.67	1752.67	0	0
N 301	525.06	525.06	0	0
N 302	525.06	525.06	0	0
N 303	2042.76	2042.76	0	0
N 304	3732.91	3732.91	0	0
N 305	4435.28	4435.28	0	0
N 320	1301.23	1301.23	0	0
N 327	915.05	915.05	0	0
N 306	5346.87	5346.87	0	0
Basin 4	10889.24	10765.3	0	1.1
N 308	290.2	290.2	0	0
N 309	487.39	487.39	0	0
N 324	398.02	398.02	0	0
N 325	672.75	672.75	0	0
N 311	879.9	879.9	0	0
N 314	373.03	373.03	0	0
N 313	703.06	703.06	0	0
N 317	149.48	149.48	0	0
N 318	534.4	534.4	0	0
N 319	588.18	588.18	0	0
N 321	31.14	31.14	0	0
N 322	138.7	138.7	0	0
Basin 1	1396.48	1396.49	0	0
N 401	157.63	157.63	0	0
N 402	517.88	517.89	0	0
N 515 U/S	0	0	0	0
N 515	28.01	28.01	0	0
N 405	345.03	345.03	0	0
N406	499.92	499.92	0	0
N 407	878.6	878.6	0	0
N 408	0	0	0	0
N 501	23.61	23.61	0	0
N 502	309.18	309.18	0	0
N 504	236.79	236.79	0	0
N 505	680.19	680.19	0	0
N 503	680.19	680.19	0	0
N 506	2398.97	2398.97	0	0
Basin 2	3373.37	3357.03	0	0.5
N 507	220.78	220.78	0	0
N 509	1567.58	1567.58	0	0
N 510	854.85	854.85	0	0
N 511	179.31	179.31	0	0
N 512	322.85	322.85	0	0
B3 Outlet	0	0	0	0
B6 Outlet	0	0	0	0
B5 Outlet	0	0	0	0
B4 Outlet	0	0	0	0
B2 Outlet	0	0	0	0
B1 Outlet	0	0	0	0
N 513	255.25	255.25	0	0
N 514	546.12	546.12	0	0
N27 U/S	0	0	0	0
N4 U/S	0	0	0	0
N 3 U/S	0	0	0	0
N 2 U/S	0	0	0	0
N 308 U/S	0	0	0	0
N 309 U/S	0	0	0	0
N 327 U/S	411.59	411.59	0	0
N 321 U/S	0	0	0	0
N 319 U/S	0	0	0	0
N 318 U/S	0	0	0	0
N 201 U/S	0	0	0	0
N 202 U/S	0	0	0	0
N 210 U/S	0	0	0	0
N 213 U/S	0	0	0	0
N 212 U/S	0	0	0	0
N 211 U/S	0	0	0	0
N 214 U/S	0	0	0	0
N 115 U/S	0	0	0	0
N 116 U/S	0	0	0	0
N422	176.55	176.55	0	0
N 422 U/S	0	0	0	0
N 104 U/S	0	0	0	0
N 409 U/S	0	0	0	0
N 405 U/S	0	0	0	0
N 504 U/S	0	0	0	0
N 512 U/S	0	0	0	0
N 511 U/S	0	0	0	0
N 409	162.7	162.7	0	0
N 18 U/S	0	0	0	0
N 17 U/S	0	0	0	0
N 110 U/S	0	0	0	0
N 118 U/S	0	0	0	0
N 120 U/S	0	0	0	0

Run Log for P0902479DRN01V06.drn run at 12:42:31 on 21/12/2009
The maximum flow exceeded the safe value in the following overflow routes: OF206, OF 205, OF 509, OF 506, OF 326, OF 320, OF 306, OF 305, OF 304, OF 303, OF 213, OF 204, OF 203, OF 118, OF108, OF 105, OF 104, OF 103, OF 26, OF 18, OF 7, OF 5, OF 4, OF 3, OF 2

14 Attachment G – Notes About This Report

Information

Important Information About Your Report

Subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Martens to help you interpret and understand the limitations of your report. Not all of course, are necessarily relevant to all reports, but are included as general reference.

Engineering Reports - Limitations

Geotechnical reports are based on information gained from limited sub-surface site testing and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretative rather than factual documents, limited to some extent by the scope of information on which they rely.

Engineering Reports – Project Specific Criteria

Engineering reports are prepared by qualified personnel and are based on the information obtained, on current engineering standards of interpretation and analysis, and on the basis of your unique project specific requirements as understood by Martens. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the Client.

Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relative if the design proposal is changed (eg. to a twenty storey building). Your report should not be relied upon if there are changes to the project without first asking Martens to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Martens will not accept responsibility for problems that may occur due to design changes if they are not consulted.

Engineering Reports – Recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption often cannot be substantiated until project implementation has commenced and therefore your site investigation report recommendations should only be regarded as preliminary.

Only Martens, who prepared the report, are fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Martens cannot be held responsible for such misinterpretation.

Engineering Reports – Use For Tendering Purposes

Where information obtained from this investigation is provided for tendering purposes, Martens recommend that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. Attention is drawn to the document 'Guidelines for the Provision of Geotechnical Information in Tender Documents', published by the Institution of Engineers, Australia.

The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Engineering Reports – Data

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings *etc* are customarily included in a Martens report and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These data should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Engineering Reports – Other Projects

To avoid misuse of the information contained in your report it is recommended that you confer with Martens before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Subsurface Conditions - General

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical aspects, relevant standards and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions - the potential for will depend partly on test point (eg. excavation or borehole) spacing and sampling frequency which are often limited by project imposed budgetary constraints.

- Changes in guidelines, standards and policy or interpretation of guidelines, standards and

policy by statutory authorities.

- The actions of contractors responding to commercial pressures.

- Actual conditions differing somewhat from those inferred to exist, because no professional, no matter how qualified, can reveal precisely what is hidden by earth, rock and time.

  The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions

If these conditions occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Subsurface Conditions - Changes

Natural processes and the activity of man create subsurface conditions. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Reports are based on conditions which existed at the time of the subsurface exploration.

Decisions should not be based on a report whose adequacy may have been affected by time. If an extended period of time has elapsed since the report was prepared, consult Martens to be advised how time may have impacted on the project.

Subsurface Conditions - Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those that were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved at the time when conditions are exposed, rather than at some later stage well after the event.

Report Use By Other Design Professionals

To avoid potentially costly misinterpretations when other design professionals develop their plans based on a report, retain Martens to work with other project professionals who are affected by the report. This may involve Martens explaining the report design implications and then reviewing plans and specifications produced to see how they have incorporated the report findings.

Subsurface Conditions - Geoenvironmental Issues

Your report generally does not relate to any findings, conclusions, or recommendations about the potential for hazardous or contaminated materials existing at the site unless specifically required to do so as part of the Company's proposal for works.

Specific sampling guidelines and specialist equipment, techniques and personnel are typically used to perform geoenvironmental or site contamination assessments. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Martens for information relating to such matters.

Responsibility

Geotechnical reporting relies on interpretation of factual information based on professional judgment and opinion and has an inherent level of uncertainty attached to it and is typically far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded.

To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Martens to other parties but are included to identify where Martens' responsibilities begin and end. Their use is intended to help all parties involved to recognize their individual responsibilities. Read all documents from Martens closely and do not hesitate to ask any questions you may have.

Site Inspections

Martens will always be pleased to provide engineering inspection services for aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site. Martens is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction.

Soil Data

Explanation of Terms (1 of 3)

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Definitions

In engineering terms, soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material does not exhibit any visible rock properties and can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726 and the S.A.A Site Investigation Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

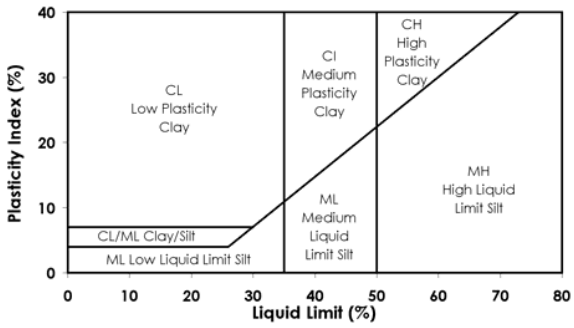
Particle Size

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay). Unless otherwise stated, particle size is described in accordance with the following table.

Division	Subdivision	Size
BOULDERS		>200 mm
COBBLES		60 to 200 mm
GRAVEL	Coarse	20 to 60 mm
	Medium	6 to 20 mm
	Fine	2 to 6 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties

Plasticity properties can be assessed either in the field by tactile properties, or by laboratory procedures.



Moisture Condition

Dry — Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist — Soil feels cool and damp and is darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet — As for moist but with free water forming on hands when handled.

Consistency of Cohesive Soils

Cohesive soils refer to predominantly clay materials.

Term	C_u (kPa)	Approx SPT "N"	Field Guide
Very Soft	<12	2	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	2 to 4	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	4 – 8	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	8 – 15	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	15 – 30	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	> 200	> 30	The surface of the soil can be marked only with the thumbnail.
Friable	-		Crumbles or powders when scraped by thumbnail

Density of Granular Soils

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration test (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	%	SPT 'N' Value (blows/300mm)	CPT Cone Value (q_c Mpa)
Very loose	< 15	< 5	< 2
Loose	15 – 35	5 - 10	2 -5
Medium dense	35 – 65	10 - 30	5 - 15
Dense	65- 85	30 - 50	15 - 25
Very dense	> 85	> 50	> 25

Minor Components

Minor components in soils may be present and readily detectable, but have little bearing on general geotechnical classification. Terms include:

Term	Assessment	Proportion of Minor component In:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5 % Fine grained soils: < 15 %
With some	Presence easily detectable by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 – 12 % Fine grained soils: 15 – 30 %

Soil Data

Explanation of Terms (2 of 3)

martens consulting engineers

Soil Agricultural Classification Scheme

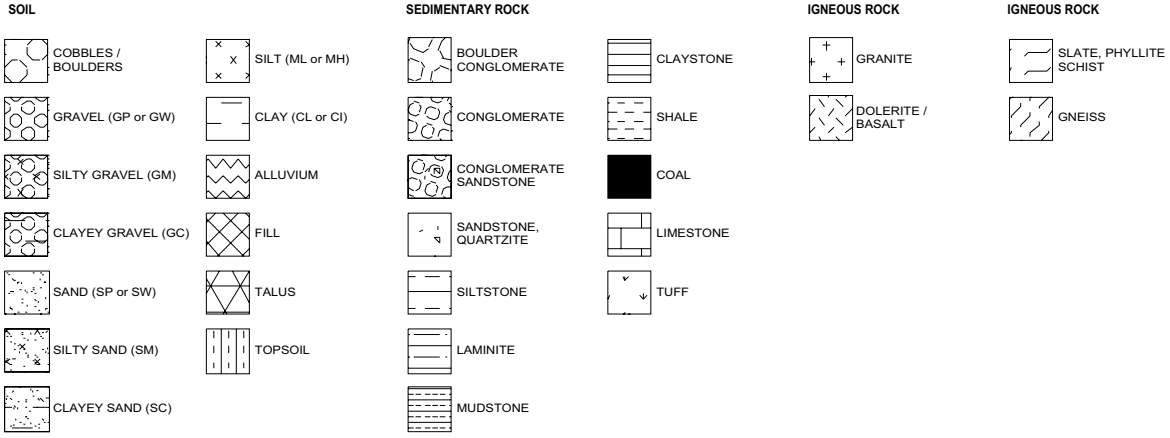
In some situations, such as where soils are to be used for effluent disposal purposes, soils are often more appropriately classified in terms of traditional agricultural classification schemes. Where a Martens report provides agricultural classifications, these are undertaken in accordance with descriptions by Northcote, K.H. (1979) *The factual key for the recognition of Australian Soils*, Rellim Technical Publications, NSW, p 26 - 28.

Symbol	Field Texture Grade	Behaviour of moist bolus	Ribbon length	Clay content (%)
S	Sand	Coherence nil to very slight; cannot be moulded; single grains adhere to fingers	0 mm	< 5
LS	Loamy sand	Slight coherence; discolours fingers with dark organic stain	6.35 mm	5
CLS	Clayey sand	Slight coherence; sticky when wet; many sand grains stick to fingers; discolours fingers with clay stain	6.35mm - 1.3cm	5 - 10
SL	Sandy loam	Bolus just coherent but very sandy to touch; dominant sand grains are of medium size and are readily visible	1.3 - 2.5	10 - 15
FSL	Fine sandy loam	Bolus coherent; fine sand can be felt and heard	1.3 - 2.5	10 - 20
SCL$^-$	Light sandy clay loam	Bolus strongly coherent but sandy to touch, sand grains dominantly medium size and easily visible	2.0	15 - 20
L	Loam	Bolus coherent and rather spongy; smooth feel when manipulated but no obvious sandiness or silkiness; may be somewhat greasy to the touch if much organic matter present	2.5	25
Lfsy	Loam, fine sandy	Bolus coherent and slightly spongy; fine sand can be felt and heard when manipulated	2.5	25
SiL	Silt loam	Coherent bolus, very smooth to silky when manipulated	2.5	25 + > 25 silt
SCL	Sandy clay loam	Strongly coherent bolus sandy to touch; medium size sand grains visible in a finer matrix	2.5 - 3.8	20 - 30
CL	Clay loam	Coherent plastic bolus; smooth to manipulate	3.8 - 5.0	30 - 35
SiCL	Silty clay loam	Coherent smooth bolus; plastic and silky to touch	3.8 - 5.0	30- 35 + > 25 silt
FSCL	Fine sandy clay loam	Coherent bolus; fine sand can be felt and heard	3.8 - 5.0	30 - 35
SC	Sandy clay	Plastic bolus; fine to medium sized sands can be seen, felt or heard in a clayey matrix	5.0 - 7.5	35 - 40
SiC	Silty clay	Plastic bolus; smooth and silky	5.0 - 7.5	35 - 40 + > 25 silt
LC	Light clay	Plastic bolus; smooth to touch; slight resistance to shearing	5.0 - 7.5	35 - 40
LMC	Light medium clay	Plastic bolus; smooth to touch, slightly greater resistance to shearing than LC	7.5	40 - 45
MC	Medium clay	Smooth plastic bolus, handles like plasticine and can be moulded into rods without fracture, some resistance to shearing	> 7.5	45 - 55
HC	Heavy clay	Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; firm resistance to shearing	> 7.5	> 50

Soil Data

Explanation of Terms (3 of 3)

Symbols for Soil and Rock



Unified Soil Classification Scheme (USCS)

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 63 mm and basing fractions on estimated mass)					USCS	Primary Name
COARSE GRAINED SOILS More than 50 % of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm.	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.	GW	Gravel
				Predominantly one size or a range of sizes with more intermediate sizes missing	GP	Gravel
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	GM	Silty Gravel
				Plastic fines (for identification procedures see CL below)	GC	Clayey Gravel
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of intermediate sizes missing.	SW	Sand
				Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Sand
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)	SM	Silty Sand
				Plastic fines (for identification procedures see CL below)	SC	Clayey Sand

FINE GRAINED SOILS More than 50 % of material less than 63 mm is smaller than 0.075 mm	IDENTIFICATION PROCEDURES ON FRACTIONS < 0.2 MM					
	DRY STRENGTH (Crushing Characteristics)	DILATANCY	TOUGHNESS	DESCRIPTION	USCS	Primary Name
	None to Low	Quick to Slow	None	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	ML	Silt
	Medium to High	None	Medium	Inorganic clays of low to medium plasticity, gravely clays, sandy clays, silty clays, lean clays	CL	Clay
	Low to Medium	Slow to Very Slow	Low	Organic slits and organic silty clays of low plasticity	OL	Organic Silt
	Low to Medium	Slow to Very Slow	Low to Medium	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH	Silt
	High	None	High	Inorganic clays of high plasticity, fat clays	CH	Clay
	Medium to High	None	Low to Medium	Organic clays of medium to high plasticity	OH	Organic Silt
HIGHLY ORGANIC SOILS	Readily identified by colour, odour, spongy feel and frequently by fibrous texture				Pt	Peat

Low Plasticity – Liquid Limit W_L < 35 % Medium Plasticity – Liquid limit W_L 35 to 60 % High Plasticity - Liquid limit W_L > 60 %

Rock Data

Explanation of Terms (1 of 2)

Definitions

Descriptive terms used for Rock by Martens are given below and include rock substance, rock defects and rock mass.

Rock Substance — In geotechnical engineering terms, rock substance is any naturally occurring aggregate of minerals and organic matter which cannot, unless extremely weathered, be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Rock substance is effectively homogeneous and may be isotropic or anisotropic.

Rock Defect — Discontinuity or break in the continuity of a substance or substances.

Rock Mass — Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

Degree of Weathering

Rock weathering is defined as the degree in rock structure and grain property decline and can be readily determined in the field.

Term	Symbol	Definition
Residual Soil	Rs	Soil derived from the weathering of rock. The mass structure and substance fabric are no longer evident. There is a large change in volume but the soil has not been significantly transported.
Extremely weathered	EW	Rock substance affected by weathering to the extent that the rock exhibits soil properties - ie. it can be remoulded and can be classified according to the Unified Classification System, but the texture of the original rock is still evident.
Highly weathered	HW	Rock substance affected by weathering to the extent that limonite staining or bleaching affects the whole of the rock substance and other signs of chemical or physical decomposition are evident. Porosity and strength may be increased or decrease compared to the fresh rock usually as a result of iron leaching or deposition. The colour and strength of the original rock substance is no longer recognisable.
Moderately weathered	MW	Rock substance affected by weathering to the extent that staining extends throughout the whole of the rock substance and the original colour of the fresh rock is no longer recognisable.
Slightly weathered	SW	Rock substance affected by weathering to the extent that partial staining or discolouration of the rock substance usually by limonite has taken place. The colour and texture of the fresh rock is recognisable.
Fresh	Fr	Rock substance unaffected by weathering

Rock Strength

Rock strength is defined by the Point Load Strength Index (Is 50) and refers to the strength of the rock substance is the direction normal to the bedding. The test procedure is described by the International Society of Rock Mechanics.

Term	Is (50) MPa	Field Guide	Symbol
Extremely weak	< 0.03	Easily remoulded by hand to a material with soil properties.	EW
Very weak	0.03 - 0.1	May be crumbled in the hand. Sandstone is 'sugary' and friable.	VW
Weak	0.1 - 0.3	A piece of core 150mm long x 50mm diameter may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.	W
Medium strong	0.3 - 1	A piece of core 150mm long x 50mm diameter can be broken by hand with considerable difficulty. Readily scored with a knife.	MS
Strong	1 - 3	A piece of core 150mm long x 50mm diameter cannot be broken by unaided hands, can be slightly scratched or scored with a knife.	S
Very Strong	3 - 10	A piece of core 150mm long x 50mm diameter may be broken readily with hand held hammer. Cannot be scratched with pen knife.	VS
Extremely strong	> 10	A piece of core 150mm long x 50mm diameter is difficult to break with hand held hammer. Rings when struck with a hammer.	ES

Rock Data

Explanation of Terms (2 of 2)

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Degree of Fracturing

This classification applies to diamond drill cores and refers to the spacing of all types of natural fractures along which the core is discontinuous. These include bedding plane partings, joints and other rock defects, but excludes fractures such as drilling breaks.

Term	Description
Fragmented	The core is comprised primarily of fragments of length less than 20mm, and mostly of width less than core diameter.
Highly fractured	Core lengths are generally less than 20mm-40mm with occasional fragments.
Fractured	Core lengths are mainly 30mm-100mm with occasional shorter and longer sections.
Slightly fractured	Core lengths are generally 300mm-1000mm with occasional longer sections and occasional sections of 100mm-300mm.
Unbroken	The core does not contain any fractures.

Test Methods

Explanation of Terms (1 of 2)

martens consulting engineers

Sampling

Sampling is carried out during drilling or excavation to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples may be taken by pushing a thin-walled sample tube into the soils and withdrawing a soil sample in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils. Other sampling methods may be used. Details of the type and method of sampling are given in the report.

Drilling Methods

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Hand Excavation – in some situations, excavation using hand tools such as mattock and spade may be required due to limited site access or shallow soil profiles.

Hand Auger - the hole is advanced by pushing and rotating either a sand or clay auger generally 75-100mm in diameter into the ground. The depth of penetration is usually limited to the length of the auger pole, however extender pieces can be added to lengthen this.

Test Pits - these are excavated with a backhoe or a tracked excavator, allowing close examination of the *in-situ* soils if it is safe to descend into the pit. The depth of penetration is limited to about 3m for a backhoe and up to 6m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) - the hole is advanced by a rotating plate or short spiral auger, generally 300mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling - the hole is advanced by pushing a 100mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength *etc.* is only marginally affected.

Continuous Spiral Flight Augers - the hole is advanced using 90 - 115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or *in-situ* testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface or, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling - the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling - similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling - a continuous core sample is obtained using a diamond tipped core barrel, usually 50mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in AS 1289 Methods of Testing Soils for Engineering Purposes - Test F3.1.

The test is carried out in a borehole by driving a 50mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300mm. In dense sands, very hard clays or weak rock, the full 450mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form:

(i) In the case where full penetration is obtained with successive blow counts for each 150mm of say 4, 6 and 7 blows:

as 4, 6, 7
N = 13

(ii) In a case where the test is discontinued short of full penetration, say after 15 blows for the first 150mm and 30 blows for the next 40mm

as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil. Occasionally, the test method is used to obtain samples in 50mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

CONE PENETROMETER TESTING AND INTERPRETATION

Cone penetrometer testing (sometimes referred to as Dutch Cone - abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in AS 1289 - Test F4.1.

In the test, a 35mm diameter rod with a cone tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on separate 130mm long sleeve, immediately behind the cone. Tranducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20mm per second) the information is output on continuous chart

Test Methods

Explanation of Terms (2 of 2)

recorders. The plotted results given in this report have been traced from the original records.

The information provided on the charts comprises:
Cone resistance - the actual end bearing force divided by the cross sectional area of the cone - expressed in MPA.
Sleeve friction - the frictional force of the sleeve divided by the surface area - expressed in kPa.
Friction ratio - the ratio of sleeve friction to cone resistance - expressed in percent.

There are two scales available for measurement of cone resistance. The lower (A) scale (0 - 5 Mpa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main (B) scale (0 - 50 Mpa) is less sensitive and is shown as a full line.

The ratios of the sleeve resistance to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%-2% are commonly encountered in sands and very soft clays rising to 4%-10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:

q_c (Mpa) = (0.4 to 0.6) N (blows/300mm)

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:

q_c = (12 to 18) c_u

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes *etc*. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

DYNAMIC CONE (HAND) PENETROMETERS
Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150mm increments of penetration. Normally, there is a depth limitation of 1.2m but this may be extended in certain conditions by the use of extension rods. Two relatively similar tests are used.

Perth sand penetrometer - a 16 mm diameter flat ended rod is driven with a 9kg hammer, dropping 600mm (AS 1289 - Test F 3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
Cone penetrometer (sometimes known as the Scala Penetrometer) - a 16mm rod with a 20mm diameter cone end is driven with a 9kg hammer dropping 510mm (AS 1289 - Test F 3.2). The test was developed initially for pavement sub-grade investigations, with correlations of the test results with California bearing ratio published by various Road Authorities.

LABORATORY TESTING
Laboratory testing is carried out in accordance with AS 1289 Methods of Testing Soil for Engineering Purposes. Details of the test procedure used are given on the individual report forms.

TEST PIT / BORE LOGS
The test pit / bore log(s) presented herein are an engineering and/or geological interpretation of the sub-surface conditions and their reliability will depend to some extent on frequency of sampling and the method of excavation / drilling. Ideally, continuous undisturbed sampling or excavation / core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variation between the boreholes.

GROUND WATER
Where ground water levels are measured in boreholes, there are several potential problems:

In low permeability soils, ground water although present, may enter the hole slowly, or perhaps not at all during the time it is left open.
A localised perched water table may lead to an erroneous indication of the true water table.
Water table levels will vary from time to time with seasons or recent prior weather changes. They may not be the same at the time of construction as are indicated in the report.
The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Annex E

Fern Bay Seaside Village
Mosquito Risk Assessment

ADDENDUM REPORT –MOSQUITO RISK ASSESSMENT FERN BAY ESTATE, FERN BAY, NSW

The Mosquito Risk Assessment: Fern Bay Estate, Fern Bay, NSW 2004 was prepared to assess the potential for mosquito impacts on the proposed Fern Bay Seaside Village Subdivision. Since the initial mosquito risk assessment was undertaken, legislation changes and submissions received have made it necessary to re-examine mosquito issues for the proposed subdivision. This addendum is based on current guidelines from Port Stephens Council and Hunter New England Health Service titled "Living with Mosquitoes in the Lower Hunter and Mid North Coast Region of NSW". It has been undertaken in order to meet the requirements of Port Stephens Council Development Control Plan 2007 and address concerns raised through the consultation process.

1.1 MOSQUITOES

The Fern Bay Seaside Village site is situated in a region containing extensive areas of salt marsh and wetlands associated with Fullerton Cove and Kooragang Island. These extensive wetlands are capable of producing enormous seasonal populations of the Saltmarsh Mosquito (*Aedes vigilax*) and other mosquito species. Saltmarsh mosquitoes can cause an impact up to 15 kilometres from the breeding areas, resulting in most areas within Port Stephens experiencing plagues at some time.

Port Stephens Council recognises that mosquitoes create nuisance and health problems during seasonal plagues throughout most of Port Stephens.

There is no legislation in NSW requiring councils or owners of land to control mosquito breeding. However, Port Stephens Council Development Control Plan 2007 places restrictions on development approvals to ensure appropriate mosquito management practices are put in place.

1.2 PORT STEPHENS COUNCIL DEVELOPMENT CONTROL PLAN 2007

Following is an extract from the Port Stephens Council DCP 2007 with respect to Mosquito Control.

1.2.1 B2.9 Mosquito Control

Mosquitoes are transmitters of disease and are recognised as a major environmental health issue. Port Stephens has a humid temperate environment with floodplains, wetlands, creeks and estuarine systems that are good habitat for mosquitoes. The location and design of development can influence the impact of mosquitoes on residents and community health and wellbeing.

Principles: Section B2.P12 identifies that all development proposals should consider the type and extent of local mosquito populations including species matrix, seasonality, harbourage and potential for human exposure.

Development Controls:

- B2.C35 identifies that where appropriate, developments within 200 metres of any wetland must provide evidence that the potential for exposure to mosquitoes has been investigated and addressed. This includes:
    - an assessment of the vulnerability of occupants to mosquitoes (age, tolerance, health);
    - the potential duration and seasonality of exposure;
    - extent and location of vegetated corridors leading to residential areas;

- methods of warning occupants during seasonal outbreaks; and
- an appropriate planning and management response to mosquitoes.

- B2.C36 Development near continuous, heavily vegetated corridors and mosquito harbourage sites or freshwater breeding sites must locate occupied structures as far as possible from the breeding or harbourage sites and at least 50m from any breeding sites;
- B2.C37 All dwellings must be equipped with effective screens on all windows, doors and openings;
- B2.C38 All rainwater tanks and fabricated water storage structures must be equipped with effective screens on all openings;
- B2.C39 Development near continuous, heavily vegetated corridors located between mosquito harbourage sites or freshwater breeding sites must locate occupied structures at least 50m from harbourage and breeding sites;
- B2.C40 All drainage and stormwater systems capable of retaining standing water for more than 48 hours must be designed and constructed to provide:
  - an edge/area ratio as small as possible to reduce the total length of edges;
  - edges with a minimum 45 degrees slope; and
  - an area of deep permanent water free of vegetation is to be provided.
- B2.C41 Extensive areas of emergent vegetation will not be permitted.

1.3 SUBMISSIONS RECEIVED

1.3.1 Reference Number 4k

A mosquito risk assessment should be included to ensure any potential mosquito breeding sites are identified. A mosquito management plan should also be developed if constructed wetlands are proposed in the residential development with consideration of best practice design.

It is highly recommended that information be sought from Port Stephens Council's Environment and Planning Department on previous mosquito assessment and surveillance undertaken.

ERM Response:

The Mosquito Risk Assessment: Fern Bay Estate, Fern Bay, NSW was prepared by Cameron E. Webb PhD and Richard C. Russell MSc PhD from the Department of Medical Entomology in 2004. The same Authors prepared the current Hunter New England Health Mosquito Management Strategy "Living with Mosquitoes in the Lower Hunter and Mid North Coast Region of NSW" referenced on Port Stephens Council web site as a strategy to "guide councils and other land managers in responding to mosquito management issues". This strategy was revised in August 2006 and contains all of the management strategies contained in the existing Mosquito Risk Assessment and the CLEMP management strategies are in accordance with the suggested methods.

The Senior Weeds and Pest Management Officer at Port Stephens Council has recently confirmed that these guidelines are Councils preferred mosquito management practices and while it will soon be reviewed there is not likely to be any significant changes but simply the consideration of additional data and knowledge. The CLEMP will be reviewed regularly in consultation with Port Stephens Council and if significant changes were to be made the mosquito management strategies would be updated at this time.

1.3.2 Reference Number 12jj

The CLEMP suggests the use of adulticides for mosquito controls. This method is outdated and potentially highly damaging to the ecology of surrounding ecosystems. The control method should be removed from the CLEMP and more emphasis put on the controls such as screens etc as outlined in the Port Stephens DCP 2007.

ERM Response:

The CLEMP has been updated, to include management methods in accordance with Port Stephens DCP 2007, as follows:

- to link management procedures to the Port Stephens Council DCP 2007;
- to remove the use of Adultacides as a suggested management procedure;
- to encourage the use of screens on doors windows and openings; and
- to encourage the use of screens on water tanks and standing water bodies.

Approval is not sought for any dwellings at this stage but later development applications for individual dwellings will need to be in accordance with Port Stephens Council DCP 2007.

1.3.3 Reference Number 20a

There has not been an assessment on development adjacent to coastal swamp forests. Issues not addressed include the effect of climate change and increasing spread of mosquito borne diseases.

ERM Response:

The Mosquito Risk Assessment: Fern Bay Estate, Fern Bay, NSW was prepared by Cameron E. Webb PhD and Richard C. Russell MSc PhD from the Department of Medical Entomology in 2004 and follows this addendum in *Annex E* of the Submissions report.

1.4 MOSQUITO MANAGEMENT MEASURES IN CLEMP

The management of mosquitoes within the Fern Bay Seaside Village should be undertaken generally in accordance with the Mosquito Risk Assessment, Fern Bay Estate (ICPMR, 2004), the management measures identified in "*Living with Mosquitoes in the Lower Hunter and Mid-North Coast Region of NSW*" (Webb and Russell, 2005) and Port Stephens Council Development Control Plan 2007.

Management measures may include:

- community education, providing not only public health messages, but also information regarding the ecology of the local mosquito habitat areas and the importance of environmentally sensitive mosquito control measures;
- management of stormwater management structures, including stormwater inlet pits, gross pollutant traps or surface storage areas by ensuring that the structures are self draining, have the siltation depth shallow enough to encourage evaporative drying and that the accumulation of organic material is maintained at low levels;
- the use of personal insect repellents, mosquito coils (containing insecticide) is highly recommended to provide protection for individuals and households and education of residents;
- all dwellings must be equipped with effective screens on all windows, doors and openings;
- all rainwater tanks and fabricated water storage structures must be equipped with effective screens on all openings; and
- treatment with a approved larval control agent.

The application of herbicides for mosquito control would require a permit under the *Threatened Species Conservation Act 1995*, however a permit for

mosquito control for amenity reasons only is unlikely to be approved by the Department of Environment, Climate Change and Water (DECCW).

Should mosquito populations be excessive, consideration should be given to undertaking mosquito faunal studies during the period December through to March to assess the species present, population sizes and harbourage areas. '*Living with Mosquitoes in the Lower Hunter and Mid-North Coast Region of NSW*' (Webb and Russell, 2005) provides monitoring data sheets for undertaking fauna studies of mosquito populations that could be utilised at the site.

icpmr
Institute of Clinical Pathology
and Medical Research

WESTERN SYDNEY AREA HEALTH SERVICE

Mosquito Risk Assessment: Fern Bay Estate, Fern Bay, NSW.

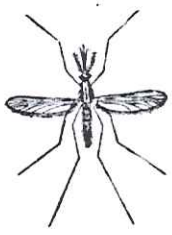


Report prepared for Environmental Resources Management Australia Pty Ltd

September 2004

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Introduction

Mosquito risk assessments are designed to provide information on actual and/or potential mosquito populations, provide comments on their significance, consider the nature and implications of the proposed development with respect to providing mosquito habitat for, or being exposed to impacts from, local 'problem' species and provide comments and recommendations for their management.

In the absence of mosquito population sampling, information on local mosquito fauna must be based on previously published studies, data provided by the NSW Arbovirus Surveillance Program or mosquito habitats identified through site visits and the inspection of aerial photographs, vegetation studies and topographic maps. Plans of proposed developments, their impact on current habitats and potential to create additional habitats are also considered.

As well as being influenced by mosquito populations associated with surrounding habitats, the proposed development may also be affected by mosquitoes if the development itself enhances on-site mosquito breeding. While it is possible to assess the likely impacts of mosquitoes on the development based on existing data from the wider local area, it is difficult to accurately determine the impact of pest mosquitoes dispersing into the area, or being produced from habitats within the area, without a faunal study.

Notwithstanding the impacts of nuisance biting, the transmission of disease-causing pathogens by mosquitoes in the Hunter region is an increasing concern. Ross River and Barmah Forest virus typically affect people aged between 20 and 50 with the diseases characterised by a range of symptoms including arthralgia and myalgia, rash or fever (generally greater for Barmah Forest virus), and arthritic multiple joint pain (generally longer for Ross River virus).

The development site

The site of the proposed Fern Bay Estate is located near Newcastle, New South Wales, to the north of the Hunter River, and East of Fullerton Cove between Nelson Bay Road and Stockton Beach (Figure 1). The proposed development is approximately 205 hectares in area and the proposed development will comprise approximately 1,000 residential lots, open space areas, new public roads, community and recreational facilities and areas set aside for habitat conservation (Appendix 1).

There does not appear to be any significant wetland habitats within the development site with the pre-developed environment dominated by sandy soils and Eucalypt forest (Figure 2). There are low lying Swamp Mahogany-Paperbark forest and Tomago sand swamp (wet heath) woodland (Appendix 2) habitats that may provide suitable breeding conditions for mosquitoes, but not necessarily cause pest impacts,

if temporary pools are created after rainfall. There are no habitats within the site influenced by tidal inundation.

There are, however, extensive estuarine (saltmarsh and mangrove) habitats along the Hunter River including productive mosquito habitats on Kooragang Island and in Tomago (including Fullerton Cove). Inland of Fullerton Cove and the Hunter River at Tomago are extensive flat remnant saltmarshes, sedgelands and forests that, although not directly influenced by tides, retain water following rainfall and often contain extensive pools that may persist for long periods of time.

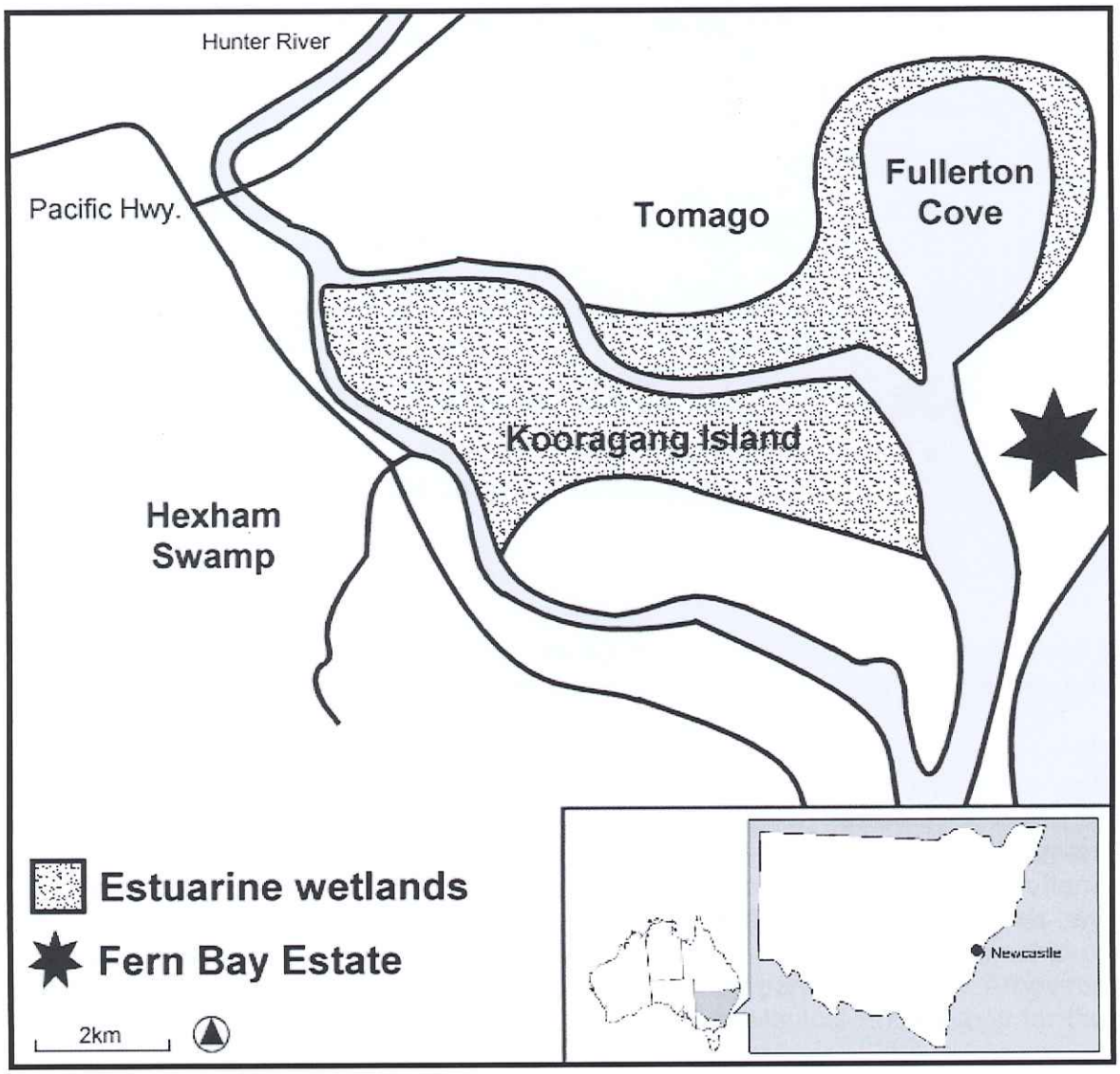


FIGURE 1: Location of the Fern Bay Estate development and major estuarine wetland areas within the Hunter estuary, NSW.



FIGURE 2: Aerial photo of the predevelopment state of the proposed Fern Bay Estate development showing the proximity to Fullertone Cove.

Pest mosquito populations

There are no data available on the mosquito fauna in the area immediately surrounding the Fern Bay site, however there is regional data that can be used to determine the likely impacts of mosquitoes on the proposed development.

There are some data available for the areas to the west of Fullerton Cove in Tomago and on the western side of Kooragang Island. This information has been collected by the Department of Medical Entomology for the Hunter-Central Rivers Catchment Management Authority (HCRCMA), as part of their ongoing estuarine wetland management and rehabilitation projects. Additional mosquito monitoring sites are located at Heatherbrae (Hunter Region Botanic Gardens) and near the township of Medowi, and are operated by Port Stephens Council as part of the NSW Arbovirus Surveillance Program undertaken by the Department of Medical Entomology for the NSW Department of Health.

The data from these traps provide generalised information on the mosquito fauna of the Hunter region and are useful in providing an assessment of potential pest impacts on the Fern Bay Estate development.

Over 20 species of mosquito have been collected from the Hunter region, with the most abundant pest mosquito species being *Coquillettidia linealis*, *Culex annulirostris*, and *Ochlerotatus vigilax*. There are also additional species that may be abundant under suitable conditions (i.e. during 'wet' summers and following significant rainfall events) and only cause pest impacts occasionally or in areas localised around breeding sites.

The species of greatest concern in the Hunter region is the saltmarsh mosquito, *Ochlerotatus vigilax*. *Ochlerotatus vigilax* is usually associated with tidally influenced saltmarsh (*Sarcocornia quinqueflora* and/or *Sporobolus virginicus*) and mangrove habitats, but also breeds in other saline and brackish water habitats such as flooded sedgelands and forests (eg. *Casuarina* spp. and *Melaleuca* spp.). The species can disperse great distances (> 10 km) from breeding habitats and it is considered to be the major pest and vector (disease-carrying) mosquito in coastal regions of NSW and south-east Queensland.

This species lays eggs at the base of saltmarsh vegetation and they hatch following inundation by the wetlands by the highest tides of each month or rainfall. During the summer months, larvae can hatch from eggs and develop to adults within 7-10 days. As a result, populations of *Oc. vigilax* are greatest approximately 10-14 days following habitat inundation when mosquitoes disperse widely from the breeding habitat (up to 25km). The mosquitoes live for approximately 2 weeks, thereafter, populations decline until the next inundation event.

Adult mosquito traps operated within Tomago and Kooragang Island have collected on occasion in excess of 10,000 *Oc. vigilax* per trap per night with collections following tidal inundation of the wetlands regularly exceeding 3,000. Traps operated at Heatherbrae and Medowie, approximately 8-10kms from the major breeding sites, have collected over 1,000 *Oc. vigilax* per trap following tidal inundation of the estuarine wetlands of Fullerton Cove and Kooragang Island.

It is difficult to quantify the relationship between the quantity of mosquitoes collected in traps and the nuisance impact of mosquito biting, because the tolerance of the community to mosquito impacts greatly determines the degree of nuisance accorded the local mosquito populations. However, it has been our Department's experience that adult trap collections that exceed 500 mosquitoes per trap per night typically reflect significant pest impact as indicated by increased complaints to local council and/or managing authority.

The location of the Fern Bay Estate, approximately 5 km from the breeding habitats in Tomago and Kooragang Island, places the development well within the flight range of *Oc. vigilax*, and it is expected that there will be significant nuisance biting impacts during the period from December until April. Impacts will be greatest following the highest tides (generally >1.8m) of each month and/or major rainfall events (generally over 50mm within three days), with populations dramatically

increasing within 7-10 days following wetland inundation and persisting for at least two weeks thereafter.

There are two more pest mosquitoes associated with the estuarine wetlands. *Ochlerotatus alternans* is associated with both saline marshes and freshwater temporary ground pools. The larvae of this species are predatory on other mosquito larvae (and other small invertebrates), and adults can be significant pests in coastal areas, but are not important as disease vector. *Culex sitiens* is usually associated with permanently inundated pools and does not travel far from breeding habitats.

In addition to the mosquitoes associated with the estuarine habitats, mosquitoes associated with permanent and ephemeral freshwater and brackish water habitats, such as *Anopheles annulipes*, *Cq. linealis*, *Cx. annulirostris, Ochlerotatus multiplex*, *Ochlerotatus procax* and *Verrallina* spp. are often abundant in the local area. Following heavy rainfall, there may be large populations of some of these species generated from temporary groundpools in the Kooragang Nature Reserve and Long Bite Swamp surrounding Fullerton Cove. Although these species will not represent the same ongoing risks as *Oc. vigilax*, they will make a significant contribution to pest and public health risks when conditions are suitable for them.

The shaded and humid resting spots for mosquitoes provided by the forested areas surrounding the Fern Bay Estate may also increase the relative impact of *Oc. vigilax* and other pest species when populations are high. These 'refuges' provide locations from which further dispersal can occur while also contributing to a potential increase in the longevity of the mosquitoes, increasing the duration of pest impacts and, potentially, the likelihood of disease transmission.

Within the Fern Bay Estate, there are only limited opportunities for mosquito breeding due to the sandy soils but there are two habitats that may support breeding by mosquitoes following rainfall. The areas defined by Swamp Mahogany-Paperbark and Wet Heath (see vegetation community map Appendix 2) both have the potential to provide suitable mosquito breeding habitats following rainfall, with the places of greatest concern in the development area being the low lying areas of swamp mahogany/paperbark/palm forest alongside Nelson Bay Road (Figure 3). There are some small ponds (currently vegetated by *Typha* spp.) (Figure 4) and many smaller depressions that may hold water. Pest species such as *An. annulipes, Oc. multiplex* and *Oc. procax* may be abundant after rainfall but, under such circumstances, there will also be considerably large populations of *Oc. vigilax*.



FIGURE 3: An example of low-lying areas of swamp mahogany/palm forest that may provide isolated breeding conditions for mosquitoes following rainfall.



FIGURE 4: Semi-permanent ponds (foreground and background) beneath the paperbark forest alongside Nelson Bay Road.

It would be difficult to determine the productivity of these habitats following the completion of the development but, due to the sandy soils dominating the site, any ponding following rainfall is likely to be minimal and any mosquitoes produced unlikely to cause pest impacts. However, care must be taken that increased runoff from hard surfaces surrounding the residential areas does not increases the amount of water, and consequently water ponding, in any area.

Mosquito management and the Fern Bay Estate

The mosquito species of greatest concern for the Fern Bay Estate is *Oc. vigilax,* and pest impacts are likely to be greatest following inundation of the nearby estuarine wetlands by tides and/or rainfall. Impacts are likely to peak approximately 10-14 days following the inundation event and typically last for two weeks. Unfortunately, there is little that can be done onsite to significantly minimise pest impacts during these periods of peak mosquito activity.

The incorporation of 'buffer zones', where vegetation is minimised, around residential developments has been proposed as a means of reducing pest impacts, but for mosquitoes such as *Oc. vigilax* that disperse widely from breeding habitats, even distances of serval hundred meters would not offer significant protection and, given the proximity of the Fern Bay Estate to breeding sites in Tomago and Kooragang Island, their use would not be practical or effective.

The use of adulticides (usually applied as an ultra low volume fog or mist) may be considered when mosquito populations become intolerable but they are generally an expensive option, time consuming and often ineffective unless routine repeated treatments are undertaken.

There are two mosquito species commonly associated with urban developments that may cause some pest impacts. *Culex quinquefasciatus* is a biting pest, often coming inside buildings at night. Their larvae are usually associated with, but not limited to, habitats with a high organic content such as drains, sullage pits, septic tanks and other water holding and water storage areas. *Ochlerotatus notoscriptus* is often a severe nuisance biting pest in urban areas, usually biting in the early afternoon and at dusk. Their larvae are usually associated with small water holding containers around dwellings such as tins, pots, ornamental ponds, blocked guttering and tyres, as well as water holding plants (eg. bromeliads) and tree holes.

For freshwater and brackish water mosquitoes breeding in habitats within the Fern Bay Estate, the residential development is unlikely to significantly enhance mosquito breeding. However, the design of the development must consider the impact of increased runoff (eg. rainwater runoff from hard surfaces) on the production of mosquitoes from habitats immediately surrounding the development, in particular the swamp mahogany forest alongside Nelson Bay Road. If mosquito breeding in these habitats is considered to be serious, some monitoring and occasional treatment with an appropriate formulation of an approved larval control agent may be required.

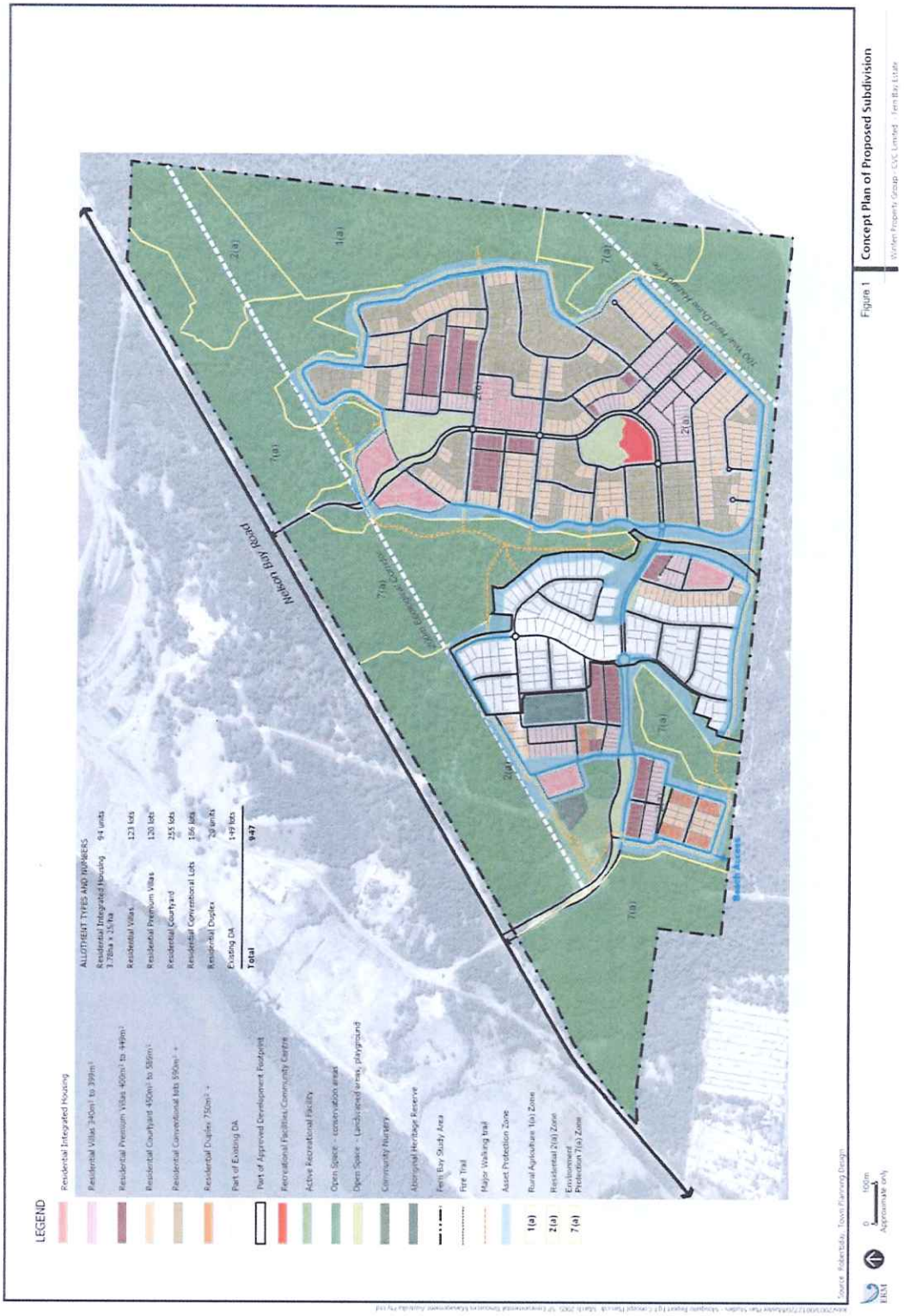
The proposed Stormwater Management Strategy for the site includes an integrated water management system incorporating bio-retention swales, infiltration basins and traditional drainage infrastructure (Stormwater Management Strategies for the Proposed Urban Development at Fern Bay (Urban Water Cycle Solution 2004)). Stormwater runoff from roads and allotments will be directed towards the bio-retention swales and infiltration basins. These structures, featuring sub-surface water flow and storage capabilities, are generally not suitable sites for mosquito production unless the carrying capacity of the drainage system is regularly exceeded and standing water pools at the surface for more than 5 days. If mosquitoes (particularly *Cx. quinquefasciatus*) can gain access to the standing water in the void spaces between the gravel, some mosquito breeding may occur with the suitability of the habitat increasing over time with sedimentation and vegetation growth.

The production of mosquitoes from stormwater inlet pits, gross pollutant traps or surface storage areas can be avoided by ensuring that the structures are self draining, have the siltation depth shallow enough to encourage evaporative drying, and that the accumulation of organic material is maintained at low levels. If these measures are not possible, occasional larval control agent applications may be required.

Given the quantity and productivity of mosquito habitats in the Hunter region, adult mosquitoes will always be active from at least December until April and some consideration should be given to reducing human activity in areas of greatest mosquito activity. Avoidance of heavily forested areas that act as harbourage and refuge sites for mosquitoes, and limiting activities during the peak periods of mosquito activity (i.e. dusk and dawn), will minimise mosquito impacts. The use of personal insect repellents (formulations containing DEET or Picaridin) or mosquito coils or heated pads (containing insecticide) is also highly recommended to provide protection for individuals and households.

Additional mosquito faunal studies could be undertaken during the period December through until March to confirm the predictions of onsite mosquito impacts based on existing data. Mosquito sampling would provide valuable information on the changing abundance of local pest mosquitoes and the incorporation of mosquito monitoring in the overall management plan for the site will greatly assist any onsite mosquito control strategies (eg. adulticide or larvicide treatments). This information will be useful to compare the relative abundance of mosquitoes at Fern Bay with nearby areas of the Hunter/Port Stephens region, and will greatly assist the local dissemination of information about the risks of nuisance biting and potential health concerns to future residents and visitors to the area so they can manage their exposure risks through personal protection measures.

APPENDIX 1:
Concept Plan of Proposed Sub-division



APPENDIX 2:
Vegetation Communities and Threatened Species in the study area

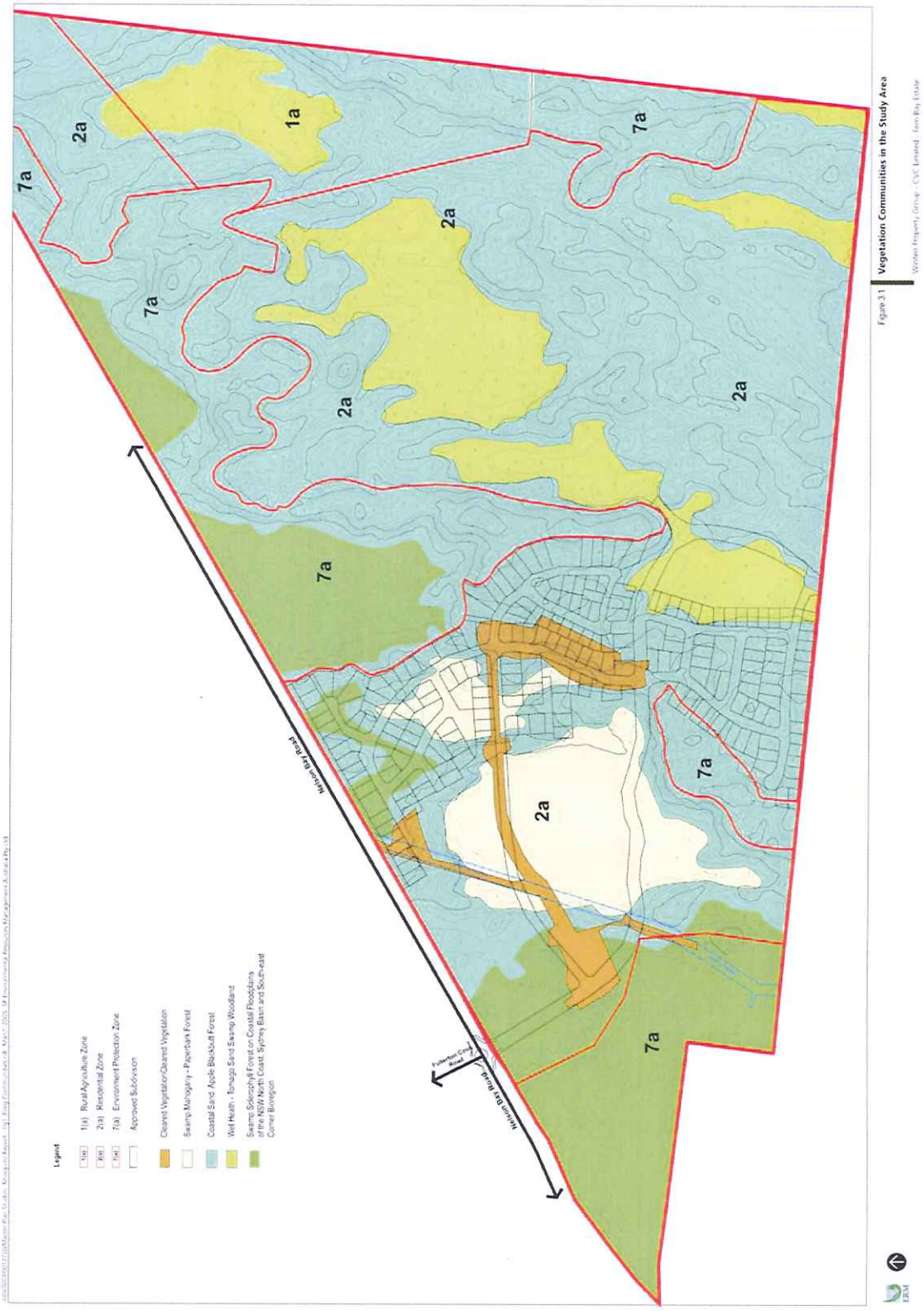


Figure 3.1 Vegetation Communities in the Study Area

Annex F

Crime Prevention through Environmental Design Principles Assessment

F.1 CRIME PREVENTION THROUGH ENVIRONMENTAL DESIGN PRINCIPLES

F.1.1 Background

Fundamental concept of crime prevention through environmental design is that it is possible to use knowledge and creativity to design built environments in ways that lesson or prevent the incidence of such crime.

The NSW Department of Urban Affairs and Planning (now DoP) released the '*Crime Prevention and the Assessment of Development Applications under Section 79C of the Environmental Planning and Assessment Act 1979'* in 2001 to facilitate the identification and assessment of crime risk and minimise opportunities for crime through development applications. The Guideline seeks to implement Crime Prevention through Environmental Design (CPTED) principles.

F.1.2 Compliance with the Principles

An assessment of the Project's compliance with the principles of CPTED has been undertaken and is detailed in *Table F.1.*

Table F.1 Compliance with Crime Prevention through Environmental Design Principles

Principle	Project Compliance
Surveillance - the attractiveness of crime targets can be reduced by providing opportunities for effective surveillance, both natural and technical	The design of Fern Bay Seaside Village facilitates surveillance by providing a compatible mix of uses including residential, commercial, community and recreation facilities. These range of uses: • provide for vehicular and pedestrian movement between uses; • enable businesses to be observed by residents after hours and residences to be observed by business people during business hours; • are located such that they maximise the contribution they make to the surveillance of places by overlooking parks, pedestrian footpaths etc; • Locating seating in areas actively used; and • provide lighting. The Design Guidelines (to be revised for Stages 4 – 20) will provide further guidance for individual dwellings, including the following considerations: • fencing design to maximise natural surveillance from the street to the building and from the building to the street; • natural surveillance for communal and

Principle	Project Compliance
	public areas by positioning active uses or windows of habitable rooms adjacent to communal public areas, eg playgrounds, swimming pools, gardens, car parks, etc; locating foyers/waiting areas where they are both visible from the building entry and close to actively used areas.
Access Control - physical and symbolic barriers can be used to attract, channel or restrict the movement of people. They minimise opportunities for crime and increase the effort required to commit crime.	Fern Bay Seaside Village will be supported by a network of pedestrian trails linking residential areas to open space and community and commercial facilities, thereby enhancing 'walkability. These paths will channel pedestrian movement throughout the estate (including to local bus stops) in defined areas to minimise opportunities for crime and increase opportunities for natural surveillance.
Territorial Reinforcement – community ownership of public space sends positive signals. People often feel comfortable in, and are more likely to visit, places which feel owned and cared for. Well used places also reduce opportunities for crime and increase risk to criminals.	All public lands and community facilities throughout Fern Bay Seaside Village will be owned and managed by the Community Association (with the exception of roads and road reserves which will be dedicated to Port Stephens Council). Therefore, the community has a vested interest in caring for and maintaining all community land throughout the estate, and are subject to the payment of fees to ensure appropriate maintenance is undertaken. The design of Fern Bay Seaside Village encourages people to use public space areas provided (including reserves and conservation areas) through the provision of defined pedestrian footpaths and a walkable neighbourhood.
Space Management - popular public space is often attractive, well maintained and well used space. Linked to the principle of territorial reinforcement, space management ensures that space is appropriately utilised and well cared for.	As above.

Annex G

Density Information

G.1 DENSITY ASSESSMENT

G.1.1 Overview

Clause 19 of the LEP 2000 specifies a number of development standards for residential development. These standards include the minimum density standard for single residential dwellings, Floor Space Ratio (FSR) and the maximum height. The minimum lot size (density standard) for vacant lot subdivision is 500m^2. The FSR is 0.5:1 and the maximum height is nine metres.

The Master Plan approval allows for 947 residential lots and the Director-General's requirements reflect this number with the proposed lots ranging in size from 340m^2 to in excess of 750m^2. Port Stephens LEP 2000 contains a minimum area for dwellings of 500m^2 in this regard the creation of lots less than 500m^2, where dwellings are not pursued concurrently, would be inconsistent with the LEP. The approved Master Plan shows approximately 600 lots less than 500m^2. In response to submissions from the Department of Planning, Port Stephens Council and the NSW Department of Housing all lots less then 500m^2 have been consolidated into "super lots". The proposed density of these super lots is outlined in *Table G.1*.

Additional Points to Consider from the Submissions *Table A.1* in *Annex A*
The proposed residential subdivision's density of 7.5 dwellings per hectare is significantly less than the recommended 12 dwellings per hectare as identified in the Lower Hunter Regional Strategy. This will further limit the subdivisions ability to support a viable public transport service.
The proposed higher density residential integrated housing lots should be located as close as possible to bus stops in order to improve the viability of services to the proposed subdivision.
The EA neglects the implications the development will have on surrounding services and facilities. It has not provided adequate evidence to support the claim (of households over the next 10 years), which has been used to determine the mix of allotments proposed within the Fern Bay Seaside Village. ***ERM Response:*** ***The proposed development seeks to incorporate a range of housing types to provide affordable housing options. Such options include residential integrated housing, residential villas, residential courtyard, conventional lots and duplexes.*** ***Additional detail of housing types and densities will be provided through the density plan in tables G.1 and G.2. This land has been zoned for residential development for 15 years and is planned for within Council's Community Services strategy. The proposed development will comply with the requirements of Council's contributions plan.***

Table G.1 Super Lot and Integrated Housing Density Plan

Lot Number	Allotment Type	Lot Size (m^2)	Master Plan Density	Port Stephens LEP Density
74	Super lot	3464	9	11
75	Super lot	4680	11	15
80	Super lot	2257	5	7
81	Super lot	3975	8	12
82	Super lot	8428	26	27
83	Super lot	4729	12	15
84	Super lot	4729	11	15
85	Super lot	4010	8	13
86	Super lot	4222	10	14
204	Super lot	2331	5	7
251	Super lot	2792	6	9
261	Super lot	4448	10	14
262	Super lot	4438	9	14
267	Super lot	4000	10	13
268	Super lot	3990	9	13
319	Super lot	2277	5	7
327	Super lot	5384	13	17
328	Super lot	5339	11	17
334	Super lot	6440	14	21
335	Super lot	4096	8	13
336	Super lot	1809	5	6
366	Super lot	1906	5	6
370	Super lot	1906	5	6
374	Super lot	1906	5	6
378	Super lot	1969	5	6
382	Super lot	2262	6	7
384	Super lot	1174	3	3
385	Super lot	1076	3	3
391	Super lot	1667	4	5
392	Super lot	1668	5	5
393	Super lot	4344	10	14
394	Super lot	4186	12	13
395	Super lot	2056	5	6
403	Super lot	3300	8	11
404	Super lot	3612	9	12
406	Super lot	903	2	3
408	Super lot	900	2	3
Total	**36**		**294**	**389**
130	Integrated Housing	12418	24	41
289	Integrated Housing	6253	33	20
290	Integrated Housing	8167	25	27
410	Integrated Housing	6979	20	23
Total	**4**		**102**	**111**

Table G.2 Preferred Project Density Plan

Master Plan Density		Project Plan Density		LEP Density	
Allotment Type	**Number**	**Allotment Type**	**Number**	**Allotment Type**	**Number**
Residential Integrated Housing 3.78ha x 25/ha	94 units	Residential Integrated Housing(planned density outlined in table D.1)	4 lots (to accommodate 102 units).	Urban Housing (minimum area per unit 300 m2)	111 units
Residential Villas 340m² to 399m²	123 lots	Super lots (planned density outlined in table D.1)	36 lots (to accommodate 294 dwellings)	Urban Housing (minimum area per unit 300 m2)	389 Dwellings
Residential Premium Villas 400m² to 449m²	120 lots	Category included in super lots			
Residential Courtyard 450m² to 589m²	255 lots	Residential Courtyard 500m² to 589m²	153	Dwelling house	153
Residential Conventional lots 590m² to 749 m²	186 lots	Residential Conventional lots 590m² to 749 m²	183	Dwelling house	183
Residential Duplex 750m² +	20 units	Residential Duplex lots 750m² +	31	Residential Duplex lots	31
Existing DA (Stages 1 – 3)	149 lots	Existing DA (Stages 1 – 3)	184	Existing DA (Stages 1 – 3)	184
		Commercial	2		
		Community Lot	**1**		
Total Lots	**947**	**Total Lots**	411 (with potential dwelling yield of up to 978 dwellings	**Total Lots**	**1051**

G.1.2 Discussion

The density of the proposed development is in line with the approved master plan. The development will still realise 409 lots with the ability to accommodate 947 dwellings and two commercial properties. The proposed development now consistent with the Port Stephens LEP 2000 as there are no lots proposed which are less than 500m^2.

The density of the development footprint may be 7.5 dwellings per hectare however after the provision of open space for active and passive recreation in close proximity to all residents to promote active transport requires a lower density. Of the remaining development footprint available for residential dwellings the density will be 21 dwellings per hectare. This when combined with the location of the higher density super lots and integrated housing along main roads and close to commercial and recreational facilities will make the already established local bus services more viable.

The above table demonstrates that the density proposed through the Master Plan approval is able to be achieved through Port Stephens LEP 2000. Furthermore there is the potential for additional density to be realised given the integrated housing provisions of the LEP.

The development is on land zoned for residential growth and population growth of this magnitude has been planned for through Council's Community Services strategy. Development contributions will also be paid in accordance with Port Stephens Council Section 94A developer contributions Plan allowing Council to provide the additional services the expected population growth will require.

G.2 CONCLUSION

The density of the proposed development is consistent with the Port Stephens LEP 2000, the approved master plan, provides ample opportunity for active transport and will support a viable public transport system. There is therefore no density related issues preventing the approval of the proposed Fern Bay Seaside Village development.

Annex H

Community Lands Environment Management Plan

ADDENDUM REPORT –COMMUNITY LANDS ENVIRONMENTAL MANAGEMENT PLAN

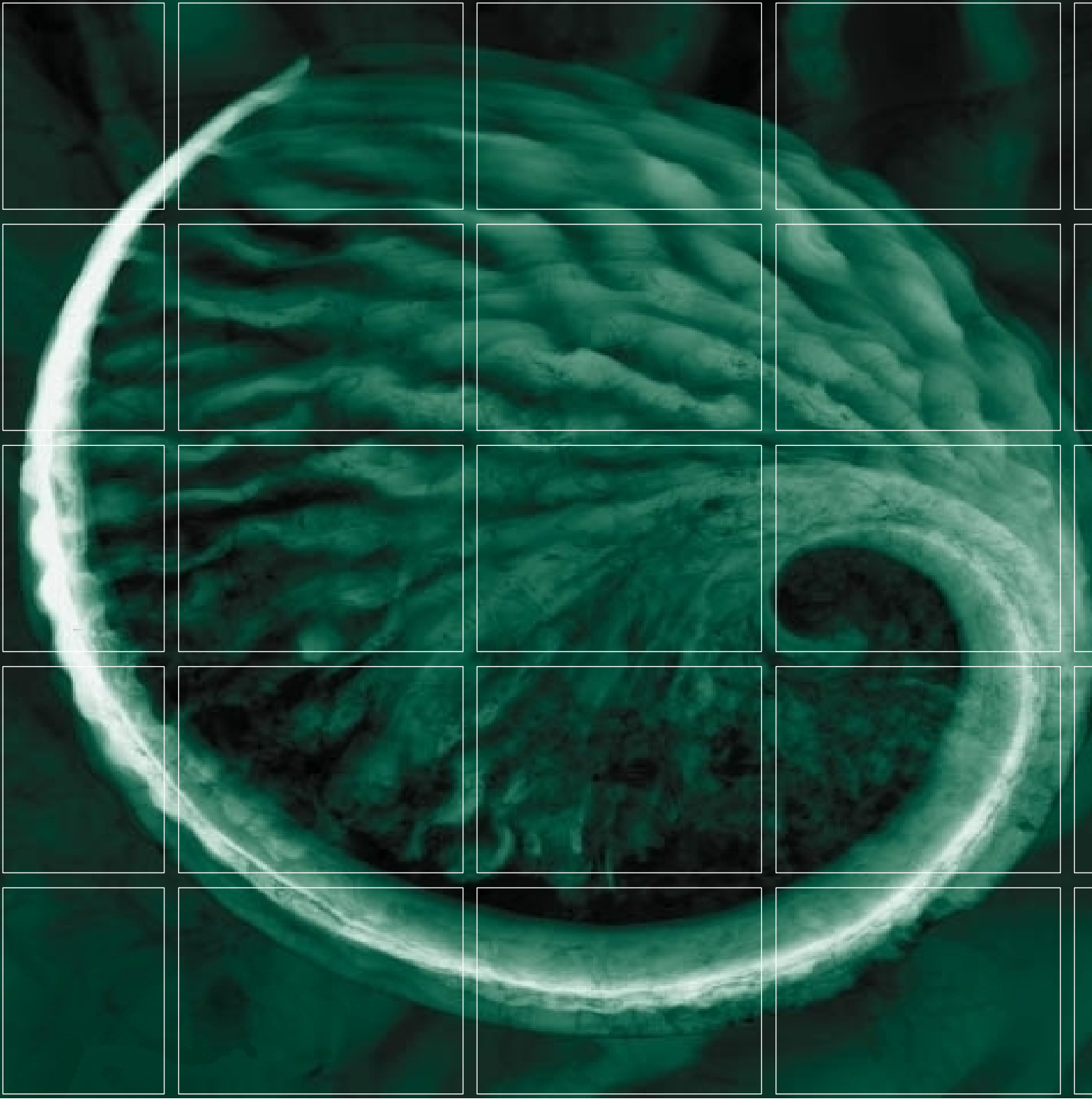
In response to submissions received through the consultation process the Community Lands Environmental Management Plan (CLEMP) has been reviewed and amended to ensure that concerns with the environmental management of Community Lands are addressed.

The majority of submissions relating to the CLEMP were that reference to it is included in the Community Management Statement (CMS) and this has been done, with the new CMS included in *Annex I* of the submissions report and the reference occurring in By Law 35B.

Changes to the CLEMP were required to:

- include reference to the provision of ongoing maintenance of pedestrian pathways in *Section 7.4*;
- update *Figure 4.1* Vegetation Communities and Threatened Species in the Study Area, *Figure 4.2* Weed Mapping Areas and *Figure 5.1* Project Plan to show the proposed lot layout including super lots and to show asset protection zones contained within the development footprint;
- amendments to *Section 6.4*, *Section 6.5* and *Section 7.1* to indicate that where possible habitat trees will be retained within asset protection zones;
- remove the use of Adultacides as a suggested mosquito management procedure; and
- encourage the use of screens on doors windows and openings as well as with water tanks and standing water bodies in accordance with PSC DCP 2007.

The indicative works programme included in the CLEMP will need dates updated post consent.



Fern Bay Seaside Village
Community Lands Environmental Management Plan

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0063154 CLEMP Final
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Community Lands Environmental Management Plan

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December 2009
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Date:	*22 December, 2009*
Partner:	Paul Douglass

Environmental Resources Management Australia Pty Ltd Quality System

This report has been prepared in accordance with the scope of services described in the contract or agreement between Environmental Resources Management Australia Pty Ltd ABN 12 002 773 248 (ERM) and the Client. The report relies upon data, surveys, measurements and results taken at or under the particular times and conditions specified herein. Any findings, conclusions or recommendations only apply to the aforementioned circumstances and no greater reliance should be assumed or drawn by the Client. Furthermore, the report has been prepared solely for use by the Client and ERM accepts no responsibility for its use by other parties.

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1 INTRODUCTION

1.1 PURPOSE

This Community Lands Environmental Management Plan (EMP) has been prepared for Fern Bay Seaside Village at Lot 16, DP 258848 Nelson Bay Road, Fern Bay (refer to *Figure 1.1* for the locality plan) and applies to land within the site to be dedicated as community conservation areas. This land will be hereafter referred to in this report as community lands. The community lands cover approximately 117 hectares (ha) or 57 percent of the site. A plan identifying the zoning of the Fern Bay Seaside Village site is provided in *Figure 1.2*.

This EMP aims to enhance and protect native vegetation and fauna habitat through rejuvenation and regeneration landscaping and maintenance of natural areas. It has been prepared to support the Community Association (established via Community Title) in managing and sustaining the ecological values of the conservation areas and reserves throughout the site.

1.2 REPORT STRUCTURE

The structure of this report is as follows:

- *Chapter 1* outlines the purpose and overall objective of the EMP;
- *Chapter 2* includes a description of relevant legislation, policies and strategies;
- *Chapter 3* details the methodology used in the development of the EMP;
- Chapter 4 describes the existing environment including the climate, geology, topography, slopes, soils, vegetation communities, weeds, fauna habitat, threatened species and Aboriginal heritage;
- *Chapter 5* addresses the potential impacts at the site from the development of Fern Bay Seaside Village;
- *Chapter 6* outlines the proposed management of these impacts pre construction, during construction and post construction;
- *Chapter 7* provides specific management requirements for threatened species and habitat areas, weeds, fire, pests, access and stormwater;
- Chapter 8 details the proposed restoration and weed management works and the implementation of the works over stages;
- *Chapter 9* outlines the monitoring program to be implemented; and
- *Chapter 10* details the responsibilities for implementing management strategies and the process of reviewing the EMP.


Four Mile Creek
Beresfield
Woodberry
Tarro
Heatherbrae
Williamtown RAAF
Williamtown
Tomago
Hexham
Lenaghan
Stockrington
Sandgate
Kooragang
Fern Bay
Fletcher
Maryland
Seahampton
Minmi
Shortland
Mayfield West
Mayfield North
Warabrook
Wallsend
Jesmond
Birmingham Gardens
Callaghan
Waratah
Tighes Hill
West Wallsend
Cameron Park
Georgetown
Maryville
Carrington
Stockton
Nobbys Head
Newcastle East
Newcastle
Elermore Vale
New Lambton Heights
Lambton
Hamilton
Wickham
Edgeworth
Barnsley
Argenton
Glendale
Cardiff Heights
Rankin Park
New Lambton
Broadmeadow
Hamilton East
Newcastle West
Cooks Hill
The Hill
Cardiff
Macquarie Hills
Kotara
Adamstown
The Junction
Bar Beach
Merewether
Garden Suburb
Adamstown Heights
Merewether Heights
Boolaroo
Cardiff South
Lakelands
Highfields
Teralba
Speers Point
Hillsborough
Charlestown
Kahibah
Whitebridge
Gateshead
Booragul
Warners Bay
Dudley
Fassifern
Fennell Bay
Marmong Point
Woodrising
Eleebana
Windale
Bennetts Green
Blackalls Park
Bolton Point
Tingira Heights
Croudace Bay
Jewells
Redhead
Toronto
Valentine
Belmont North
Kilaben Bay
Carey Bay
Belmont
Coal Point
Rathmines
Lake Macquarie
Pacific Gardens
Visitors Centre & Cafe
Tomago Village
Newcastle International Speedway
Historic Tomago House
KOORAGANG NATURE RESERVE
Fullerton Cove
Hunter Valley Equestrian Centre
Orchard End Equestrian Centre
Ash Island
Island
Newcastle Interchange
West Wallsend Interchange
Summerhill Waste Management Centre
Wallsend Plaza
Shortland Wetlands Centre
Shortland Waters
Stockton Bridge
Stockton Beach Tourist Park
Nobbys Beach
Newcastle Beach
Dixon Park Beach
Bar Beach
Merewether Beach
Redhead Beach
Ocean Breeze
Redhead Pt
Little Redhead Pt
Dudley Beach
Toronto Bay Lake Macquarie Cruises
Toronto Country Club
Styles Pt
Boughton Pt
Harley Pt
Dowey Pt
Green Pt
Cardiff Pt
Black Jacks Pt
Belmont Bayview
Belmont Hospital
Green Point Foreshore Reserve
Awaba Nature Reserve
Pambalong Nature Reserve
Hunter Wetlands National Park
Newcastle Airport
Fighter World
Newcastle Crematorium
Tomaree Lookout & Sand Surfing
Tomaree Head
Fort Wallace RAN Facility
Port Waratah
Wash Pt
Hexham Bridge
Tomago Bridge
Ash Island Bridge
Sandgate Cemetery
Shortland Private Hospital
The Hunter Valley Priv Hospital
John Hunter Hospital
Energy Australia Stadium
Newcastle Golf Club
Lakelands Golf Club
Warners Bay Private
Lake Macquarie City Art Gallery
Awaba House
Five Islands
Teralba Lakeside
Fennell Bay
Lake Macquarie
Pipeline
Gas Pipeline
Water Pipeline
Sewer Line
Power Line
Swamp
Creek
Hunter
Williamtown RAAF Base
Tomaree Lookout & Sand Surfing
Fighter World
Newcastle Airport
Newcastle Crematorium
Tomago Village
Hexham



Legend

- Fern Bay Seaside Village
- 1(a) 1(a) Rural Agriculture Zone
- 2(a) 2(a) Residential Zone
- 7(a) 2(a) Environment Protection Zone

Figure 1.2

Fern Bay Seaside Village Community Lands Zoning - Master Plan Approved

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_CLEMP_11		
Date:	12/11/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:	-		
Scale:	Refer to Scale Bar		

N

0 50 100 150m

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53 Bonville Avenue, Thornton, NSW 2322
Telephone +61 2 4964 2150

ERM

1.3 OBJECTIVE

The main objective of this CLEMP is the prescription of management strategies and methods to mitigate impacts on natural and modified vegetation communities, threatened flora and fauna species, and habitats that may occur within conservation areas, reserves and other areas throughout the site as a result of the development. This will be achieved by:

- management of threatened species, including their habitat and endangered ecological communities (ECC);
- management of retained habitat features within the development footprint, including during the construction phase;
- management of specific habitat enhancement measures, (eg hollow/habitat trees, koala fencing, artificial hollows and nest boxes);
- regeneration and landscaping works;
- weed management;
- pest animal control;
- fencing;
- bush fire management;
- public access management; and
- stormwater management.

2 POLICY FRAMEWORK

This EMP has been prepared to ensure that the management of conservation areas and reserves, specifically the management of threatened species and their habitat, is undertaken in a way that is consistent with Commonwealth, State and local government legislation, policies, strategies and guidelines. Relevant legislation, policies, strategies and guidelines are presented below.

2.1 COMMONWEALTH

2.1.1 Revised National Weeds Strategy 1999

The National Weeds Strategy was produced by the Commonwealth Government in 1999 to reduce the impact of weeds on the sustainability of Australia's productive capacity and natural ecosystems by adopting a more coordinated and integrated approach to weed management. The National Weeds Strategy also defines the roles and responsibilities of various stakeholders in weed management.

Two of the principles upon which this Strategy is based relate to the roles and responsibilities of those involved in weed management. These principles are reproduced below.

- '*Successful weed management requires a coordinated national approach which involves all levels of government in establishing appropriate legislative, educational and coordination frameworks in partnership with industry, landholders and the community*.'; and

- '*The primary responsibility for weed management rests with landholders/land managers but collective action is necessary where the problem transcends the capacity of the individual landholder/land manager to address it adequately*.'

A central component of the National Weeds Strategy 1999 is the identification of Weeds of National Significance (WONS). WONS are listed in *Annex A*. WONS are prioritised using a series of questions that measure each weeds invasiveness, impact, potential for spread and socioeconomic and environmental values. WONS identified on site are Alligator Weed (*Alternanthera ohiloxeroides*), Bitou Bush (*Chrysanthemoides monilifera* subsp *rotundata*), Blackberry (*Rubus fruiticosus*) and Lantana (*Lantana camara*).

The Strategy has also identifies 28 weeds as National Environmental Alert Weeds, including Chinese Violet (*Asystasia gangetica* subsp *micrantha*) which has been recorded as occurring on the site. National Environmental Alert Weeds are non native plant species that are in the early stages of establishment and have the potential to become a significant threat if they are not managed.

The Strategy specifies that individual landowners have a role to:

- understand that weeds are an important factor in land degradation;
- detect and report new weed occurrences;
- understand land use systems and the cause/effect relationships which apply to weed problems;
- apply their knowledge and skills to improve weed management;
- integrate economic and environmental values in the management of weed problems on their land;
- cooperate with and, where relevant, plan weed management activities jointly with neighbours; and
- support and promote sustainable production practices to minimise the development of weed problems.

The Strategy specifies that communities have a role to:

- coordinate local group development and action on weed problems;
- encourage local involvement in the management of public land;
- participate in local and regional weed management programs; and
- raise awareness and improve education on weed issues.

2.1.2 Agricultural and Veterinary Chemicals Code Act 1994

All pesticides (herbicides, insecticides and fungicides) used, supplied or distributed in Australia must be registered under the *Agricultural and Veterinary Chemicals Code Act 1994* by the Australian Pesticides and Veterinary Medicines Authority (APVMA: formerly the National Registration Authority for agricultural and veterinary chemicals (NRA). All APVMA approved chemicals (or products) have affixed product labels, which contain specific usage requirements and application rates. Label breaches can result in prosecutions under this Act.

All herbicides to be used on site in weed management should adhere to relevant requirements under this Act.

2.1.3 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) regulates significant environmental impacts on species and communities listed as threatened under this Act. The *EPBC Act* can be triggered if activities are

considered likely to have a significant impact on matters of national environmental significance.

Matters of national environmental significance under the Act include the following:

- World Heritage properties;
- National Heritage places;
- Ramsar wetlands of international importance;
- threatened species or ecological communities listed in the *EPBC Act*;
- migratory species listed in the *EPBC Act*;
- commonwealth marine environment; and
- nuclear actions.

There are no World Heritage properties, National Heritage places, Commonwealth marine areas, Commonwealth listed ecological communities or nuclear actions on or near the proposed development area.

The Fullerton Cove covers part of the Hunter Estuary National Park and is a Ramsar listed wetland. It is located approximately 400 metres to the west of Nelson Bay Road.

Care must be taken on site to minimise the impacts associated with weeds and vegetation management activities particularly on the nationally listed threatened Newcastle Doubletail Orchid (*Diuris praecox*) that has been recorded on site.

2.2 NEW SOUTH WALES

2.2.1 *Threatened Species Conservation Act 1995*

The *Threatened Species Conservation Act 1995* (*TSC Act*) lists a number of species and ecological communities, which are protected under this Act, which should not be disturbed without a permit. This Act regulates significant environmental impacts on listed species. Ten threatened species listed under the TSC Act have been recorded on site (refer to *Section 4.7* for a list of these species).

The NSW Scientific Committee established by the *TSC Act*, has listed 'the invasion of native plant communities by exotic perennial grasses', 'invasion of native plant communities by Bitou Bush and Boneseed', 'invasion and establishment of exotic vines' and 'invasion, establishment and spread of

Lantana' as key threatening processes under the *TSC Act*. These threatening processes are operating in Fern Bay Seaside Village and are considered in the EMP.

In addition DECC has approved a threat abatement plan for Bitou Bush. This plan seeks to control the invasion of native plant communities by Bitou Bush/Boneseed (*Chrysanthemoides monilifera*). The site is not identified in the threat abatement plan.

2.2.2 Noxious Weeds Act 1993

The *Noxious Weeds Act 1993* identifies, classifies and guides the control of noxious weeds in NSW. The Act defines the roles of government, councils, private landholders and public authorities in the management of noxious weeds. It also determines control actions for the various noxious weeds, according to their potential to cause harm to our local environment. There are five different "control classes" listed under the Act. Landowners are obliged to control all noxious weeds on their land according to specified "control classes".

The current list of noxious weeds within the Port Stephens local government area (LGA) is reproduced in *Annex B*.

2.2.3 National Parks and Wildlife Act 1974

The objectives of the *National Parks and Wildlife Act 1974* (NP&W Act) include:

(a) 'the conservation of nature, including, but not limited to, the conservation of:

(i) habitat, ecosystems and ecosystem processes, and

(ii) biological diversity at the community, species and genetic levels, and

(b) the conservation of objects, places or features (including biological diversity) of cultural value within the landscape, including, but not limited to:

(i) places, objects and features of significance to Aboriginal people.'

Under this Act a person must not intentionally cause damage to any habitat of or pick a threatened or protected species unless authorised under the Act.

Care must be taken to minimise the impacts associated with weed and vegetation management activities on threatened species (refer to *Section 4.7)*, protected flora (listed in Schedule 13 of the Act), protected fauna (those not listed in Schedule 13 of the Act) and aboriginal objects, places or features known to occur on the site.

2.2.4 *Protection of the Environment Operations Act 1997*

The *Protection of the Environment Operations Act 1997* (POEO Act) provides a framework for environment protection in New South Wales. Under the *POEO Act* it is an offence to pollute water. Waste is also required to be transported and disposed of in accordance with the Act and its associated regulations. The selection and use of herbicides should be undertaken in such a manner that prevents the pollution of water.

2.2.5 *Pesticides Act 1995*

The *Pesticides Act 1995* and the Pesticides Regulation 1995 regulate the use of all pesticides in NSW after the point of sale, and provides specific provision of record keeping, training, and notification of use. The Act requires that pesticides are used according to instructions on the label or permit, and that for each use actions are taken to ensure appropriate application.

All pest animal control works which require the use of pesticides (for example the use of 1080 for the control of foxes and wild dogs), must be undertaken in accordance with the *Pesticides Act 1995*.

2.2.6 *Rural Lands Protection Act 1998*

The pest animal provisions of the *Rural Lands Protection Act 1998* (RLP Act) outline the conditions under which animals, birds and insects are "declared" pests and provides for the control of such pest species. Gazettal of pest species occurs through Pest Control Orders that allow the Minister for Primary Industries to specify pest species on a state wide or local basis and the conditions or factors that apply to the control of each pest. Rabbits, wild dogs and feral pigs have been declared pest animals throughout NSW.

2.2.7 *Humane Pest Animal Control Code of Practice and Standard Operating Procedures, 2005*

The Code of Practice identifies pest animal control methods that are considered the most humane, target specific, cost effective and safe for use in the control of pest animal species. The recommended methods should be used for the control of pest animal species. The Code of Practice is supported by a number of Standard Operating Procedures and provides guidance on the control of foxes, wild dogs, feral pigs, feral cats and rabbits.

All pest animal control works undertaken should be consistent with the Code of Practice and Standard Operating Procedures to ensure the control of pest animal species is undertaken in a humane and safe manner.

2.2.8 Natural Resource Commission Statewide Targets

The NSW Natural Resource Commission has established statetwide targets for natural resource management. One of the targets is specifically aimed at addressing the impact of invasive pest and weed species. The target is:

"By 2015 there is a reduction in the number of invasive species".

In order to measure progress towards meeting the targets, the following indicators have been developed:

- *'number of new invasive species established;*
- *distribution and abundance of key invasive species;*
- *success of control programs foe widespread invasive species as measured by:*
    - *i. a reduction in biodiversity impacts; and*
    - *ii. a reduction in other impacts;'* (DECC, 2008).

Statewide and regional priorities are currently being established. In addition, a statewide dataset for invasive species together with a three-tiered monitoring program are currently being established and are expected to be released during 2009. The monitoring program will build upon that which has already been development for the Bitou Bush Threat Abatement Plan and will provide standardised protocols for monitoring.

This CLEMP has been prepared prior to the release of the monitoring program. This CLEMP, including the identification of targets and a monitoring program consistent with DECC requirements (once released) will be updated in subsequent reviews.

2.3 PLANS AND STRATEGIES

Other legislation, plans, strategies and documents that relate to weed and pest animal management, waste removal and environmental restoration on site include:

- the *Bitou Bush Management Strategy* (Port Stephens Council, 2004) which provides for the control of bitou bush and includes up-to-date maps of the infestation in the region;
- the *NSW Weeds Strategy* (NSW Agriculture, 1998) which aims to reduce the negative impacts of weeds on the economy, community, industries and environment. One outcome of the Strategy is the development and implementation of programs to reduce environmental degradation and the loss of biodiversity through weed invasion;

- the *NSW Threat Abatement Plan* (Department of Environment and Conservation, 2006) which seeks to control the invasion of native plant communities by bitou bush/boneseed (*Chrysanthemoides monilifera*);

- The *NSW Threat Abatement Plan* for predation by the Red Fox, which aims to reduce the impact of red foxes on threatened species;

- the *NSW Bitou Bush Strategy* (NSW National Parks and Wildlife Service, 2000) which is designed to assist in reducing the impacts of bitou bush on NSW coastal ecosystems;

- the *NSW Occupational Health and Safety Regulation (2001)* under which there is a requirement for the Controller of Premises to provide information on hazards associated with site activities to ensure safety of the workers, environment and general public through appropriate disposal of hazardous materials;

- the *Fern Bay Estate Master Plan* (ERM, 2005a) which identifies ecological values and management issues on the site. This report identifies the need to control the spread of weeds during construction as part of the environmental considerations;

- the *Fern Bay Estate Landscape Master Plan* (Verge Landscape Architects, 2007) which illustrates the layout and management of landscaping within the proposed development area of Fern Bay Estate;

- the *Port Stephens Vertebrate Pest Management Strategy* (Hunter Water Corporation, 1999) which provides details on the management of vertebrate pests within the Port Stephens area; and

- Vegetation Management Plan, Worimi Regional Park (ERM, 2008), which identifies vegetation management strategies, including weed control and waste management within the adjacent Worimi Regional Park.

3 METHODOLOGY

3.1 METHODOLOGY OVERVIEW

This Community Lands EMP has been developed based on a desktop review of previous specialist studies and their recommendations together with on site survey of weed presence and abundance.

3.2 DESKTOP ASSESSMENT

A review of relevant documents was undertaken to provide background information on the existing environment of the Fern Bay Seaside Village and to identify the key recommendations from specific environmental studies undertaken at the site, including:

- the Fern Bay Estate Species Impact Statement (ERM, 2005b) which identifies the likely impact on threatened flora and fauna and recommended mitigation measures to minimise impacts;
- the Fern Bay Estate Water Cycle Management Strategy (Urban Water Cycle Solutions, 2007), which identifies the proposed water cycle process and treatment at the site and maintenance requirements to ensure optimum operation of the system;
- the Fern Bay Seaside Village Conservation Offset Package: Worimi Regional Park Vegetation Management Plan (ERM, 2008), which identifies the management strategies to be undertaken within the adjacent Worimi Regional Park, and in which the on site strategies should be consistent;
- the Fern Bay Estate Vegetation Management Plan (ERM, 2005c), which identifies the rehabilitation and restoration program and weed management within the site;
- the Fern Bay Estate Weed Management Plan, Emergency Fire Trail (ERM, 2006);
- the draft Bushfire Assessment Report (ERM, 2007), identifying the requirements for bushfire hazard management throughout the site; and
- the Mosquito Risk Assessment, Fern Bay Estate (Institute of Clinical Pathology and Medical Research, 2004).

3.3 FIELD INVESTIGATIONS AND DATA ANALYSIS

Information on particular weed species and broad distribution was obtained from Clements *et al.* (1992) and Gunninah (1996 revised 1997 and 2002) and through field surveys by ERM (2005c). Discussions with the Senior Weeds Officer for Port Stephens Council in 2008 also identified additional weeds now occurring at the site. The results from broad weed maps were prepared using aerial photographs, topographic maps, past vegetation maps, reports and surveys. During field surveys notes were taken on the dominant weed species within each vegetation community. A GPS was used to record general locations of weed infestations. Bushland condition was mapped according to the level of high, medium or low levels of weed infestation.

4 EXISTING ENVIRONMENT

4.1 CLIMATE

The site is situated in an area that experiences a warm temperate climate. According to data obtained from the Bureau of Meteorology's Williamtown weather station (approximately six kilometres to the north of the site) for the period 1942 to 2003, mean temperature ranges from a minimum of 6.4 degrees Celsius in July to a maximum of 27.8 degrees Celsius in January. Average annual rainfall is 1124 millimetres, with 137 mean number of raindays per year. The period of highest rainfall is from January to June.

During summer, the predominant wind direction is from the east and south east, with stronger winds during the afternoon. In autumn and winter months, morning breezes are predominantly from the west and north west, with south and south east breezes increasing in the afternoons. In winter, stronger winds generally blow from the west to north west. The impact of prevailing winds is decreased by the undulating topography of the site and surrounding area.

4.2 GEOLOGY, TOPOGRAPHY, SLOPES AND SOILS

The site is situated within the Newcastle Bight barrier dune system and is situated within the outer Holocene dune system, which was deposited from off-shore sand deposits 6000 years ago. The outer barrier has undergone three major transgressions, with the most recent being the presently active frontal dune.

The transgression of dunes across the site has resulted in a series of prominent ridges and distinct sandy knolls, principally north south in orientation and separated by interdunal valleys. Elevation on site varies from sea level up to 26.3 metres AHD in the north eastern part of the site. Slopes vary significantly across the site.

Soils on the site consist of a topsoil layer, about 0.2 metres thick, of silty sand over a sand layer with a thickness that varies from 13 to 27 metres that overlays sandy clay. The soils are underlain by rock at a depth of approximately 60 metres. Peat has been found in the low lying areas of the site adjacent to Nelson Bay Road.

High infiltration rates are expected in the sand layer. Observations from Coffey Partners (1992 and 1996) indicate that 75 percent to 90 percent of rainfall falling on the site is infiltrated in the sand layer.

According to the Williamtown Acid Sulfate Soil Risk Map (Soil Conservation Service of NSW, 1995), the majority of the site is mapped as having a low probability of acid sulfate soils greater than three metres below the surface.

Two areas along the eastern boundary of the site and one along the southern boundary have been mapped as having a low probability of containing acid sulfate soils between one and three metres below the surface. Two small areas along the northern boundary of the site and one in the western corner of the site have been mapped as having a high probability of containing acid sulfate soils within one metre of the surface. A Acid Sulfate Soils Management Plan will be prepared for the site.

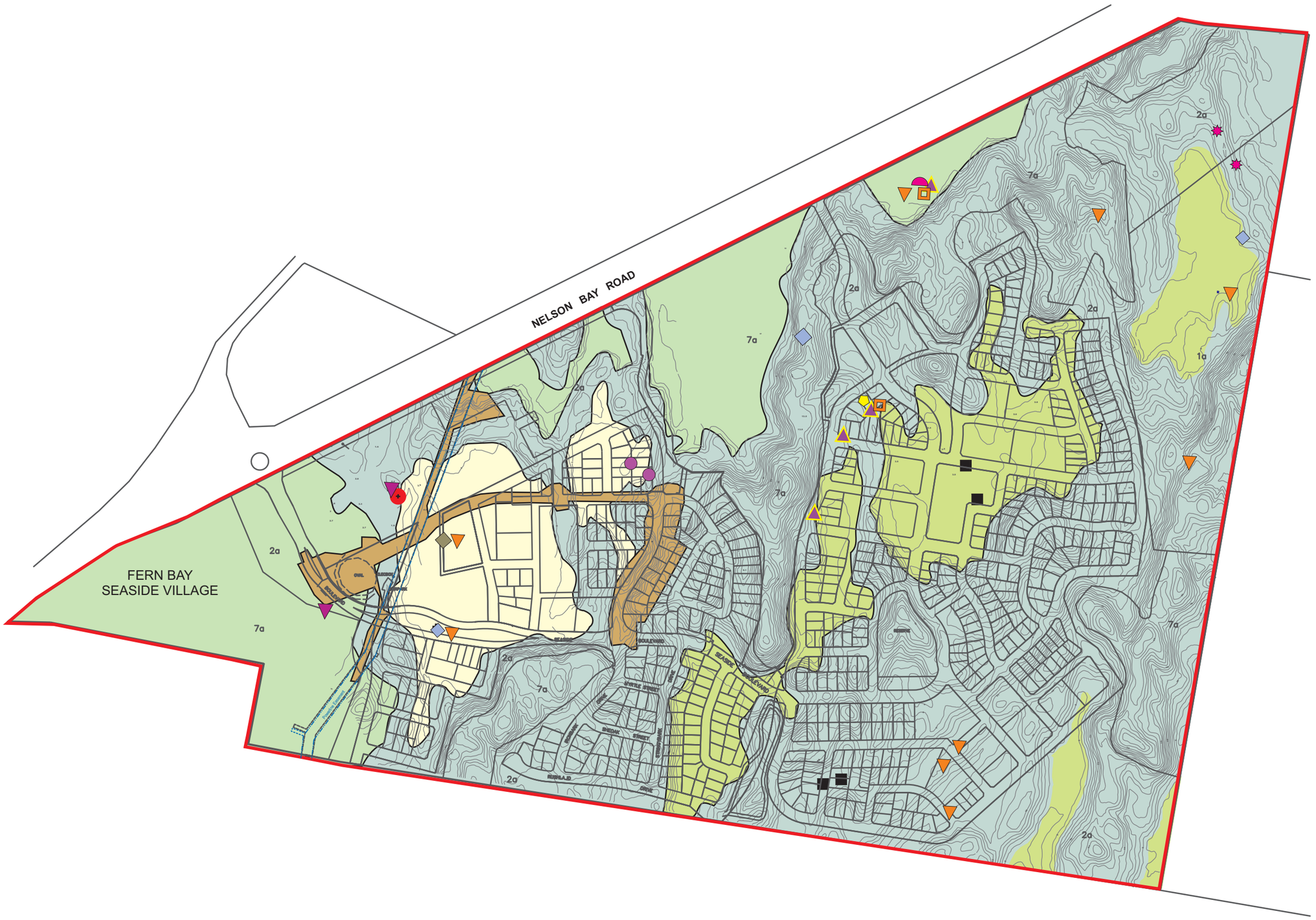
4.3 NATIVE VEGETATION COMMUNITIES

Gunninah Consultants (1996 revised 1997 and 2002) identified the flora species present on the site (refer to *Annex C*). Broad vegetation communities in the locality have also been mapped in the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (House 2003). The site includes three vegetation communities: Coastal Sand Apple – Blackbutt forest, Swamp Oak Rushland forest and Swamp Mahogany – Paperbark forest. Refinement of the LHCCREMS mapping by ERM (2005b), based on the vegetation mapping of Clements *et al*. (1992), delineated these vegetation communities into Dry Sclerophyll forest (Coastal Sand Apple – Blackbutt forest) and Swamp forest (Swamp Oak Rushland forest and Swamp Mahogany – Paperbark forest). The 'wet heath' community described by Clements *et al*. (1992) was determined by ERM to correspond to the LHCCREMS mapping unit of 'Tomago sand swamp woodland'. These vegetation communities are illustrated on *Figure 4.1* and are described below.

It was determined by ERM that the swamp forest on site where it adjoins Nelson Bay Road is representative of the 'Swamp Sclerophyll forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East corner Bioregions' Endangered Ecological Community (refer to *Figure 4.1*).

Dry Sclerophyll Open Forest (Coastal Sand Apple – Blackbutt Forest)

The dry sclerophyll open forest community occupies the greatest area and is dominated by Smooth-barked Apple (*Angophora costata*), Blackbutt (*Eucalyptus pilularis*) and Old Man Banksia (*Banksia serrata*), with occasional Red Bloodwood (*Corymbia gummifera*) and Black She-Oak (*Allocasuarina littoralis*). The canopy density ranges from 30 to 70 percent and the mid-storey is sparse, reflecting the likely fire history of the site. There is a well-developed understorey, mainly of shrubs, although some herbaceous species are also present. Some Bitou Bush occurs in this community. This community corresponds to the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) mapping unit of Coastal Sand Apple – Blackbutt forest.



Legend

- Fern Bay Seaside Village
- Cleared Vegetation
- Swamp Mahogany - Paperbark Forest
- Coastal Sand Apple Blackbutt Forest
- Wet Heath - Tomago Sand Swamp Woodland
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-East Corner Bioregion
- 1(a) 1(a) Rural Agriculture Zone
- 2(a) 2(a) Residential Zone
- 7(a) 7(a) Environment Protection Zone
- Powerful Owl Roost Tree

Threatened Species

- Powerful Owl
- Masked Owl
- Squirrel Glider
- Grey-headed Flying-fox
- *Diuris praecox*
- Greater Broad-nosed Bat
- Eastern Bentwing-bat
- Little Bentwing-bat
- Hoary Wattled Bat
- Wallum Froglet
- *Eucalyptus parramattensis* subsp. *decadens E.robusta*
- Approved Master Plan Footprint

Figure 4.1

Vegetation Communities and Threatened Species in the Study Area

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_CLEMP_01		
Date:	12/11/2009	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:	-		
Scale:	Refer to Scale Bar		

N

0 100 200m

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ERM

Swamp Forest (Swamp Mahogany – Paperbark Forest)

The swamp forest is dominated by Broad-leaved Paperbark (*Melaleuca quinquenervia*), Swamp Mahogany (*Eucalyptus robusta*), Swamp Oak (*Casuarina glauca*) and Cabbage Tree Palm (*Livistona australis*). The community mainly occurs along the Nelson Bay Road boundary of the site, with an extensive patch in the western corner of the site. The canopy density is 70 percent or greater and there is a sparse mid-storey of occasional Broad-leaved Paperbark. The ground cover is sparse and is dominated by Swamp Water Fern *(Blechnum indicum*), Jointed Twigrush (*Baumea articulata*) and Saw Sedge (*Gahnia clarkei*). Weeds such as Pennywort (*Hydrocotyle bonariensis*) are present, due to the favourable moisture conditions.

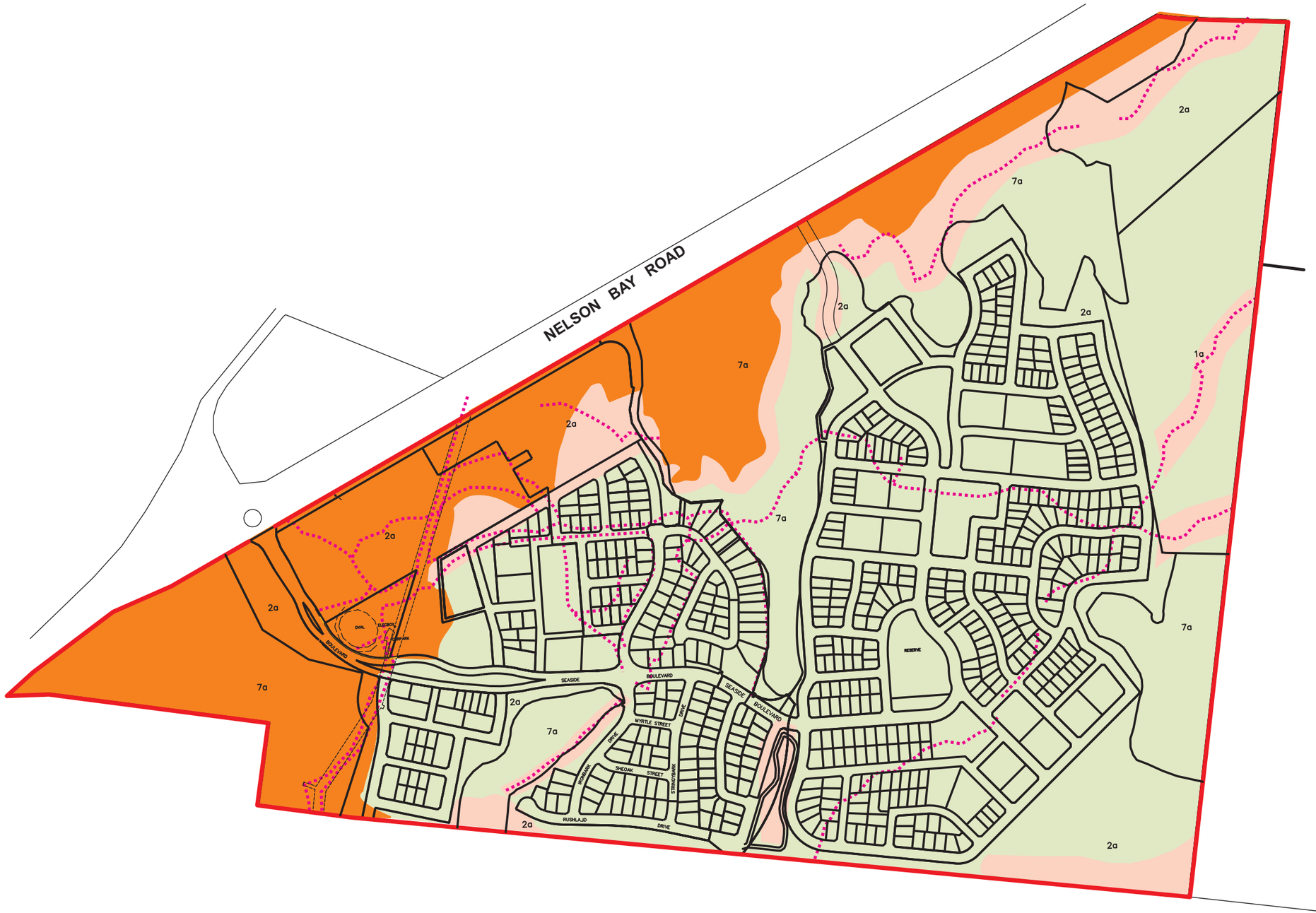
This community corresponds to the LHCCREMS mapping unit Swamp Mahogany – Paperbark forest. Although the western half of the site has been mapped by LHCCREMS as Swamp Oak - Rushland forest, this area of swamp forest is more characteristic of Swamp Mahogany – Paperbark forest due to the dominant plant species present in the canopy, mid and ground strata.

Coastal Scrub (Wet Heath)

The coastal scrub community is dominated by Swamp Mahogany, Red Bloodwood and Old Man Banksia as occasional emergent trees, although the community is generally less than three metres in height. This community corresponds to the wet heath community identified by Clements *et al.* (1992), and can be delineated into heath occurring on a 2000 year BP sand transgression, dominated by red bloodwood, and a 4000 year BP sand mass dominated by swamp mahogany that occurs further inland. Wet heath species such as *Melaleuca nodosa* and *Restio tetraphyllus* dominate the community. This community corresponds to the LHCCREMS mapping unit of Tomago sand swamp woodland on the 4000 year BP sand transgression.

4.4 WEEDS

A map of broad distribution and abundance of weeds has been prepared (see *Figure 4.2)*. Information on the particular species and broad distribution of weed species was obtained from Clements *et al.* (1992) and Gunninah (1996 revised 1997 and 2002), through field surveys by ERM (2005c) and discussions in 2008 with the Port Stephens Council Senior Weeds Officer. The low local occurrence of exotic weed species in the undisturbed areas of the site (as opposed to the cleared areas) is indicative of soil nutrient levels unfavourable to their growth. Off road vehicles and garbage dumping are likely to have contributed to the transportation of weeds to the site.



Legend

- Fern Bay Study Area
- Major Walking Trail
- Existing Tracks

Weed Infestation Levels	*Weed Species Present*
High	Lantana, Morning Glory, Blackberry Nightshade,Turkey Rhubarb, Love Grass, Inkweed, Bitou Bush, African Lovegrass,Guinea Grass,Whiskey Grass, Fleabane, Pennywort, Paddy's Lucerne, Blackberry, Purpletop, Fishbone Fern, Ambrosia
Medium	Bitou Bush, Fireweed, Fleabane, Variable Groundsel, African Lovegrass,Cyperus, Guinea Grass, Lantana
Low	Variable Groundsel, Cyperus, Fleabane, Bitou Bush, Toothed Hebenstrentia

Figure 4.2

Weed Mapping Areas

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_CLEMP_02		
Date:	12/11/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	AA
Source:	-		
Scale:	Refer to Scale Bar		

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0 160 320m

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ERM

A wide variety of significant weeds occur in the site including perennial and annual grasses, herbs, shrubs and climbers. On the site the greatest variety and density of weeds occurs within the northern and western parts of the property. The main weed infestations generally occur and have established:

- within cleared areas where rubbish has been dumped and spread;
- along Nelson Bay Road;
- within the electricity easement;
- along four-wheel drive tracks; and
- in parts of the native swamp forest and the hind dune dry open forest where the highly invasive species Lantana and Bitou Bush have established.

Table 4.1 lists the significant weed species identified on site and provides a description of their abundance and distribution and level of control priority. Significant weed species are those with the highest densities which pose the most significant threat to the conservation values of the site. Noxious weed species for the Port Stephens local government area occur in much lower densities and are identified *Table 4.1*. These include Alligator Weed, Bitou Bush, Blackberry, Chinese Violet and Lantana, which are also Weeds of National Significance.

Table 4.1 Dominant Weed Species on Site

Common Name	Species Name	Description of Weeds from Previous Surveys	Control Priority
African Love Grass	*Eragrostis curvula*	Sides of the tracks and in disturbed areas.[1] Invaded some disturbed areas although mostly confined to vegetation edges.[2]	high
Aligator Weed	*Alternanthera phitoxeroides* Class 3, N	Cleared areas, largely associated with previously disturbed areas from construction, spreading into conservation lands.[5]	high
Ambrosia	*Ambrosia tenuifolia*	Cleared areas.[4]	low
Bitou Bush	*Chysanthemoides monilifera subsp. rotundata* Class 4, N	Forms clumps on the foredune and is dominant in small patches of the hind dune vegetation and seedlings were widespread throughout the dry sclerophyll forest. Bitou Bush appears to require open sand and perhaps continuous nutrient enrichment for establishment. Occurs on the boundaries between the swamp forest and dry sclerophyll open forest.[1] Occurs extensively through the site especially along edges of disturbed swamp forests. Common along edges of dune vegetation.[2] One of the main weed species present in the dry sclerophyll open forest.[3]	high
Blackberry	*Rubus fruticosu*s ssp. *aggregate* Class 4, N	Not common and is generally confined to large cleared areas where dumping has occurred. [2]	high
Chinese Violet	*Asystasia gangetica ssp. Micrantha* Class 1, N, AW	Within conservation lands. [5]	high
Cyperus	*Cyperus dubius* and *C. flavus*	Localised to the Newcastle region. Appears to be naturalised in the dry sclerophyll open forest.[1]	moderate
Fire Weed	*Senecio madagascariensis*	This wind and tyre carried species was relatively widespread in the dry sclerophyll open forest.[1]	moderate
Fishbone Fern	*Nephrolepsis cordifolia*	Small but dense infestations along entry road.[4]	moderate
Fleabanes	(*Conzya albida, C.canadensis* and *C parva)*	These wind and tyre carried species were relatively widespread in the dry sclerophyll open forest.[1]	moderate
Guinea Grass	*Panicum maximum*	Sides of the tracks and in disturbed areas.[1]	high
Ink Weed	*Phytolacca octandra*	Not common and is generally confined to large cleared areas where dumping has occurred. [2]	low
Lantana	*Lantana camara* Class 5, N	Occurs on the boundaries between the swamp forest and dry sclerophyll forest.[2] Large patches of infestation within swamp forest.[4]	high
Mile- a -Minute	*Ipomoea cairica*	Common along Nelson Bay Road. Particularly noticeable growing over the canopies of a number of swamp forest stands.[2]	high

Common Name	Species Name	Description of Weeds from Previous Surveys	Control Priority
Paddy's Lucerne	*Sida rhombifolia*	Common along Nelson Bay Road.[2]	moderate
Pennywort	*Hydrocotyle bonariensis*	Has become naturalised on the NSW coast including the site.[1] Commonly occurring species beneath the swamp forest canopy.[2] Found in swamp forest due to favourable moisture conditions.[3]	low
Purpletop	*Verbena bonariensis*	Common within cleared areas.[4]	moderate
Toothed Hebenstretia	*Hebenstretia dentata*	Weeds of disturbed sandy places, localised to the Hunter Region.[1]	low
Turkey Rhubarb	*Acetosa sagittata*	Common along Nelson Bay Road.[2]	low
Variable Groundsel	*Senecio lautus*	Few weeds are present, but one of the main weed species in the dry sclerophyll open forest.[3]	low
Whisky Grass	*Andropogon virginicus*	On the sides of the tracks a higher abundance and number than within the natural vegetation. The most widespread with a habitat preference for open areas in low nutrient soils. It does not occur in natural vegetation unless the vegetation has been cleared or disturbed.[1] Invaded some disturbed areas mostly confined to vegetation edges.[2]	high
Wild Tobacco Plant	*Solanum mauritianum*	Not common and is generally confined to large cleared areas where dumping has occurred.[2]	Moderate

References

[1] Clements *et al*, 1992; [2] Gunninah, 2002; [3] Gunninah 1996 revised 1997; [4] ERM 2005 field surveys; [5] Senior Weeds Officer, Port Stephens Council (pers com)

Noxious Weeds in Port Stephens LGA

Class 1* - Notifiable weed, must be fully and continuously suppressed and destroyed

Class 2* –Notificable weed, must be fully and continuously suppressed and destroyed

Class 3 - The plant must be fully and continuously suppressed and destroyed

Class 4 - The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority

Class 5* - There are no requirements to control existing plants

* Classes 1,2 and 5 weeds are prohibited from sale in NSW.

National Environmental Alert Weeds

AW – national environmental alert weeds

Weeds of National Significance

N- nationally significant

4.5 *FAUNA HABITAT*

The dry sclerophyll open forest community provides fauna habitat in the form of tree hollows, logs and ground cover such as grasses and bracken. Logs and ground cover provide shelter and foraging habitat for reptiles and small ground-dwelling mammals. The sandy substrate enables small to medium-sized mammals to create burrows for shelter. Tree hollows of this community provide suitable roosting habitat for the Squirrel Glider, Powerful Owl, Masked Owl and microchiropteran bats. No habitat in the form of bush rock or rock platform was identified on the site. The presence of banksia in the mid-strata provides foraging resources for nectivorous birds and the Squirrel Glider.

The coastal scrub community has little to no fauna habitat in the form of tree hollows, however, the dense grass cover and presence of Acacia, Banksia and Leptospermum provides extensive foraging habitat for granivorous and nectivorous birds, and some sheltering habitat for reptiles and small ground-dwelling mammals.

The swamp forest community provides potential foraging habitat for Koalas, Squirrel Gliders, the Powerful Owl, Grey-headed Flying-fox and migrating nectivorous birds such as the Swift Parrot. Swamp Mahogany comprises the primary winter foraging resource in this community, although melaleucas also provides a flowering resource. Some hollow-bearing trees are also present in this community, providing potential roost sites for the Squirrel Glider and microchiropteran bats. This vegetation community also supports a ephemeral wetland that provides suitable habitat for frog species such as the Wallum Froglet. This community acts as a biological filter for the movement of water between the site and Fullerton Cove. Management of the on site conservation lands within Fern Bay Seaside Village will be undertaken consistent with the requirements to protect and enhance the ephemeral wetland environment.

4.6 *THREATENED POPULATIONS AND ECOLOGICAL COMMUNITIES*

No threatened populations currently listed under the *TSC Act 1995* and *EPBC Act 1999* have been recorded within the site.

The Endangered Ecological Community 'Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions' is represented in the swamp forest that adjoins Nelson Bay Road (refer to *Figure 4.1*).

4.7 THREATENED SPECIES

There are 41 threatened species listed under the *TSC Act 1995* that have the potential to occur within a 10 kilometre radius of the site (ERM, 2005b). Thirty-seven of these threatened species have the potential to be impacted by development on the site. These species are listed in *Table 4.2*.

Table 4.2 Threatened Species under the TSC Act 1995 with Potential to be Impacted by Development on Site

Type of Animal / Plant	Species
Hollow-dependent bird	Glossy Black-Cockatoo (*Calyptorhynchus lathamii*)
	Masked Owl (*Tyto novaehollandiae*)
	Barking Owl (*Ninox connivens*)
	Powerful Owl (*Ninox strenua*)
Other birds	Swift Parrot (*Lathamus discolor*)
	Brown Treecreeper (eastern species*) (Climacteris picumnus victoriae)*
	Square-tailed Kite (*Lophoictinia isura*)
	Osprey (*Pandion haliaetus*)
	Grey-crowned Babbler (eastern subspecies) (*Pomatostomus temporalis temporalis*)
	Wompoo Fruit-dove (*Ptilinopus magnificus*)
	Rose-crowned Fruit-dove (*Ptilinopus regina*)
	Superb Fruit-dove (*Ptilinopus superbus*)
	Regent Honeyeater (*Xanthomyza phrygia*)
Cave-roosting bats	Large-eared Pied Bat (*Chalinolobus dwyeri*)
	Little Bentwing-bat (*Miniopterus australis*)
	Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*)
	Large-footed Myotis (*Myotis adversus*)
Hollow-dependent mammals	Hoary Wattled Bat (*Chalinolobus nigrogriseus*)
	Spotted Tailed Quoll (*Dasyurus maculatus*)
	Eastern False Pipistrelle (*Falsistrellus tasmaniensis*)
	Eastern Freetail-bat (*Mormopterus norfolkensis*)
	Squirrel Glider (*Petaurus norfolcensis*)
	Brush-tailed Phascogale (*Phascogale tapoatafa*)
	Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)
	Greater Broad-nosed Bat (*Scoteanax rueppellii*)
Other mammals	Koala (*Phascolarctos cinereus*)
	Grey-headed Flying-fox (*Pteropus poliocephalus*)
Frogs	Wallum Froglet (*Crinia tinnula*)
	Green and Golden Bell Frog (*Litoria aurea*)
	Green-thighed Frog (*Litoria brevipalmata*)
Plants	Netted Bottlebrush (*Callistemon linearifolius*)
	Leafless Tongue Orchid *Cryptostylis hunteriana)*
	Sand Doubletail (*Diuris arenaria*)
	Newcastle Rough Doubletail (*Diuris praecox*)
	Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)
	Heath Wrinklewort (*Rutidosis heterogama*)
	Dwarf Kerrawang (*Rulingia prostrata*)

Three flora species and five fauna species listed as threatened in the EPBC Act are considered to have a moderate to high likelihood of occurring on site, as well as four bird species listed in the migratory provisions of this Act. These species are listed in *Table 4.3*.

Table 4.3 ***Threatened Species Listed under the EPBC Act 1999 with potential to be impacted by Development on Site***

Type of Animal / Plant	Species
Plants	Newcastle Doubletail (*Diuris praecox*)
	Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)
	Dwarf Kerrawang (*Rulingia prostrata*)
Fauna	Swift Parrot (*Lathamus discolor*)
	Regent Honeyeater (*Xanthomyza phrygia*)
	Large-eared Pied Bat (*Chalinolobus dwyeri*)
	Spotted Tailed Quoll (*Dasyurus maculatus*)
	Grey-headed Flying-fox (*Pteropus poliocephalus*)
Migratory birds	White-throated Needletail (*Hirundapus caudacutus*)
	Black-faced Monarch (*Monarcha melanopsis*)
	Satin Flycatcher (*Myiagra cyanoleuca*)
	White-Bellied Sea-eagle (*Haliaeetus leucogaster*)

Of those threatened species listed in *Tables 4.2* and *4.3*, 12 have been recorded on site during ecological investigations (ERM, 2005b):

- Newcastle Doubletail Orchid (*Diuris praecox*);
- Wallum Froglet (*Crinia tinnula*);
- Hoary Wattled Bat (*Chalinolobus nigrogriseus*);
- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Greater Broad-nosed Bat (*Scoteanax rueppellii*);
- Little Bentwing-bat (*Miniopterus australis*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Grey-headed Flying-fox (*Pteropus poliocephalus*);
- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*) and
- Squirrel Glider (*Petaurus norfolcensis*).

The impact of the proposed development on these species is addressed in the Fern Bay Estate Species Impact Statement (ERM, 2005b).

Many of these species have been recorded within areas of the site zoned 7(a) Environment Protection and 1(a) Rural Agriculture under the Port Stephens Local Environmental Plan 2000 as shown in *Figure 4.1*.

A Powerful Owl roost tree was recorded in 2002 in the north western part of the site and an individual was observed roosting nearby. A 100 metre buffer will be maintained around this roost tree (see *Figure 4.1*).

There are no recent records of Koalas on the site, with the last recorded siting in 1992. However, the site supports both preferred and supplementary Koala habitat as defined in the Port Stephens Comprehensive Koala Plan of Management (Port Stephens Council 2001).

Previous investigations identified approximately 20 clumps of the hybrid *Eucalyptus parramattensis* subsp *decadens* species and an estimated population size of approximately 74 trees have been identified in the immediate locality (ERM 2007). Of these only seven trees occur within the Fern Bay Seaside Village development area, with the remaining 67 located within the adjacent Worimi Regional Park. Further taxonomic investigations of flowering specimens collected in June 2008 have been identified the trees as *Eucalyptus parramattensis* subsp *decadens* x *E. robusta*. This species is not listed as threatened under State or Commonwealth legislation however it is considered to have a very high conservation value.

The majority of the population of *Eucalyptus parramattensis* subsp *decadens* x *E. robusta* will not be impacted directly by the project, however all seven individual trees located within the Fern Bay Seaside Village site will be removed.

No threatened fish species listed under the *Fisheries Management Act 1994* occur on the site.

4.8 ABORIGINAL HERITAGE

Twenty-five Aboriginal archaeological sites have been recorded within the site, including middens, open artefact scatters, a hearth, and a Worimi Cleaver. The low ridgeline in the western part of the site has been identified as being of high archaeological significance because of the hearth and Worimi cleaver that were recovered from this area. This area is to be conserved.

The sub-surface investigations also demonstrated that Aboriginal objects could be present across the entire site. The highest densities of Aboriginal objects are likely to be found along the low ridgelines.

Archaeological sites should be clearly identified prior to any works to avoid disturbance and damage. Weed removal, other restoration or access should not be undertaken within or through significant archaeological sites. If works are essential within close proximity of these sites, it is particularly important that informed and qualified bush regeneration contractors undertake this work in consultation with Archaeologists.

5 ISSUES AND IMPACTS

There are a range of potential impacts arising from the proposal that could affect species and ecological communities on site. The following is an overview of the management issues relating to the site, including potential impacts that may rise from the development of part of the site.

5.1 DIRECT LOSS OF HABITAT

Fern Bay Seaside Village will involve the direct loss of approximately 93 hectares of vegetation comprising swamp forest, wet heath and dry sclerophyll open forest. Approximately 22.8 hectares of vegetation proposed to be cleared has been approved to be cleared under the existing development consent that applies over part of the site. Most of the vegetation that is likely to be cleared is dry sclerophyll open forest.

A significant proportion of the site's vegetation will be conserved, rehabilitated and maintained. Relative to the area that will be conserved, the greatest loss of habitat in the site will be wet heath, with 27 percent of the total area being conserved. Approximately 70 percent of the swamp forest will be conserved, mostly within the minimum 200 metre wide ecological corridor along Nelson Bay Road. Over half of the dry sclerophyll forest in the site will be conserved.

Figure 5.1 illustrates the areas proposed to be developed, reserved and landscaped on the site. The community conservation lands are to be managed for their ecological and environmental values. Managed community services/parks are active and passive recreation areas for community purposes.

5.2 CORRIDORS AND HABITAT FRAGMENTATION

The development of Fern Bay Seaside Village will involve the removal of approximately 46 percent of the site's native vegetation. This vegetation forms part of an existing vegetative corridor along the sand dunes of Stockton Bight. A minimum 200 metre wide ecological corridor is to be retained along the northern boundary of the site, to provide connectivity of swamp forest in the Fern Bay area. Two access roads into the estate will fragment this corridor although it is currently fragmented by a powerline easement. Two areas of wet heath will be cleared, leaving a smaller area isolated in the northern portion of the site. Although an area of wet heath occurs on Boral's land holdings to the north, it is discontinuous with the wet heath on the site.

Dry sclerophyll open forest will be fragmented throughout the site, leaving the only intact corridor of this vegetation near the eastern boundary of the site. The design of Fern Bay Seaside Village facilitates the retention of



Legend

- Managed Community Reserves/Parks[1]
- Community Conservation Lands[2]
- Local Activity Centre
- Mixed Use Residential Development
- Commercial Development
- Cultural Heritage Reserve
- Part of the Approved Subdivision Area
- Potential Stormwater Management Infrastructure
- Pathway
- Fire Trail
- 10 metre Asset Protection Zone
- 20 metre Asset Protection Zone (width of road reserve)
- 25 metre Asset Protection Zone

Notes:

1 Managed Community Reserves/Parks are areas of active and passive recreation for community purposes and do not form part of the community land.

2 Community lands are the 'Conservation Lands' to be managed for ecological and environmental values.

Figure 5.1
Project Plan

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_CLEMP_03		
Date:	13/11/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:			
Scale:	Refer to Scale Bar		

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0 50 100 150m

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approximately 300 metres of existing bushland between the proposed residential allotments and the mobile dunes of Stockton Bight, providing a movement corridor for fauna through dry sclerophyll open forest.

The corridors of swamp forest and dry sclerophyll open forest will facilitate the movement of fauna so that threatened species, populations and ecological communities will not become isolated from the currently interconnecting areas of habitat to the south and north. Nelson Bay Road presently disrupts fauna movement west of the site, although some fauna such as the Squirrel Glider may be able to glide across the canopy above the road. Cleared agricultural land west of Nelson Bay Road also presents a barrier to the movement of terrestrial fauna.

5.3 EDGE IMPACTS

Edge effects in the swamp forest have been minimised by the inclusion of a 50 metre wide buffer around the boundary of the communities to be reserved. Most edge effects disappear over the first 50 metres into a remnant of native vegetation. Edge effects are likely to be greatest in the dry sclerophyll open forest due to the large interface area between this community and the development footprint.

Physical changes that have the potential to occur at the interface between the development and natural bushland include changes in soil and water conditions and potentially an increase in light penetration to the understorey. However, this can be prevented through effective rehabilitation and ongoing monitoring and management of the reserves and in particular the interface.

5.4 WEED DISPERSAL

Weeds are currently a problem within the site. Weed invasion into low nutrient environments such as dry sclerophyll forest is a potential issue, given this vegetation community will be fragmented by the proposed development.

Most weeds produce prolific numbers of seeds or other propagules. They typically benefit from disturbance to soils or native vegetation through rapid colonisation of bare substrates and disturbance niches, although some are aggressive and can invade relatively undisturbed vegetation. Clearing and fires can trigger major outbreaks of weeds. Such outbreaks often occur from seeds that have laid dormant in the soil until the disturbance provides the conditions necessary for germination. Weeds can spread from infested areas to weed free areas via wind or water or by travelling as seeds or propagules on vehicles, people or animals from one place to another. A reduction in tree cover and the undertaking of earthworks are likely to facilitate weed dispersal and establishment.

Weed removal and treatment is required as part of restoration works within the reserves and the proposed development area. This should be followed by ongoing management and monitoring of weeds at the site to remove regrowth. Works will focus on areas particularly susceptible to weed invasion, such as road edges, asset protection zones and parks.

5.5 PESTS

5.5.1 Predation by Vertebrate Pests

Vertebrate pests such as dogs, cats, foxes and rabbits are present within the development area and surrounding areas. Impacts associated with these species would include predation on native fauna species by dogs, foxes and cats. Rabbits may impact native vegetation through erosion and ground instability associated with rabbit warrens. In the absence of restriction on dog and cat ownership, increases may occur, thereby directly impacting fauna through predation. The development does however have the potential to aid in the dispersal of vertebrate pests through construction activities.

5.5.2 Mosquitoes

Mosquito impact on the Fern Bay Seaside Village is influenced by both the potential for mosquito populations dispersing in the area from surrounding areas, and / or being produced from habitats within the area. This not only generates impacts associated with nuisance biting, but also the potential for the transmission of disease causing pathogens, which are an increasing concern in the Hunter Region (ICPMR, 2004).

5.6 STORMWATER RUNOFF AND EROSION

The absence of streams and drainage lines on the site reduces the potential issue of sedimentation as a result of the proposed development, however urban development usually increases the proportion of impervious services in a stormwater catchment that increase runoff volumes and peak discharges to a receiving environment whilst decreasing or eliminating infiltration of rainwater into soils (Urban Water Cycle Solutions, 2007). Increases in stormwater runoff can also convey pollutants (including high nutrient loads) that are generated by urban development to receiving waters and resultant environmental impacts.

Weed invasion at the site is already a problem and increased stormwater runoff with the increase of hard surfaces and nutrients could increase the level of weed invasion of the reserved areas. The implementation of the stormwater management strategies (Urban Water Cycle Solutions 2007) will control the movement of stormwater and sediment within and off the site.

5.7 *ROAD TRAFFIC*

The construction of roads increases the risk of traffic strike to fauna. Fauna are particularly vulnerable to being killed when crossing roads especially in urban areas and / or areas where prime habitat has been fragmented. Fauna may also be impacted by machinery associated with the construction phases of the development.

5.8 *BUSH FIRE*

The site is regarded as having a high bush fire hazard potential. A Bush Fire Hazard Assessment (ERM 2007) has been prepared for the site. This identifies various bush fire management measures to reduce bush fire hazard including the provision of appropriate asset protection zones around future residential areas. These are generally provided by the perimeter roads and road reserves. In some instances asset protection zones will be provided by parks. These are required to be established and maintained in accordance with the requirements of *Planning for Bushfire Protection* (NSW Rural Fire Service 2001). Asset protection zones do not extend into environmental protection zones. *Figure 5.1* identifies the location of asset protection zone within the site.

5.9 *RUBBISH DUMPING*

Garden and non–compostable household rubbish dumping is currently occurring on site. This has primarily occurred along tracks with easy access from Nelson Bay Road and has occurred despite signage warning against this practice.

With residential development of the site, garden rubbish dumping may become a greater problem and could potentially introduce more weeds to the reserves. Rubbish dumping also introduces nutrients and provides ideal conditions for the establishment of the dumped weeds. The sheer weight of the rubbish can smother and break native plants (Buchanan 1989).

Non-compostable household rubbish is currently located on site. Assuming this rubbish is non-toxic this group of rubbish is less damaging than garden rubbish. It looks unsightly but it does not introduce weeds or plant nutrients.

5.10 KEY THREATENING PROCESSES

The following key threatening processes as listed under the *TSC Act* are relevant to the site and require appropriate management:

- clearing of native vegetation;
- invasion of native plant communities by exotic perennial grasses;
- invasion of native plant communities by Bitou Bush (*Chrysanthemoides monilifera*);
- invasion of native plant communities by exotic vines and scramblers;
- invasion, establishment and spread of Lantana camara;
- high frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition;
- predation by the Red Fox (*Vulpes vulpes*);
- predation by the Feral Cat (*Felis catus*);
- competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*);
- feral pigs;
- removal of dead trees and dead wood; and
- loss of hollow bearing trees.

6 IMPACT MANAGEMENT

6.1 IMPACT MANAGEMENT

There is potential for a variety of direct and indirect impacts as a consequence of the proposed works during construction and the subsequent activities at the site following the completion of the development. Outlined below are the objectives and measures for managing the potential impacts on the vegetation communities and fauna habitat on the site and in undertaking restoration works. Management actions have been separated into pre construction, construction and post construction mitigation measures to clearly identify the stages to the management activities.

6.2 INDICATIVE PROGRAM

An indicative work program is provided in *Annex D*. Individual programs have been developed for pre construction, construction and post construction activities. The programs will apply to each stage of the development. Given the actual timing for the construction of the development (both commencement and the duration of the stages) is unknown, the program provides indicative timing only in this respect. However the actual times identified for each individual task is considered appropriate.

Prior to the commencement of each stage, the programs should be revised based on the specific commencement and predicted durations.

6.3 MANAGEMENT OBJECTIVES

The objective for managing the site involves the protection and enhancement of vegetation communities and fauna habitat on site over time through enforced strategies, weed management, ongoing bush regeneration works, pest animal control, stormwater management, fire management, traffic management, waste and domestic pet management. An appropriate monitoring program is required in order to ensure mitigation measures are achieving the desired outcome.

6.4 MANAGEMENT OF POTENTIAL IMPACT PRIOR TO CONSTRUCTION

During the planning phase of development, the potential impacts of the proposed development on the conservation areas and reserves can be minimised through design principles such as the incorporation of local provenance species into landscaping plans and revegetation works. General pre-construction management measures include:

- clear identification of the boundaries between clearance areas and those set aside for conservation;

- clear identification of individual habitat trees that are to be retained within asset protection zones where possible;

- pre clearance surveys of hollow bearing trees is to be conducted by a suitably qualified wildlife professional. Wildlife recovered by the wildlife professionals are to be released by the professional into the environmental protection zone within the site at appropriate times. If microchiropteran bat roosts are located, the wildlife professional may attempt to relocate the roost to nearby habitat in reserved areas;

- collection of seed from *Eucalyptus parramattensis* subsp *decadens* hybrid plants and subsequent propagation and planting of the plants within the wet health area to be retained (refer to *Section 7.1*);

- specific guidelines developed for contractors to avoid soil compaction and damage to the roots, stems and branches of trees to be retained, for example appropriate placement of stockpiles, machinery and location of digging;

- specific strategies to avoid the introduction and further spread of weeds onto and within the site (refer to *Section 5.4* and *Chapter 7*);

- collection of seed, vegetative material or translocatable individuals within the development area to be grown or used in restoration and reconstructive landscaping;

- engagement of bushland regeneration contractors; and

- beginning weed control and regeneration in areas of natural bushland not directly impacted within the proposed development area.

6.5 MANAGEMENT OF POTENTIAL IMPACT DURING CONSTRUCTION

It is important that measures are put in place during the construction of the proposed development. These measures will include:

- construction activities are to be generally restricted to daylight hours to minimise impacts to nocturnal fauna such as the Powerful Owl;

- tree clearing operations are to be undertaken generally in accordance with the Habitat Clearing Protocol of the Squirrel Glider Conservation Management Plan (Smith, 2002) detailed in *Section 7.1.1*, in order to minimise mortality to adult and juvenile squirrel gliders. In essence this process requires the clearing of non habitat trees first, followed by an interval before felling of habitat trees (refer to *Section 7.1.1*);

- placement of dead wood and dead mature trees removed from the construction footprint into reserves and open space areas and / or reused within landscaping works in accordance with the bush fire hazard requirements. This will reduce the impact of the key threatening process 'removal of dead wood and dead trees';

- any wildlife observed ahead of / during clearing works are to be removed by a qualified wildlife professional and relocated to the conservation area within the site at an appropriate time. Any injured wildlife are to be provided to wildlife care organisations for rehabilitation prior to release within the site. This strategy is however not recommended for the management of Squirrel Gliders as individuals are likely to return to the den tree. The tree clearing strategy is the recommended management strategy for this species;

- construction of the asset protection zones in accordance of the Bush Fire Hazard Assessment. Habitat trees within the asset protection zones are to be retained where possible;

- phase construction activities to minimise erosion and impacts on the stormwater management system and infiltration processes;

- erecting temporary fencing along the construction area and bushland interface to prevent the disturbance of bushland in conservation areas and the transport of weeds;

- containing runoff from impermeable surfaces within the development areas of the site and minimising soil erosion;

- placing stockpiles and storing machinery away from the conservation areas and any other vegetation to be retained. Temporary fencing will be erected around the immediate area of construction activities in order to protect adjacent conservation areas;

- ensuring that any soil or vegetative material from the site that may contain weed seed is not deposited in or in close proximity to the conservation areas;

- vegetation removed from the proposed development footprint should not be dumped within or in close proximity to the conservation areas;

- informing contractors about environmental responsibilities either through pamphlets or inductions;

- re-establishing native vegetation cover as soon as possible after earthworks;

- removal of all waste generated during construction activities from the site in accordance with the requirements of the *NSW POEO Act*;

- avoiding the disturbance of areas of heavy weed infestation when the weeds are flowering or seeding (see *Table 4.1* for significant weed species occurring on the site);

- installation of wildlife warning signs along the two access roads into the subdivision to warn road users of potential presence of wildlife. The signs should provide contact details for wildlife carers that can be contacted in the event of wildlife being injured; and
- removing weeds immediately adjacent to roads that are constructed on site (particularly the access roads) to prevent the transport of weeds by vehicles.

Table 6.1 Weed Species Flowering and Fruiting Periods

Species	Peak Flowering	Peak Fruiting
Bitou Bush	April to July. Can occur all year round (DEC 2004).	June to September
Lantana	Usually October to April. Almost continuous whenever soil is moist (DEH 2003).	November to June
Chinese Violet		
Alligator Weed	Mid summer	
Blackberry	November to February (DEH 2003).	December to April

Note:
DEC – NSW Department of Environment and Conservation.
DEH - Department of Environment and Heritage (Cwth)

6.6 MANAGEMENT OF POTENTIAL IMPACT AFTER CONSTRUCTION

Management after construction will focus on:

- the ongoing management and monitoring of natural vegetation, weeds and pests. Refer to *Section 7* for specific information regarding their management;
- education and involvement of future residents and the formation of a local environmental group;
- continued management of stormwater runoff from impermeable surfaces and provision of management that avoids runoff into reserves;
- management of passive access to reserves to prevent degradation, the spread of weeds and waste; and
- management of bush fire hazard.

Post construction measures will be implemented over a period of 20 years from the date of development consent, the need for which will be assessed during the review of the CLEMP as identified in *Section 10.4*.

7 SPECIFIC MANAGEMENT REQUIREMENTS

7.1 THREATENED SPECIES MANAGEMENT

In addition to the conservation of habitat areas, the following specific mitigation measures are required in order to mitigate the impact on threatened species:

- clear identification of individual habitat trees that are to be retained within asset protection zones where possible;
- pre clearance surveys of hollow bearing trees is to be conducted by a suitably qualified wildlife professional. Wildlife recovered by the wildlife professionals are to be released by the professional into the conservation areas within the site at appropriate times. If microchiropteran bat roosts are located, the wildlife professional may attempt to relocate the roost to nearby habitat in reserved areas;
- the use of salvaged tree hollows and nest boxes are not recommended for the Squirrel Glider or other hollow dependent fauna due to the abundance of hollows in the conservation areas; and
- placement of dead wood and dead mature trees removed from the construction footprint into reserves and open space areas and / or reused within landscaping works in accordance with the bush fire hazard requirements to reduce the impact of the key threatening process 'removal of dead wood and dead trees'.

7.1.1 *Protocol for Management of the Squirrel Glider*

Tree clearing operations are to be undertaken generally in accordance with the Habitat Clearing Protocol of the Squirrel Glider Conservation Management Plan (Smith, 2002). The protocol states that where clearing of habitat with known Squirrel Glider populations occur, the following procedures should be observed:

- all potential Squirrel Glider habitat trees in the area to be cleared will be identified (by survey) and marked;
- marked habitat trees and corridors of retained trees linking marked habitat trees with the nearest uncleared (secure) habitat areas will be left standing after initial vegetation clearing for a period of at least three weeks (to encourage gliders to disperse into adjacent uncleared habitat);
- after the three waiting period, standing habitat trees and corridors may be felled commencing with the most distant trees from secure habitat;
- where possible, clearing should be undertaken in the Spring to Autumn period to facilitate survival of displaced animals;

- if habitat trees are in short supply (<4 suitable trees per hectare) artificial nest sites (nest boxes) should be installed in adjacent (secure) habitat before clearing; and
- if no secure habitat exists nearby to areas to be cleared, land owners should seek advice from DECC before proceeding with clearing.

7.1.2 Protocol for Management of Diuris praecox

Two individual *Diuris praecox* were identified in 2002 along a track in the north east corner of the Fern Bay Seaside Village site, external to the development footprint. This access track will be closed as part of the management of the community lands. No other active management of the species is recommended for the first year of the CLEMP.

It is recognised that over time, regrowth of vegetation along the track is expected to overshadow the recorded individuals, reducing habitat suitability. Conversely, the creation of asset protection zones within the Fern Bay Seaside Village site may provide potential habitat for this species to colonise.

Therefore, long term management of the two individuals located along the track will be required. Such management may include reducing competition from other plants in the immediate vicinity of the individuals, for example via slashing. Any such control works will be subject to prior liaison with DECC to determine the most effective management strategy for this species. Liaison will occur with DECC during the first review of this CLEMP.

7.2 REGENERATION, RESTORATION AND WEED MANAGEMENT

7.2.1 Restoration Objectives

Given the large areas of natural bushland and parkland within the development area, it is likely that a combination of rejuvenation (lower level of intervention) and regeneration (including planting) (higher level of intervention) would be required. Restoration of the site will take place prior to, during and after construction and the techniques and timing at each stage will depend on their practicability.

The main objective of site restoration is to establish self-sustaining vegetation communities through the treatment and reduction of weeds, natural rejuvenation and regeneration and re-planting of native species local to the area to:

- restore similar composition and diversity of vegetation in reserves; and
- reinstate basic functions.

7.2.2 Principles

The following principles of rejuvenation and regeneration should be applied to the restoration of the site:

- apply the minimum intervention necessary for success;
- carefully assess potential for natural rejuventation prior to determining whether a regeneration / replanting approach is necessary;
- planting and or direct seeding may be necessary for establishing indigenous vegetation where regeneration potential is severely depleted;
- in cases where the site conditions have been so altered that the pre-existing community cannot perpetuate on site in the long term, construction of an alternative locally occurring indigenous vegetation community is a potential option;
- always work from good areas with native plants towards more degraded weed infested areas ie. from good bush to bad bush;
- minimise disturbance;
- let native plant regeneration dictate rate of weed removal; and
- undertake several stages of weed removal ie. primary, consolidation and long term maintenance (Greening Australia, 1999 and Buchanan, 1999).

7.2.3 Methods

The following methods of rejuvenation and regeneration should be applied to the restoration of the site:

- reverse degradation processes and causes;
- reintroduce seed sources where known to be missing;
- appropriate selection of species for regeneration;
- ensuring genetic integrity and diversity;
- appropriate site preparation and maintenance;
- undertake weed control in accordance with the methods detailed in *Section 7.2.4;*
- ensure disturbed areas are stabilised, mulched with weed free mulch or revegetated as quickly as possible;
- consider the use of tree guards, fencing or signage to protect regenerating areas from disturbance or predation;

- ensure that the bush regeneration does not increase the bush fire risk within the proposed development area or interface; and

- all rubbish such as pots and tree guards, should be removed from the site, when no longer necessary (Greening Australia, 1999 and Buchanan, 1999).

Annex E contains fact sheets providing an overview of suggested techniques for weed removal and dune planting for specific weed species.

7.2.4 Weed Control

The objective of the weed control program at Fern Bay Seaside Village is to improve the environmental values of Fern Bay Seaside Village through a reduction in weed species occurrence and distribution, ensuring legislative requirements are met. Protocols should be introduced at all stages of the development to reduce the spread of weeds, particularly minimising disturbance. Establishing and maintaining such protocols will reduce the costs of weed management in the long term. Weed control throughout the site should be consistent with the management of weeds within the adjacent Worimi Regional Park (ERM, 2008) and the Weed Management Plan, Fern Bay Estate Emergency Fire Trail (ERM, 2006).

Weed management and control will depend on the correct identification and the abundance, distribution and ecology of native and exotic species present. The treatment of noxious weeds and dominant weeds are the focus of weed management. Profiles describing the ecological characteristics (appearance, life cycle, dispersal mechanisms) and control recommendations for the Noxious and Nationally Significant Bitou Bush, Lantana and Blackberry, are provided in *Annex E.* The environmental alert for Chinese Violet and Alligator Weed is also included in this Annex.

As detailed in *Section 4.4*, there are a range of weeds evident at the site. Weed management will be initially undertaken on the higher priority weeds as identified in *Table 4.1*.

Baseline Assessment and Treatment

Baseline field survey and review of recent aerial photographs of Fern Bay Seaside Village would be undertaken at commencement of the weed removal program to update the data presented in *Figure 4.2* and to identify any additional areas of weed infestation.

The results of the baseline field survey would be used as a benchmark against which the success of weed control treatments will be assessed. The baseline survey will include the establishment of photo points and/or plot based surveys to measure the density (number of plants per unit area over different age classes) and cover abundance. Quantitative surveys would be replicated in treated and untreated areas. Priority native species as identified in the

Bitou Bush Threat Abatement Plan would also be identified. The presence or absence of threatened flora species would be noted.

Other features such as size and shape of area to be treated, accessibility and topography should be noted.

The baseline assessment would identify target weed species and appropriate treatment regime (method of application, choice of herbicide, timing of treatment) and operational plan for each infestation. Where flora species of conservation significance are present appropriate management measures would be identified to avoid impacts (eg no foliar spray to avoid spray drift).

Primary weed removal will be undertaken based on the results of the baseline field survey within the first year of the CLEMP. Treatment will commence in areas of low infestation using species appropriate treatment techniques as identified further below and in *Annex E*. Treatment would avoid disturbance of heavy weed infested areas during flowering or seeding. Where weed seeds and/or fruit are present in treatment areas these would be bagged and disposed off site. All treatment and records of herbicide use would be logged and maintained for annual reporting.

It is recommended that weed control works be undertaken at a similar time to weed control works within adjacent lands, such as the Worimi Regional Park in order to maximise effectiveness of control.

In subsequent years, annual weed surveys will be undertaken to ascertain weed occurrence and densities, assess the effectiveness of weed control (against the baseline year) and identify future weed treatments.

Benchmarks and Targets

The treatment regime would identify benchmarks against which post treatment monitoring would be compared. It is noted that various factors influence the occurrence of weeds species and the success of weed control treatment (for example drought conditions, prevalence of seed stock in the ground, vehicle and pedestrian spread of seeds etc).

The target of the weed control program within the Fern Bay Seaside Village is to achieve a 40% reduction in mature weed plants within the first three (3) of treatment. This target is consistent with the Natural Resources Commission target of "*By 2015 there is a reduction in the number of invasive species*".

This target will be reviewed following each annual weed survey to ensure the target is relevant and achievable based on the species and densities evident. Additionally, the weed control project will aim for a 95% weed treatment application within surveyed areas each year (ie a minimum of 95% of all weeds surveyed will have some form of treatment annually).

The weeds targeted in weed control works will be consistent with the classification of the weeds and the Natural Resources Commissions defined invasive species (refer to *Section 2.2.8*).

Methods

The following methods of weed control should be applied to the site:

- where possible weed removal by hand should take place in small patches to reduce the amount of bare ground. These areas should be maintained and allowed to naturally regenerate or be replanted with local provenance species;

- herbicide spraying of dense infestations of weeds using herbicides that are suitable for use near aquatic situations (eg glyphosate). The chosen methods for treating weeds will depend on the characteristics and densities of weed and native species;

- cut and paint, stem injection and frill/chip methods should be used for plants whose stems are greater that 10 centimetres;

- biological control methods should be considered where possible, particularly for Bitou Bush; and

- seeds or fruit should be bagged and disposed of off site.

The selection of each method is dependent on the extent of weed infestation and potential affects on surrounding native vegetation.

A log should be maintained by the weed contractor describing baseline density and species based on age (eg seedlings or mature plants), removal methods and time spent.

In areas containing significant infestations of target weed species such as Bitou Bush and Lantana, consideration should be given to the provision of erosion control structures if large areas of sand are likely to be exposed. This should be determined at the discretion of personnel undertaking weed management activities. Appropriate control methods may include keeping dead plants in situ, the provision of fences, brush matting, planting of tube stock and synthetic ground covering for larger areas of exposed sand. It is particularly important that such control strategies be adopted in areas in close proximity to wetlands and steeper dune slopes.

Any weed control works should target reproductive potential for each species and provide appropriately timed inspections and removal prior to seedset. Monitoring of weed control works is discussed in *Section 9.1*.

7.2.5 Revegetation

Vegetation clearance and weed removal will be followed by a revegetation strategy and maintenance schedule. Reconstructive landscaping within the proposed development area will be designed to integrate natural bushland with the built environment. This involves selecting species that will not invade the surrounding natural bushland and provide fauna habitat. This is particularly important at the interface of the development and the native bushland including the exclusion of invasive exotic grass species such as Kikuyu. The street planting concept plan has been prepared by Verge Landscape Architects (2007) and planting palettes are shown in *Figure 7.1.*

Once weeds are removed from bushland competition for light, water and nutrients is lowered and native plants may naturally establish from the soil seed bank. Natural regeneration is an effective management technique in areas of natural bushland that are likely to regenerate when weeds are removed. Areas that are more degraded may need assistance to bring back the vegetation given a lack of a soil seed bank or large amounts of weeds. This would involve planting of a range of plants at varying densities.

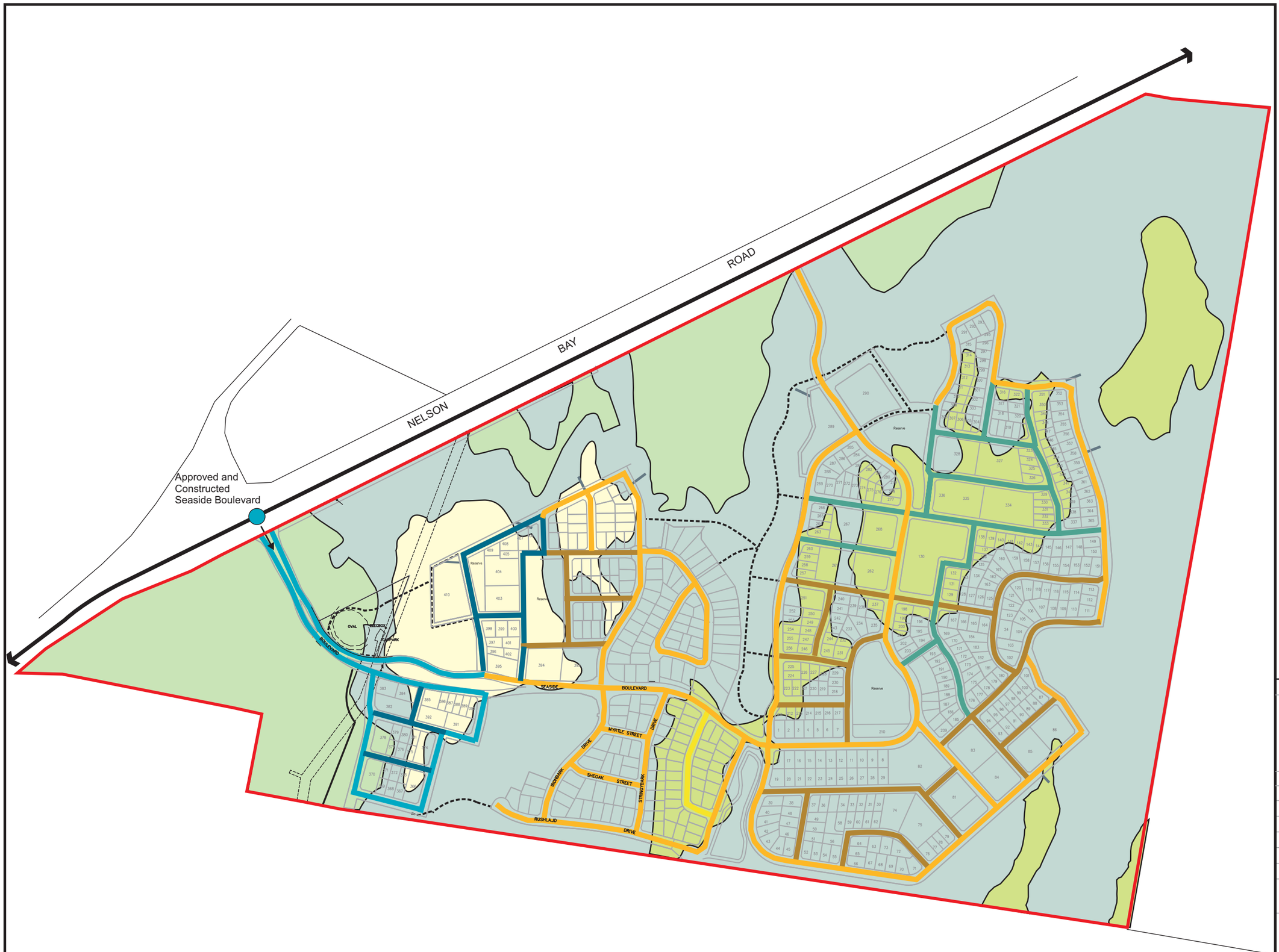
7.3 FIRE CONTROL

A Bush Fire Hazard Assessment Report (ERM, 2007) has been prepared for the site, which identifies asset protection zones (APZs) for the site. The APZs will need to maintain minimal fuel loads, have minimal continuous vegetation and not contain any woodpiles, garden mulch or other combustible materials. APZ's for the site are identified in *Figure 5.1.* Any planting in APZs will require the selection of species that are less flammable or are fire resistant.

7.4 ACCESS

Future residents will be able to enjoy the natural bushland within the reserves and open space areas, within its carrying capacity. The site must be accessed and utilised in a way that does not cause damage to the natural vegetation or degrade threatened species habitat. This can be undertaken by:

- well designed pedestrian trails that minimise disturbance of native vegetation and are located away from important threatened species habitat and archaeological areas;
- provision of ongoing maintenance of pedestrian pathways;
- provision of waste receptacles within public reserve areas if required;
- providing a buffer around any environmentally sensitive areas, such as the owl roost tree;



Legend

Proposed Streetscape Planting

- Swamp Mahogany Paperbark Forest - bush palette with complementary street trees.
- Swamp Mahogany Paperbark Forest - urban palette with complementary street trees.
- Apple Blackbutt Forest - bush palette with complementary street trees.
- Apple Blackbutt Forest - urban palette with complementary street trees.
- Heath - bush palette with complementary street trees.
- Heath - urban palette with complementary street trees.

Note: Streetscape planting will also apply to the Controlled Vegetation Zones (CVZ) within individual lots

Existing Vegetation

- to be retained and managed according to ecological principles and bushfire reuirements

- Swamp Mahogany Paperbark Forest
- Apple Blackbutt Forest
- Wet Heath
- Swamp Sclerophyll Forest

- Potential Stormwater Management Infrastructure
- Pathway

Figure 7.1

Street Planting Concept Plan from Master Plan 2007

Client:	Aspen Group Pty Ltd		
Project:	Fern Bay Seaside Village		
Drawing No:	0063154hv_PPP_CLEMP_04		
Date:	11/12/09	Drawing size:	A3
Drawn by:	SP	Reviewed by:	PD
Source:			
Scale:	Refer to Scale Bar		

N

0 50 100 150m

Environmental Resources Management Australia Pty Ltd
53 Bonville Avenue, Thornton, NSW 2322
Telephone +61 2 4964 2150

ERM

- utilising interpretive signage and directive fencing;
- excluding trail bikes and vehicles from walking tracks to avoid erosion, weed spread, waste and noise through gates only wide enough to allow for pedestrian access;
- excluding unleashed domestic dogs and horses from walking trails; and
- undertaking annual inspections of on site conservation areas and reserves to determine the presence of illegally deposited waste material and the subsequent removal of the material.

7.5 PEST MANAGEMENT

7.5.1 Vertebrate Pests

Vertebrate pest control works will be undertaken consistent with control programs being implemented by Port Stephens Council. Works should be undertaken in consultation with DECC to ensure coordinated control works between Fern Bay Seaside Village and the adjacent Worimi Conservation Lands. This may include a coordinated baiting program for wild dogs and foxes and other pest species.

The Port Stephens Feral Animal Management Committee, comprising a number of government and non government landholders in the Port Stephens area, including DECC, generally undertake a coordinated 1080 baiting program for wild dogs and foxes on an annual basis. Given the benefits of a coordinated program, the Fern Bay Seaside Village should consider participating and / or baiting at the same time to maximise results should the site be a harbourage for foxes and / or wild dogs. This should be done in consultation with DECC in relation to the adjacent Worimi Regional Park and Worimi State Conservation Area. Baiting for wild dogs and foxes should be undertaken by appropriately qualified persons and any program should include sand pad monitoring at bait stations to assess the potential impact on non target species.

Other control programs, particularly for rabbits and cats, should be undertaken when there is evidence that there may be or is an impact on the environment through erosion and ground instability and / or if there is evidence that the population is increasing. Control programs for rabbits may include biological control, fumigation or ripping of warrens, however warren ripping has the potential to create erosion issues and damage habitat and must therefore be appropriately managed. Control programs for feral cats include trapping. Consultation with DECC should occur prior to implementing a control program.

Vertebrate pest sighting forms should be developed and distributed to all residents within Fern Bay Seaside Village for use in reporting sightings of vertebrate pests, including foxes, wild dogs, cats and rabbits. This information is to be forwarded by residents to the community association for use to determine the presence and relative abundance of the pest animals, which will inform the implementation of control actions.

7.5.2 Mosquitoes

The management of mosquitoes within the Fern Bay Seaside Village should be undertaken generally in accordance with the Mosquito Risk Assessment, Fern Bay Estate (ICPMR, 2004), the management measures identified in "*Living with Mosquitoes in the Lower Hunter and Mid-North Coast Region of NSW*' (Webb and Russell, 2005) and Port Stephens Council Development Control Plan 2007.

Management measures may include:

- community education, providing not only public health messages, but also information regarding the ecology of the local mosquito habitat areas and the importance of environmentally sensitive mosquito control measures;
- management of stormwater management structures, including stormwater inlet pits, gross pollutant traps or surface storage areas by ensuring that the structures are self draining, have the siltation depth shallow enough to encourage evaporative drying and that the accumulation of organic material is maintained at low levels;
- the use of personal insect repellents, mosquito coils (containing insecticide) is highly recommended to provide protection for individuals and households and education of residents;
- all dwellings must be equipped with effective screens on all windows, doors and openings;
- all rainwater tanks and fabricated water storage structures must be equipped with effective screens on all openings; and
- treatment with a approved larval control agent.

The application of herbicides for mosquito control would require a permit under the *Threatened Species Conservation Act 1995*, however a permit for mosquito control for amenity reasons only is unlikely to be approved by DECC.

Should mosquito populations be excessive, consideration should be given to undertaking mosquito faunal studies during the period December through to March to assess the species present, population sizes and harbourage areas. '*Living with Mosquitoes in the Lower Hunter and Mid-North Coast Region of NSW*' (Webb and Russell, 2005) provides monitoring data sheets for undertaking fauna studies of mosquito populations that could be utilised at the site.

7.6 STORMWATER MANAGEMENT

Ongoing maintenance of the stormwater system is required in order to ensure optimum operation of the Water Sensitive Urban Design treatment train. It is important to periodically remove litter and sediment from the inlet pits in the street drainage system. Failure to do so may result in decreased stormwater quality and greater water levels in the swales within road reserves. The implementation of erosion and sediment control during construction activities is essential in order to minimise impacts.

The requirements for stormwater management include:

- inspecting and cleaning the inlet pits in the street drainage system on a quarterly basis;
- phasing construction activities to minimise erosion and minimise impacts on the stormwater management measures that rely on infiltration processes;
- minimising vegetation clearing;
- using sediment basins, silt fences and perimeter banks during construction to minimise erosion and sediment transport to receiving waters; and
- restoring vegetated ground cover as soon as possible following construction.

7.7 EDUCATION

Education and raising the awareness of residents about environmental issues on the site is important. Relevant issues include native vegetation communities, fauna habitat, weeds, nutrient runoff, appropriate use of pesticides and fertilisers, snakes, responsible ownership of domestic animals, and bush fire. This will include the placement of signage and provision of pamphlets and/or information sessions to residents on the purchase of their property. Residents will be involved in the management and protection of the conservation reserves on the site, which will be subdivided and managed under Community Title.

8 STAGING OF RESTORATION / WEED CONTROL WORKS

8.1 STAGING

Restoration, landscaping and weed control works across the site will be extensive and will require a staged approach to their implementation. It is proposed that these works will be undertaken in four stages. These four stages of restoration and weed control works apply to each stage of the development.

Annex D provides an indicative work program. The timing of the works is indicative only and will be abased on the approval date of the development, as well as the construction start date. The total time required for the carrying out of works, specifically weed control and waste removal is also indicative. Baseline surveys undertaken prior to construction will identify the current weed species present and extent of occurrence on site. The baseline assessment would identify target weed species and appropriate treatment regime (method of application, choice of herbicide, timing of treatment) and operational plan for each infestation.

8.1.1 Stage 1 (Prior To Construction Phase)

Stage 1 will involve the engagement of qualified bush regeneration and landscape contractors. There will be a clear and documented identification of restoration approaches, selection of species to be acquired and vegetative collection, weed removal in areas not proposed to be developed, site stabilisation and preparation for planting. Specific vegetation protection measures will be determined and measures explained to all contractors during the site induction in which all contractors will be required to attend prior to commencing work on site. Additional information regarding the contents of the induction program is identified in *Section 10.2*.

Species Selection and Seed Collection

The species utilised in revegetation and landscaping will be dependent on the vegetation community present and/or likely to be present and local conditions. Seed stock and vegetative material will be collected from native species present on the site. This will be undertaken over several years to cover a variety of flowering seasons and to account for annual variation. Collection at this stage will concentrate on the proposed development area. It is important that seeds and vegetative material are collected from healthy, vigorous plants. Similar quantities of seeds will be collected from several well-spaced plants to encourage genetic diversity. These activities will follow Florabank's (1999) Best Practice Guidelines.

In undertaking species selection and seed collection, the following will be considered:

- the availability of appropriate local species that can be acquired/propagated to suit the design intent and program of the first stage of development;
- suitable local indigenous species to be reintroduced to the site; and
- consider positions and design of walking tracks and interpretive signage within reserves and development of weeding strategies.

Weed Removal and Site Preparation

Regeneration and weed control could begin within areas not directly impacted by the proposed development. Works will commence in areas of low weed infestation (see *Figure 4.2*), in areas where natural regeneration is likely to occur and then move into areas of heavier infestation where additional replanting may be necessary. Control works will target invasive species. Appropriate treatments for control will be implemented based on the target species and will typically involve hand removal of large wood species plus the painting of herbicides on these species.

At this stage tracks will be closed and regenerated with spreading of brush and weed removal works will commence along the tracks. These works will commence in areas of low infestation and then move into areas of heavier infestation. Tracks will be monitored to assess rehabilitation.

8.1.2 Stage 2 Rehabilitation during Construction (1 year +)

Stage 2 will focus on the site for the duration of construction of the proposed development, which includes land clearance, creation of infrastructure and dwelling construction. Management will involve the protection of threatened species habitat, archaeological sites and areas of vegetation to be retained, weed management and replanting on site.

Flora and Fauna Habitat

Plants that can be translocated should be removed and replanted in areas to be retained or landscaped. Branches, logs and brush material should be utilised in regeneration, stabilisation and landscaping works where possible. Additional cleared vegetative matter should be mulched and utilised in landscaping and/or regeneration where possible and in accordance with bushfire management measures.

Weed Removal and Revegetation

Weed removal will continue on site and the proposed development area will be landscaped and maintained as specified in the landscaping plan. Restoration will continue in reserves with natural regeneration encouraged and some planting to be undertaken. Transplanted plants are to be maintained and additional seed collected if required for use in open spaces and private gardens.

As each stage is constructed, weed management works will commence in areas of low weed infestation (see *Figure 4.2*) and then move into areas of heavier infestation where additional replanting may be necessary. Areas of low weed infestation include the conservation areas that support Coastal Sand-Apple Blackbutt forest and the area of Swamp Mahogany-Paperbark forest near the playing fields.

8.1.3 Stage 3 Regeneration and Maintenance after Construction

Stage 3 will be undertaken at the end of and following the construction phase. This will involve continued weed removal and restoration within landscaped areas and within and on the fringe of the development, around infrastructure and heavily infested areas. The monitoring and maintenance of areas already treated within reserves, planting of any additional landscaping at appropriate times of the year, maintenance and replacement of any failed plantings. Signage and interpretive tracks and permanent fencing will be put in place as required. Educational pamphlets will be prepared for distribution to property owners.

8.1.4 Stage 4 Maintenance (> 3 years)

Stage 4 will be undertaken over the long term and will involve continued weed monitoring and maintenance weeding, and monitoring of the regeneration areas and bushfire hazard management. Specifically, long term maintenance activities will involve (for a period of up to 20 years from the date of development consent):

- annual weed survey to identify weed species present, location and densities;
- development of an annual weed maintenance program following the weed survey , specifying weed control works over a 12 month period, taking into consideration weeds present and weed control timing requirements based on seasonality factors;
- annual survey of regeneration areas to determine health of vegetation and identify need for replacement or additional planting. The survey is to additionally assess the regeneration of closed tracks and assess vegetation

within asset protection zones and identify the need for maintenance activities to minimise bushfire risk within the APZ's; and

- annual waste survey and subsequent development of a waste removal program for the following 12 month period.

The community will be encouraged and assisted in establishing a local environmental group to undertake ongoing maintenance.

9 MONITORING PROGRAM

9.1 MONITORING

Regular monitoring of the effectiveness of management measures and regeneration, including pre construction, construction and post construction activities will be undertaken.

9.1.1 Monitoring during Construction

A monitoring program will be implemented during the construction phase of the development and will involve regular audits of the construction activities against the requirements of this CLEMP. All areas of disturbance will be subject to inspection during the audits to ensure appropriate measures are in place to minimise environmental impact. The monitoring of construction activities will include (but is not limited to):

- ensuring the appropriate placement of stockpiles, machinery storage and machinery movement;
- assessing the effectiveness of weed control and revegetation / landscaping works;
- ensuring construction hours of operation are limited to daylight hours;
- ensuring the management of displaced fauna is as per the requirements of this management plan;
- ensuring that dead wood and dead mature trees have been relocated to conservation areas and reserves consistent with the Bush Fire Hazard Assessment Report (ERM, 2007);
- ensuring vegetation cleared and not relocated is wood chipped / mulched for use in site landscaping;
- checking the temporary fence erected to delineate between the construction and conservation areas is appropriately sited and maintained; and
- checking erosion and sediment control measures are installed and being regularly maintained.

An Audit Checklist for use during construction is provided in *Annex F*.

9.1.2 Post Construction Monitoring

Monitoring post construction will include both short term and long term monitoring and is the responsibility of the Community Association. It is noted that the DECC are currently developing standardised monitoring protocols for the monitoring of weeds, however this has not been released to date. Accordingly, the monitoring proposed within the CLEMP will be modified to be consistent with the DECC monitoring program following its release.

Short Term Monitoring

Short term monitoring will be undertaken as a follow up after weed control, revegetation and landscaping works, to ensure that the works have been successful and identify where follow up works may be required, for example re-treatment of weeds or watering of plants.

Follow up inspections of revegetation and landscaping works should occur within one week of the works being undertaken to maximise survival rates of the plants.

Follow up inspections of weed control works is to be undertaken no greater than six months after treatment or prior to seed production. During the inspection, the treated and untreated replicate plots would be resurveyed noting the following:

- species presence and abundance;
- age structure;
- photographic record;
- success of treatment (eg number of dead plants, regrowth, seedling recruitment);
- any adverse impacts on non-target species; and
- response of other weed species.

All monitoring data would be logged and maintained for annual reporting. Data provided at six month monitoring would provide the basis for planning of treatment for the next year.

Once the densities of weeds have been initially reduced they need to be regularly monitored to suppress any outbreak or spread. This will prevent weeds from re-establishing in the site and to maximise the effect of the initial control works. This type of monitoring is essential for grassy and herbaceous weeds, which could remain hidden amongst non-target vegetation during the initial control activities. A short term monitoring checklist is included in *Annex F*. Additional inspections of revegetation and landscaping works should also be undertaken during weed control monitoring to assess the effectiveness of the works and identify required following up actions.

Monitoring would also provide data on condition and regeneration of native species. Natural regeneration of native plants will be encouraged in preference to active revegetation. It is possible that the seed bank will be too severely depleted in some areas and the need for supplementary planting will be assessed after 12 months.

The receipt of feedback forms by the Community Association pertaining to feral animal sightings will be ongoing and will be used by the Community Association to make decisions on the need to implement control works.

Long Term Monitoring

Annual inspections will be undertaken throughout the conservation and reserve areas to assess (but not limited to):

- the success, or otherwise of weed control works, including the identification of weed infestations throughout the areas and changes to weed densities (this weed survey will inform weed control works over the following 12 month period);
- the success, or otherwise of revegetation and regeneration, including changes in species composition, extent of native plant regeneration and general health of native vegetation and plant communities. This may involve the establishment of photo points and quantitative measures such as plot or transect based surveys to measure density and cover. This approach could also be used for monitoring weed infestations;
- evidence of waste disposal within the areas and recommendations for the removal of waste;
- evidence of pest activity – to add to the ongoing community sightings received via a feedback form; and
- evidence of illegal public access (for example vehicles accessing the conservation areas).

The objective of the long-term monitoring program is to provide sufficient feedback on the success of the overall weed control strategies including suppression and prevention of weed spread and establishment. It will provide information about the successful regeneration of native vegetation communities and success of revegetation programs. It will also provide the Community Association with information pertaining to waste and pest animal issues throughout the site, with recommendations regarding management actions to address identified issues.

The annual long term monitoring inspections will be reported to the Community Association via an annual report incorporating recommendations (including timeframes). The Community Association will be responsible for ensuring annual monitoring is undertaken, and the recommendations are implemented.

Each annual report will identify whether recommendations in previous annual reports have been implemented and their effectiveness.

10 IMPLEMENTATION RESPONSIBILITIES

10.1 IMPLEMENTATION OF RESPONSIBILITIES

The developer, Aspen Group, will be responsible for implementing all management strategies outlined in this document during the construction and establishment stages of the development. Aspen will be responsible for the implementation of environmental auditing and monitoring during construction activities and implementing the short term monitoring program during the site establishment works. Where appropriate these responsibilities will be delegated to environmental consultants, bush regenerators and building and landscape contractors. The strategies outlined in this document will be implemented in consultation with Port Stephens Council, the Department of Environment and Climate Change (DECC), the Fern Bay Seaside Village Community Association and other relevant parties.

The Community Association, established under Community Title will be responsible for the management of the conservation areas and reserves following the establishment of these areas. The Community Association will also be responsible for the long term monitoring of the site in accordance with these procedures.

10.2 INDUCTION PROGRAM

All contractors will be required to attend an induction program prior to commencing works on site. The induction will incorporate health and safety matters, as well as environmental management requirements for construction activities. The induction program will involve the presentation of environmental requirements, as well as the provision of information flyers and fact sheets to assist the construction workforce in the field to implement appropriate management measures. The induction program will be supported by site signage advising the workforce of key environmental requirements, including incident response and reporting requirements as appropriate.

Specifically, the induction program will incorporate the following environmental management requirements:

- approved construction site ingress and egress;
- operational requirements and activities, including:
  - areas approved for clearing and procedures for the protection of conservation areas;
  - clearing procedures;
  - management of fauna during clearing;

- procedures for managing Aboriginal items and relics that may be encountered during construction; and
- incident response and reporting procedures.

- information regarding ecological and Aboriginal values of the site; and
- waste management requirements.

10.3 CONTACTS

10.3.1 List of Contacts

The following contacts are likely to provide additional direction and advice in relation to issues of vegetation management on the site:

Aspen Group
Level 5, 33 York Street, Sydney NSW 2000
Ph: 02 8916 6700

Australia Association of Bush Regenerators
c/- Total Environment Centre
Level 2 362 Kent Street Sydney NSW 2000
Ph: 0407 002 921
Email: aabt@zip.com.au

Graham Prichard
Senior Weeds/ Pest Management Officer
Port Stephens Council
PO Box 42 Raymond Terrace, NSW 2324.
Ph: 02 4980 0392
Email: graham.prichard@portstephens.nsw.gov.au

Greening Australia NSW
142 Addison Road
Marrickville NSW 2204
Ph: 02 9560 9144
Fax: 02 9550 0576

Gordon Patrick
Trees in Newcastle
Parry Street Newcastle 2300
Ph: 02 969 1500
Email: tin@bravo.net.au

Mel Schroder
Pest Species Officer
Department of Environment and Conservation
Ph: 02 4984 8200
Bruce Peterson

Environmental Services Manager
Port Stephens Council
PO Box 42 Raymond Terrace, NSW 2324.
Ph: 02 4980 0255

10.3.2 Community Programs

The following programs are likely to be relevant to vegetation management on site and provide additional information for management of the site. The community will be encouraged to become involved in voluntary groups such as Landcare, Bushcare and Coastcare in order to promote community involvement and an awareness of environmental issues.

Natural Heritage Trust

There are three Natural Heritage Trust programs relevant to the site including Bushcare, Rivercare and Coastcare programs. Bushcare invests in activities that contribute to conserving and restoring habitat for our unique native flora and fauna which underpin the health of our landscapes. The Rivercare program invests in activities that contribute to improved water quality and environmental conditions in our river systems and wetlands. The Coastcare program invests in activities that contribute to protecting our coastal catchments, ecosystems and the marine environment (EA 2003a in DEC, 2004).

Environmental Trust

The Environmental Trust, delivered through the DECC provides an opportunity for community groups and members to seek funding for rehabilitation and restoration projects.

City and Country Environmental Restoration Program

This funding program delivered by the DECC provides funds under different categories, including an urban sustainability program that seeks to reduce the ecological footprint of urban areas, focusing on urban bushland to provide habitat for rare and endangered flora and fauna.

10.4 REVIEW OF CLEMP

This CLEMP will be reviewed regularly by suitably qualified persons engaged by the Community Association. The reviews will be undertaken in consultation with Port Stephens Council and the Department of Environment and Climate Change to determine the efficacy of the original plan and schedule.

The reviews are proposed to be undertaken annually for the first three years, after which an assessment of the frequency of the review will be undertaken and a revised review period agreed. The review will:

- assess the effectiveness of the CLEMP in managing the community lands on site, including the proposed works schedule and modify as appropriate;

- assess the ongoing need and frequency of the implementation of management measures identified in the CLEMP if previous control works have sufficiently managed the issues;

- update targets and monitoring requirements based on DECC developed statewide weed monitoring protocols and targets; and

- identify and include additional issues relating to the community lands that may need to be incorporated into the CLEMP.

The reviewed report will be submitted to the Community Association and will be available to Port Stephens Council, DECC and residents of Fern Bay Seaside Village.

The Community Association will be responsible for ensuring that the CLEMP reviews are undertaken in accordance with the frequency identified in the plan. In this way the document will become flexible, changing in response to the changing needs of the reserves and conservations areas as rehabilitation and development progresses.

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Annex A

Nationally Significant Weed Species

Table:A1 WEEDS OF NATIONAL SIGNIFICANCE

Scientific Name	**Common Name**
Alternanthera philoxeroides	alligator weed
Tamarix aphylla	athel pine
Chrysanthemoides monilifera	bitou bush / boneseed
Rubus fruticosus agg.	blackberry
Asparagus asparagoides	bridal creeper
Cabomba caroliniana	cabomba
Nassella neesiana	Chilean needle grass
Ulex europaeus	gorse
Hymenachne amplexicaulis	hymenachne
Lantana camara	lantana
Prosopis spp.	mesquite
Mimosa pigra	mimosa
Parkinsonia aculeata	Parkinsonia
Parthenium hysterophorus	parthenium weed
Annona glabra	pond apple
Acacia nilotica spp. indica	prickly acacia
Cryptostegia grandiflora	rubber vine
Salvinia molesta	salvinia
Nassella trichotoma	serrated tussock
Salix spp. except S. babylonica, S. X calodendron and S. X reichardtiji	Willows except weeping willows, pussy willow and sterile pussy willow

Annex B

Noxious Weeds in Port Stephens LGA

Class 2 Regionally Prohibited Plants
Control Requirements- The plant must be eradicated from the land and the land must be kept free of the plant.

Common name	Scientific name
Hygrophila	*Hygrophila costata*

Class 3 Regionally Controlled Plants
Control Requirements-The plant must be fully and continuously suppressed and destroyed.

Common name	Scientific name
Alligator Weed	*Alternanthera philoxeroides*
Groundsel Bush	*Baccharis halimifolia*
Mother-of-millions	*Bryophyllum* species and hybrids
Green Cestrum	*Cestrum parqui*
Salvinia	*Salvinia molesta*
Giant Parramatta Grass	*Sporobolus fertilis*


Alligator Weed

Weedbusters
Local Heroes - Global Champions

Class 4 Locally Controlled Plants
Control Requirements-The growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.
*The plant may not be sold, propagated or knowingly distributed.

Common name	Scientific name
Crofton Weed	*Ageratina adenophora*
Mistflower	*Ageratina riparia*
Spiny Burrgrass	*Cenchrus incertus**
Spiny Burrgrass	*Cenchrus longispinus**
Boneseed	*Chrysanthemoides monilifera* subspecies *monilifera*
Bitou Bush	*Chrysanthemoides monilifera* subspecies *rotunda*
Pampas Grass	*Cortaderia* species
Prickly Pear	*Cylindropuntia* species*
Paterson's Curse,Vipers Bugloss, Italian Bugloss	*Echium* species
Water Hyacinth	*Eichhornia crassipes*
Spiny emex	*Emex australis*
Harrisia Cactus	*Harrisia* species*
St. John's Wort	*Hypericum perforatum*
Long-leaf Willow Primrose	*Ludwigia longifolia*
African Boxthorn	*Lycium ferocissimum*
Cape Tulip	*Moraea* species
Chilean Needle Grass	*Nassella neesiana**
Serrated tussock	*Nassella trichotoma**
Prickly pear	*Opuntia* species except *O. ficus-indica**
Blackberry	*Rubus fruticosus* aggregate species*
Johnson Grass	*Sorghum halepense*
Columbus Grass	*Sorghum x almum*
Rhus Tree	*Toxicodendron succedanea*
Bathurst & Noogoora Burrs	*Xanthium* species

Local control plans for class 4 noxious plants can be viewed on the council website at http://portstephens.local-e.nsw.gov.au/

Salvinia



Mother of Millions



Green Cestrum



Port Stephens COUNCIL
... a community partnership

Noxious Weeds List


Bitou Bush

This brochure contains a list of plants declared noxious for the Port Stephens Council area. There are five classes of noxious weeds with differing control requirements. Classes 1, 2 and 5 are notifiable weeds and new outbreaks must be reported to council.
Occupiers of land have obligations to control noxious weeds in accordance with the control requirements for the class the weed is in.
To report known or suspected noxious weeds and for information on controlling noxious weeds contact 49800392.


Chinese Violet


Lantana

Class 1 State Prohibited Plants
Control Requirements- The plant must be eradicated from the land and the land must be kept free of the plant.

Common name	**Scientific name**
Karoo Thorn	*Acacia karroo*
Prickly Acacia	*Acacia nilotica*
Pond Apple	*Annona glabra*
Chinese Violet	*Asystasia gangetica* subspecies *micrantha*
Kochia	*Bassia scoparia*
Spotted Knapweed	*Centaurea maculosa*
Black Knapweed	*Centaurea nigra*
Siam Weed	*Chromolaena odorata*
Rubbervine	*Cryptostegia grandiflora*
Anchored Water Hyacinth	*Eichhornia azurea*
Horsetail	*Equisetum* species
Senegal Tea Plant	*Gymnocoronis spilanthoides*
Hawkweed	*Hieracium species*
East Indian Hygrophila	*Hygrophila polysperma*
Hymenachne	*Hymenachne amplexicaulis*
Lagarosiphon	*Lagarosiphon major*
Yellow Burrhead	*Limnocharis flava*
Miconia	*Miconia* species
Mimosa	*Mimosa pigra*
Eurasian Water Milfoil	*Myriophyllum spicatum*
Mexican Feather Grass	*Nassella tenuissima*
Broomrapes	*Orobanche species except the native O. cernua variety australiana and O. minor*
Parthenium Weed	*Parthenium hysterophorus*
Water Lettuce	*Pistia stratiotes*
Water Soldier	*Stratiotes aloides*
Witchweed	*Striga species except native species and Striga parviflora*
Water Caltrop	*Trapa* species


Senegal Tea Plant


Horsetail


Water Lettuce

Class 5 Restricted Plants
Control Requirements- The requirements in the Noxious Weeds Act 1993 for a notifiable plant must be complied with (the plants must not be purchased, sold or moved without a written permit).

Common name	**Scientific name**
Espartillo	*Achnatherum brachychaetum*
Dodder	All *Cuscuta* species except the native species *C. australis, C. tasmanica* and *C. victoriana*
Oxalis	All Oxalis species and varieties except the native species *O. chnoodes, O. exilis, O. perennans, O. radicosa, O. rubens*, and *O. thompsoniae*
Onion Grass	All *Romulea* species and varieties except *R. rosea* var. *australis*
Annual Ragweed	*Ambrosia artemisiifolia*
Burr Ragweed	*Ambrosia confertiflor*a
Mexican Poppy	*Argemone mexicana*
Bridal Creeper	*Asparagus asparagoide*s
Sand Oat	*Avena strigosa*
Smooth-stemmed Turnip	*Brassica barrelieri* subspecies *oxyrrhina*
Cabomba	*Cabomba caroliniana*
Glaucous Star Thistle	*Carthamus glaucus*
Gallon's Curse	*Cenchrus biflorus*
Fine-bristled burr grass	*Cenchrus brownii*
Mossman River Grass	*Cenchrus echinatus*
Artichoke Thistle	*Cynara cardunculus*
Yellow Nutgrass	*Cyperus esculentus*
Leafy Elodea	*Egeria densa*
Clockweed	*Gaura lindheimeri*
Clockweed	*Gaura parviflora*
Texas Blueweed	*Helianthus ciliari*s
Lantana	*Lantana* species
Long-leaf Willow Primrose	*Ludwigia longifolia*
Red Rice	*Oryza rufipogon*
African Feather Grass	*Pennisetum macrourum*
Fountain Grass	*Pennisetum setaceum*
Soldier Thistle	*Picnomon acarna*
Arrowhead	*Sagittaria montevidensis*
Sagittaria	*Sagittaria platyphylla*
Willows	*Salix* species except *S. babylonica, S.* x *reichardtii, S.* x *calodendron*
Golden Thistle	*Scolymus hispanicu*s
African Turnip Weed	*Sisymbrium runcinatum*
African Turnip Weed	*Sisymbrium thellungii*
Corn Sowthistle	*Sonchus arvensis*
Cayenne Snakeweed	*Stachytarpheta cayennensis*
Athel Tree/Athel Pine	*Tamarix aphylla*


Long Leaf Willow-primrose

Notifiable plants in other parts of NSW. A person must not sell or purchase the plant, or any animal or thing which has on it or contains such plant material.

Common name	**Scientific name**
Mesquite	*Prosopis* species
Parkinsonia	*Parkinsonia aculeata*
Blue Hound's Tongue	*Cynoglossum creticum*
Cape Broom	*Genista monspessulana*
Gorse	*Ulex europaeus*

Annex C

Flora Species List (Gunninah Environmental Consultants 1997)

PROPOSED RESIDENTIAL DEVELOPMENT

NELSON BAY ROAD FERN BAY

APPENDIX 1

FLORA SPECIES RECORDED DURING PREVIOUS INVESTIGATIONS on the SUBJECT SITE and in the GENERAL VICINITY

Codes for Appendix 1

1	Species recorded throughout the study area
2	Species recorded on the Howship Holdings site
A	Clements *et al* 1992
B	Corkery & Co Pty Ltd 1988
C	Fanning & Clark 1993
D	NP&WS Wildlife Atlas within 10km of the study area (taken from the Newcastle 1:100 000 map sheet)
*	introduced species
#	Threatened species as listed in the *NSW Threatened Species Conservation Act 1995.*

Gunninah Environmental Consultants
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APPENDIX 1 Flora species recorded on the Howship Holdings site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
FILICOPSIDA		
Blechnaceae		
Blechnum indicum	A,B,C	●
Doodia aspera	B	●
Dennstaedtiaceae		
Hypolepis glandulifera	A	●
Pteridium esculentum	A,B,C	●
Polypodiaceae		
Pyrrosia confluens	A	●
Sinopteridaceae		
Cheilanthes sieberi	A	
Pellaea falcata	A	●
Thelypteridaceae		
Cyclosorus interruptus	A	●
MAGNOLIOPSIDA - DICOTYLEDONS		
Acanthaceae		
**Justica* sp	A	●
Aizoaceae		
Carpobrotus glaucescens	A,B,C	●
**Galenia pubescens*	A	●
Anacardiaceae		
Euroschinus falcata	A,B	●
Apiaceae		
Actinotus helianthi	A,B,C	●
Centella cordifolia	A	●
**Eryngium maritimum*	A	
Hydrocotyle algida	A	●
**Hydrocotyle bonariensis*	A	●
Platysace ericoides	A,B,C	●
Platysace lanceolata	A,C	●
Apocynaceae		
Parsonsia straminea	A,B	●
Asclepiadaceae		
**Gomphocarpus fruticosus*	A	●
Marsdenia sp	B	●
Asteraceae		
**Acanthospermum australe*	A	●
**Ambrosia tenuifolia*	A	●
**Aster subulatus*	A	●
Cassinia longifolia	A	
Chrysanthemoides monilifera	A,B,C	●
**Cirsium vulgare*	A	●
Conyza albida	A,C	●
**Conyza canadensis*	A	●
**Conyza parva*	A	●
Enydra fluctuans	A	●
**Erechtites valerianifolia*	A	●
**Gnaphalium americanum*	A	
Helichrysum diosmifolium	A	●
**Heterotheca grandiflora*	A	
Senecio bipinnatisectus	A	
**Senecio crassiflorus*	A	
Senecio hispidulus	A,C	●
Senecio sp E *aspargifolius*	A	●
Senecio lautus	A,B,C	●

APPENDIX 1 contd Flora species recorded on the site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
Asteraceae contd		
**Senecio madagascariensis*	A	●
**Sigesbekia orientalis*	A	●
Solenogyne bellioides	A	●
Vernonia cinerea	A	●
Xanthium occidentale	A	●
Bigoniaceae		
Pandorea pandorana	A,B	●
Brassicaceae		
**Cakile edentula*	A	
Cactaceae		
Opuntia stricta	C	
Campanulaceae		
Wahlenbergia stricta	A,B,C	●
Casuarinaceae		
Allocasuarina littoralis	A,B,C	●
Casuarina glauca	A,B	●
Chenopodiaceae		
Einadia hastata	A,C	
Convolvulaceae		
Calystegia marginata	A	●
Cuscula australis	A	●
Ipomoea sp	C	
Cucurbitaceae		
**Citrullus lanatus*	A	●
Cunoniaceae		
Ceratopetalum gummiferum	A	
Dilleniaceae		
Hibbertia acicularis	A	●
Hibbertia fasciculata	A,C	●
Hibbertia linearis	A,B,C	●
Hibbertia scandens	A,B	●
Droseraceae		
Drosera sp	B	●
Elaeocarpaceae		
Elaeocarpus obovatus	A	
Epacridaceae		
Brachyloma daphnoides	A,B,C	●
Leucopogon ericoides	A,B,C	●
Leucopogon parviflorus	A	●
Monotoca elliptica	A,B,C	●
Monotoca scoparia	A,B,C	●
Euphorbiaceae		
Amperea xiphoclada	A,B,C	●
Breynia oblongifolia	A,B,C	●
Glochidion ferdinandi	A,B	●
Omalanthus populifolius	A,B	●
Poranthera microphylla	A	●
Ricinocarpos pinifolius	A,B,C	●
Ricinus communis	C	
Fabaceae-Faboideae		
Aotus ericoides	A,B,C	●
Bossiaea ensata	A,B,C	●
Bossiaea heterophylla	A,B,C	●
Bossiaea rhombifolia	A,B,C	●

APPENDIX 1 contd Flora species recorded on the site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
Fabaceae-Faboideae contd		
Desmodium sp	B	●
Desmodium brachypodum	A	●
Desmodium rhytipophyllum	A	●
Desmodium varians	A	●
Dillwynia retorta	A,B,C	●
Glycine clandestina	A,B,C	●
Gompholobium latifolium	A,B,C	●
Hardenbergia violacea	A,B,C	●
Indigophora australis	A,B,C	●
Kennedia rubicunda	A,B,C	●
Viminaria juncea	A	●
Fabaceae-Mimosoideae		
Acacia sp	B	●
Acacia irrorata	A	●
Acacia longifolia	A,B,C	●
Acacia myrtifolia	B	●
Acacia sophorae	A,C	
Acacia suaveolens	A,B,C	●
Acacia ulicifolia	A,B,C	●
Goodeniaceae		
Dampiera stricta	A,B,C	●
Goodenia ovata	B	●
Haloragaceae		
Gonocarpus chinensis	A	●
Gonocarpus micranthus	A,C	●
Gonocarpus teucrioides	A,B,C	●
Lamiaceae		
Lycopus australis	A	●
Lauraceae		
Cassytha sp	B	●
Cassytha glabella	A,C	●
Cassytha pubescens	A,C	●
Endiandra sieberi	A,B,C	●
Lobeliaceae		
Lobelia alata	A	●
Pratia purpurascens	A	●
Loranthaceae		
Dendrophthoe vitellina	A	
Lythraceae		
Lythrum salicaria	A	●
Malvaceae		
Hibiscus trionum	A	●
Sida rhombifolia	A	
Meliaceae		
Dysoxylum fraserianum	A	
Menispermaceae		
Sarcopetalum harveyanum	A,B	●
Menyanthaceae		
Villarsia exaltata	A	●
Moraceae		
Ficus henneana	B	●
Maclura cochinchinensis	A,B	●
Myrsinaceae		
Rapanea howittiana	A	●
Rapanea variabilis	A,B	●

APPENDIX 1 contd Flora species recorded on the site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
Myrtaceae		
Acmena smithii	A,B	●
Angophora costata	A,B,C	●
Baeckea linearis	C	
Callistemon salignus	A,B	●
Calytrix tetragona	A	●
Eucalyptus acmenoides	A	
Eucalyptus gummifera	A,C	
Eucalyptus pilularis	A,B,C	●
Eucalyptus robusta	A,B,C	●
Leptospermum attenuatum	B,C	●
Leptospermum flavescens	B,C	●
Leptospermum juniperinum	A,C	●
Leptospermum laevigatum	A,B,C	●
Leptospermum polygalifolium	A	●
Leptospermum trinervium	A	●
Melaleuca linariifolia	A	●
Melaleuca nodosa	A,B,C	●
Melaleuca quinquenervia	A,B	●
Melaleuca sieberi	A	
Melaleuca styphelioides	A,B	●
Oleaceae		
Notelaea longifolia	A,B,C	●
Olax stricta	A	●
Onagraceae		
**Oenothera drummondii*	A	
**Oenothera mollissima*	A	
Oxalidaceae		
Oxalis sp aff *corniculata*	A,C	
Passifloraceae		
Passiflora herbertiana	A	●
Pittosporaceae		
Billardiera scandens	A,B	●
Citriobatus pauciflorus	B	●
Pittosporum revolutum	A,B	●
Polygalaceae		
Comesperma ericinum	A,C	●
Polygonaceae		
Muehlenbeckia gracillima	A	●
Persicaria decipiens	A	●
Persicaria strigosa	A	●
Proteaceae		
Banksia integrifolia	A,C	
Banksia serrata	A,B,C	●
Conospermum taxifolium	A,B,C	●
Persoonia lanceolata	B	●
Persoonia levis	A,C	●
Ranunculaceae		
Clemantis aristata	A,B	●
Rhamnaceae		
Alphitonia excelsa	A,B	●
Pomaderris ferruginea	A	●
Rosaceae		
**Rubus discolor*	A	●
Rubus parvifolius	A	
Rubiaceae		
Opercularia aspera	A	●
Pomax umbellata	A,B,C	●

APPENDIX 1 contd Flora species recorded on the site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
Rutaceae		
Acronychia oblongifolia	A	●
Zieria smithii	A	●
Santalaceae		
Exocarpos cupressiformis	A,C	●
Sapindaceae		
Cupaniopsis anacardioides	A	
Dodonaea triquetra	C	
Solanaceae		
Duboisia myoporoides	A,B	●
Solanum americanum	A	●
Thymelaeaceae		
Wilkstroemia indica	A,B	●
Verbenaceae		
Clerodendrum tomentosum	A,B	●
**Lantana camara*	A,B,C	●
Violaceae		
Viola hederaceae	A	●
Vitaceae		
Cayratia clematidea	A	●
Cissus antarctica	A,B	●
Cissus hypoglauca	B	●
MAGNOLIOPSIDA - MONOCOTYLEDONS		
Amaryllidaceae		
Crinum pedunculatum	A,B	●
Anthericaceae		
Tricoryne elatior	A,B	●
Araceae		
Alocasia macrorrhizos	A,B	●
Arecaceae		
Livistona australis	A,B	●
Commelinaceae		
Commelina cyanea	A	●
Cyperaceae		
Baumea articulata	A	●
Baumea rubiginosa	A	●
Baumea juncea	A	●
Carex appressa	A	●
Carex neurochlamys	A	●
Cladium procerum	A	●
**Cyperus dubius*	A	●
**Cyperus flavus*	A	●
Gahnia clarkei	A,B,C	●
Gahnia sieberiana	A	●
Isolepis nodosa	A	
Lepidosperma laterale	A,B	●
Lepidosperma urophorum	A	
Schoenus ericetorum	A,C	●
Iridaceae		
**Gladiolus gueinzii*	A	
Juncaceae		
Juncus pallidus	A	
Juncus polyanthemus	A	
Juncus prismatocarpus	A	●

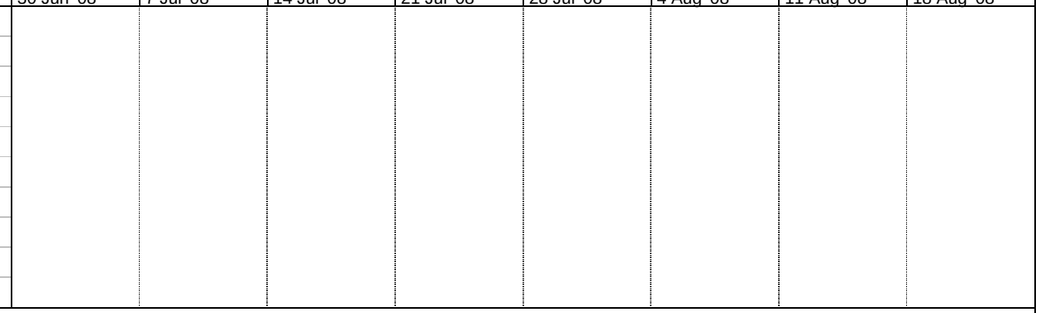
APPENDIX 1 contd Flora species recorded on the site at Fern Bay and in the vicinity.

SPECIES NAME	1	2
Juncaginaceae		
Triglochin procera	A	●
Lomandraceae		
Lomandra longifolia	A,B,C	●
Orchidaceae		
Acianthus sp.	A,B,C	●
Caladenia alba	B,C	●
#*Diurus* sp 5	D	
Pterostylis acuminata	A	●
Pterostylis longifolia	B	●
Pterostylis nutans	B	●
Philesiaceae		
Eustrephus latifolius	A	●
Geitonoplesium cymesum	A	●
Phormiaceae		
Dianella caerulea	A,B,C	●
Poaceae		
Andropogon virginicus	A	●
Axonopus affinis	A	●
**Chloris virgata*	A	
Cymbopogon refractus	A	●
Cynodon dactylon	A	●
Danthonia tenuior	A	
Dichelachne micrantha	A	●
Dichelachne crinita	A	
Digitaria parviflora	A	●
Echinopogon sp	B	●
**Ehrharta erecta*	A	
Entolasia marginata	A	●
Entolasia stricta	A,C	●
Eragrostis brownii	A,C	●
**Eragrostis curvula*	A	
Hemarthria uncinata	A	●
Imperata cylindrica	A,B,C	●
Isachne globosa	A	●
Oplismenus aemulus	A	●
Oplismenus imbecillis	A,B	●
Panicum bisulcatum	A	●
**Panicum maximum*	A	●
Paniculum simile	A	
Paspalidium distans	A	●
**Paspalum orbiculare*	A	●
Phragmites australis	A,B	●
**Setaria viridis*	A	●
Spinifex sericeus	A	
Sporobolus elongatus	A	●
**Stenotaphrum secundatum*	A	●
Themeda australis	A,B,C	●
Restionaceae		
Leptocarpus tenax	B	●
Restio pallens	A,C	●
Restio tetraphyllus	A,B,C	●
Smilacaceae		
Smilax australis	A,B	●
Smilax glyciphylla	A,B	●
Tremandraceae		
#*Tetratheca juncea*	D	
Typhaceae		
Typha orientalis	A	●
Zannichelliaceae		
#*Zannichellia palustris*	D	

Annex D

Indicative Work Program

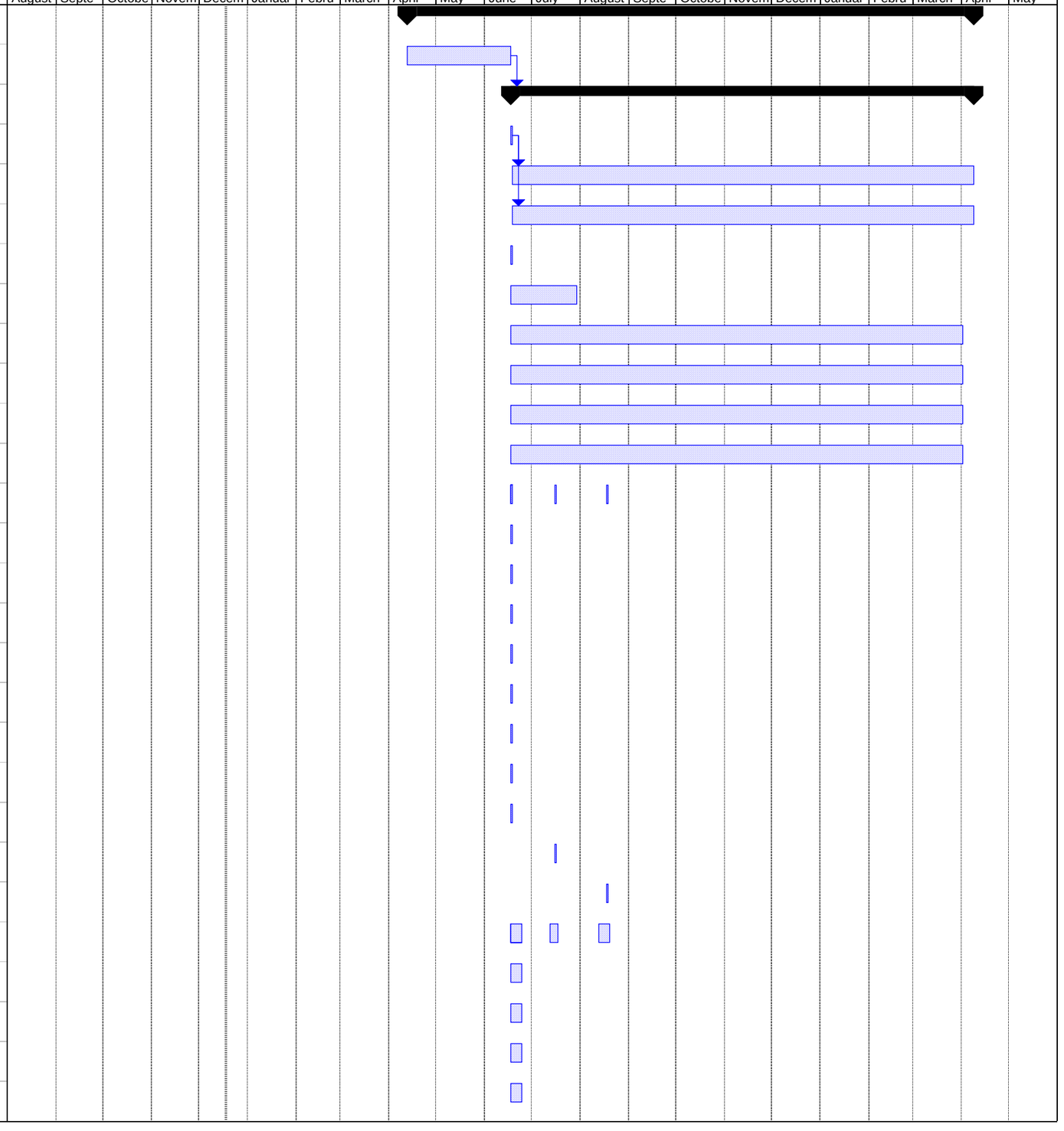
ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**Community Lands Environmental Management Plan**	**33 days**	**Mon 2/03/09**	**Wed 15/04/09**		
2	Project Start	0 days	Mon 2/03/09	Mon 2/03/09		
3	**Pre Construction Management Measures for each Stage**	**33 days**	**Mon 2/03/09**	**Wed 15/04/09**	**2**	
4	Boundary identification and demarcation	3 days	Mon 2/03/09	Wed 4/03/09		
5	Identification of habitat trees	5 days	Thu 5/03/09	Wed 11/03/09	4	
6	Pre clearance surveys of hollow bearing trees ahead of clearing	5 days	Thu 12/03/09	Wed 18/03/09	5	
7	Seed collection	5 days	Thu 12/03/09	Wed 18/03/09	5	
8	Contractor guidleline development	5 days	Thu 12/03/09	Wed 18/03/09	5	
9	Weed removal	10 days	Thu 19/03/09	Wed 1/04/09	8	
10	Regeneration works	20 days	Thu 19/03/09	Wed 15/04/09	8	



Project: Pre Construction Measures to apply to each development stage
Date: Wed 17/12/08

Task
Split
Progress
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External Tasks
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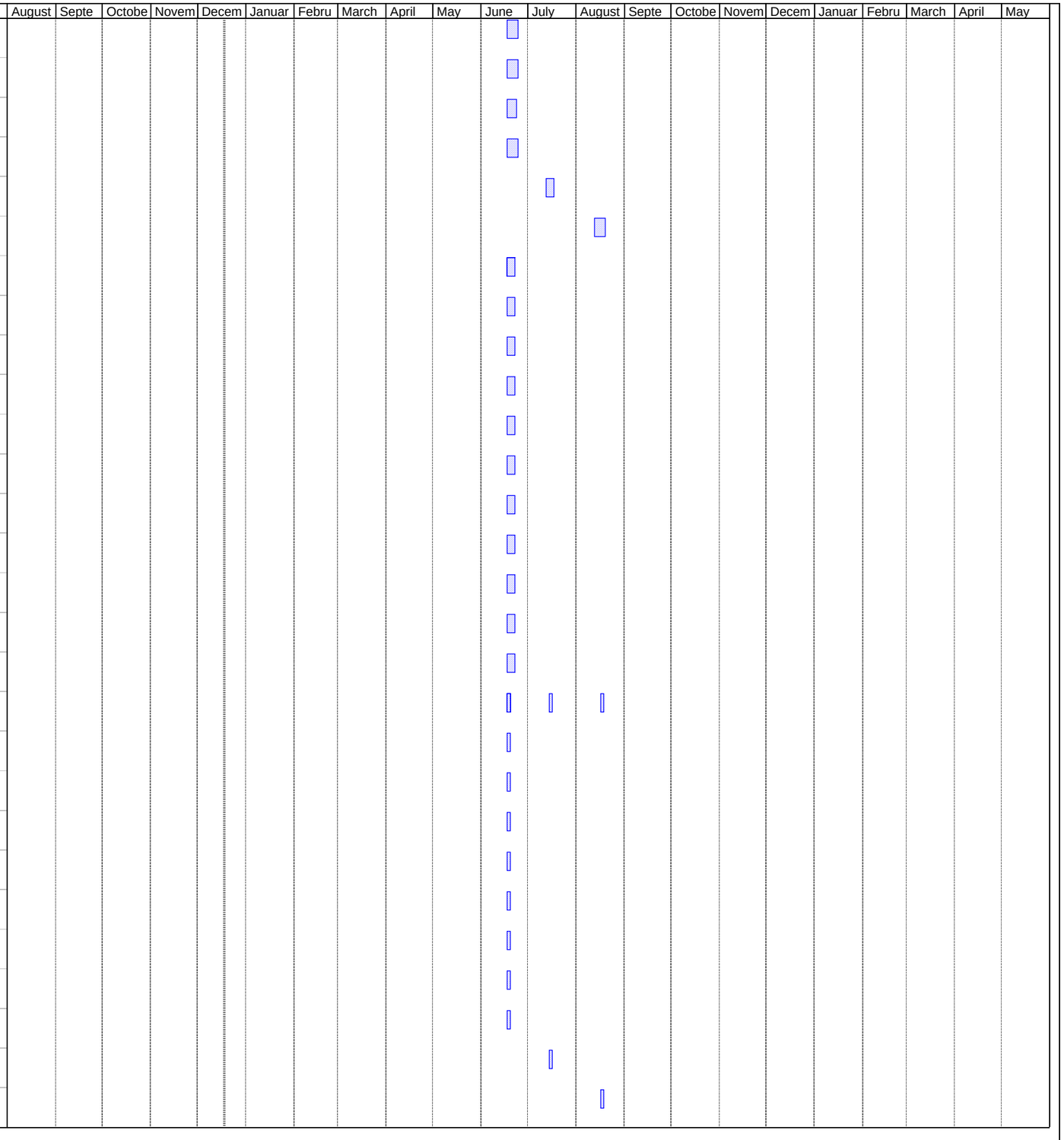
ID	Task Name	Duration	Start	Finish	Predecessors
1	**Community Lands Environmental Management Plan**	**259 days**	**Mon 13/04/09**	**Thu 8/04/10**	
2	Construction start	48 days	Mon 13/04/09	Wed 17/06/09	
3	**Construction Measures for each stage**	**211 days**	**Thu 18/06/09**	**Thu 8/04/10**	**2**
4	Environmental inductions	1 day	Thu 18/06/09	Thu 18/06/09	
5	Temporary fencing	210 days	Fri 19/06/09	Thu 8/04/10	4
6	Erosion and sediment control measures	210 days	Fri 19/06/09	Thu 8/04/10	4
7	Installation of wildlife signs	1 day	Thu 18/06/09	Thu 18/06/09	
8	Tree clearing	30 days	Thu 18/06/09	Wed 29/07/09	
9	Release of wildlife from areas of clearing to conserva	206 days	Thu 18/06/09	Thu 1/04/10	
10	Stockpile management	206 days	Thu 18/06/09	Thu 1/04/10	
11	Re-establishment of vegetative cover	206 days	Thu 18/06/09	Thu 1/04/10	
12	Establishment of open space / reserve - vegetation p	206 days	Thu 18/06/09	Thu 1/04/10	
13	**Waste Removal - as required**	**44 days**	**Thu 18/06/09**	**Tue 18/08/09**	
14	Waste Removal - Month 1	1 day	Thu 18/06/09	Thu 18/06/09	
15	Waste Removal 2	1 day	Thu 18/06/09	Thu 18/06/09	
16	Waste Removal 3	1 day	Thu 18/06/09	Thu 18/06/09	
17	Waste Removal 4	1 day	Thu 18/06/09	Thu 18/06/09	
18	Waste Removal 5	1 day	Thu 18/06/09	Thu 18/06/09	
19	Waste Removal 6	1 day	Thu 18/06/09	Thu 18/06/09	
20	Waste Removal 7	1 day	Thu 18/06/09	Thu 18/06/09	
21	Waste Removal 8	1 day	Thu 18/06/09	Thu 18/06/09	
22	Waste Removal 9	1 day	Thu 16/07/09	Thu 16/07/09	
23	Waste Removal 10	1 day	Tue 18/08/09	Tue 18/08/09	
24	**Weed Management - as required**	**45 days**	**Thu 18/06/09**	**Wed 19/08/09**	
25	Weed Management 1	5 days	Thu 18/06/09	Wed 24/06/09	
26	Weed Management 2	5 days	Thu 18/06/09	Wed 24/06/09	
27	Weed Management 3	5 days	Thu 18/06/09	Wed 24/06/09	
28	Weed Management 4	5 days	Thu 18/06/09	Wed 24/06/09	



Project: Construction Measures.mpp
Date: Thu 18/12/08

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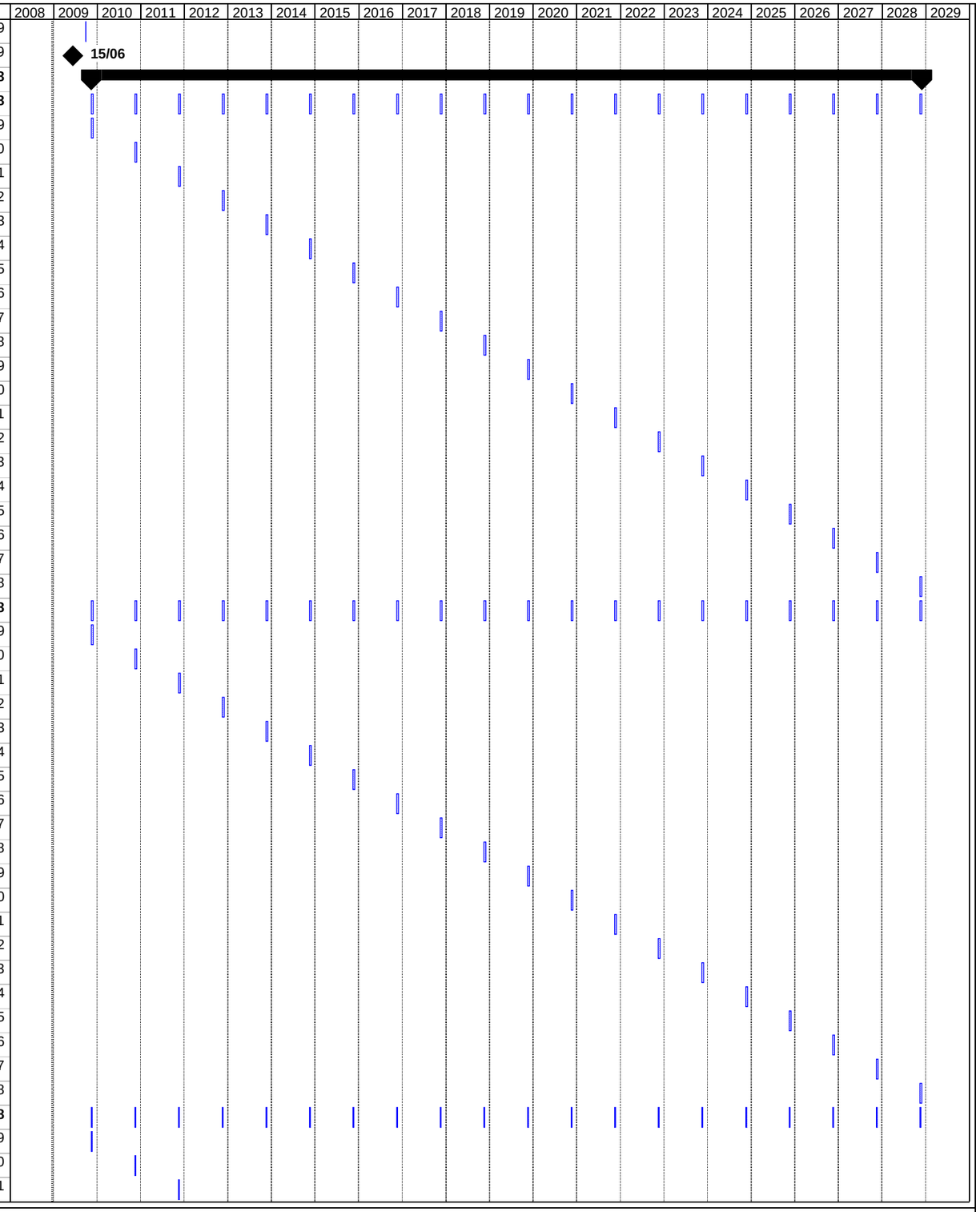
ID	Task Name	Duration	Start	Finish	Predecessors
29	Weed Management 5	5 days	Thu 18/06/09	Wed 24/06/09	
30	Weed Management 6	5 days	Thu 18/06/09	Wed 24/06/09	
31	Weed Management 7	4 days	Thu 18/06/09	Tue 23/06/09	
32	Weed Management 8	5 days	Thu 18/06/09	Wed 24/06/09	
33	Weed Management 9	5 days	Mon 13/07/09	Fri 17/07/09	
34	Weed Management 10	5 days	Thu 13/08/09	Wed 19/08/09	
35	**Regeneration - as required**	**3 days**	**Thu 18/06/09**	**Mon 22/06/09**	
36	Regeneration Month 1	3 days	Thu 18/06/09	Mon 22/06/09	
37	Regeneration Month 2	3 days	Thu 18/06/09	Mon 22/06/09	
38	Regeneration Month 3	3 days	Thu 18/06/09	Mon 22/06/09	
39	Regeneration Month 4	3 days	Thu 18/06/09	Mon 22/06/09	
40	Regeneration Month 5	3 days	Thu 18/06/09	Mon 22/06/09	
41	Regeneration Month 6	3 days	Thu 18/06/09	Mon 22/06/09	
42	Regeneration Month 7	3 days	Thu 18/06/09	Mon 22/06/09	
43	Regeneration Month 8	3 days	Thu 18/06/09	Mon 22/06/09	
44	Regeneration Month 9	3 days	Thu 18/06/09	Mon 22/06/09	
45	Regeneration Month 10	3 days	Thu 18/06/09	Mon 22/06/09	
46	**Placement of dead wood - as available**	**44 days**	**Thu 18/06/09**	**Tue 18/08/09**	
47	Placement of dead wood 1	2 days	Thu 18/06/09	Fri 19/06/09	
48	Placement of dead wood 2	2 days	Thu 18/06/09	Fri 19/06/09	
49	Placement of dead wood 3	2 days	Thu 18/06/09	Fri 19/06/09	
50	Placement of dead wood 4	2 days	Thu 18/06/09	Fri 19/06/09	
51	Placement of dead wood 5	2 days	Thu 18/06/09	Fri 19/06/09	
52	Placement of dead wood 6	2 days	Thu 18/06/09	Fri 19/06/09	
53	Placement of dead wood 7	2 days	Thu 18/06/09	Fri 19/06/09	
54	Placement of dead wood 8	2 days	Thu 18/06/09	Fri 19/06/09	
55	Placement of dead wood 9	2 days	Wed 15/07/09	Thu 16/07/09	
56	Placement of dead wood 10	2 days	Mon 17/08/09	Tue 18/08/09	



Project: Construction Measures.mpp
Date: Thu 18/12/08

Task
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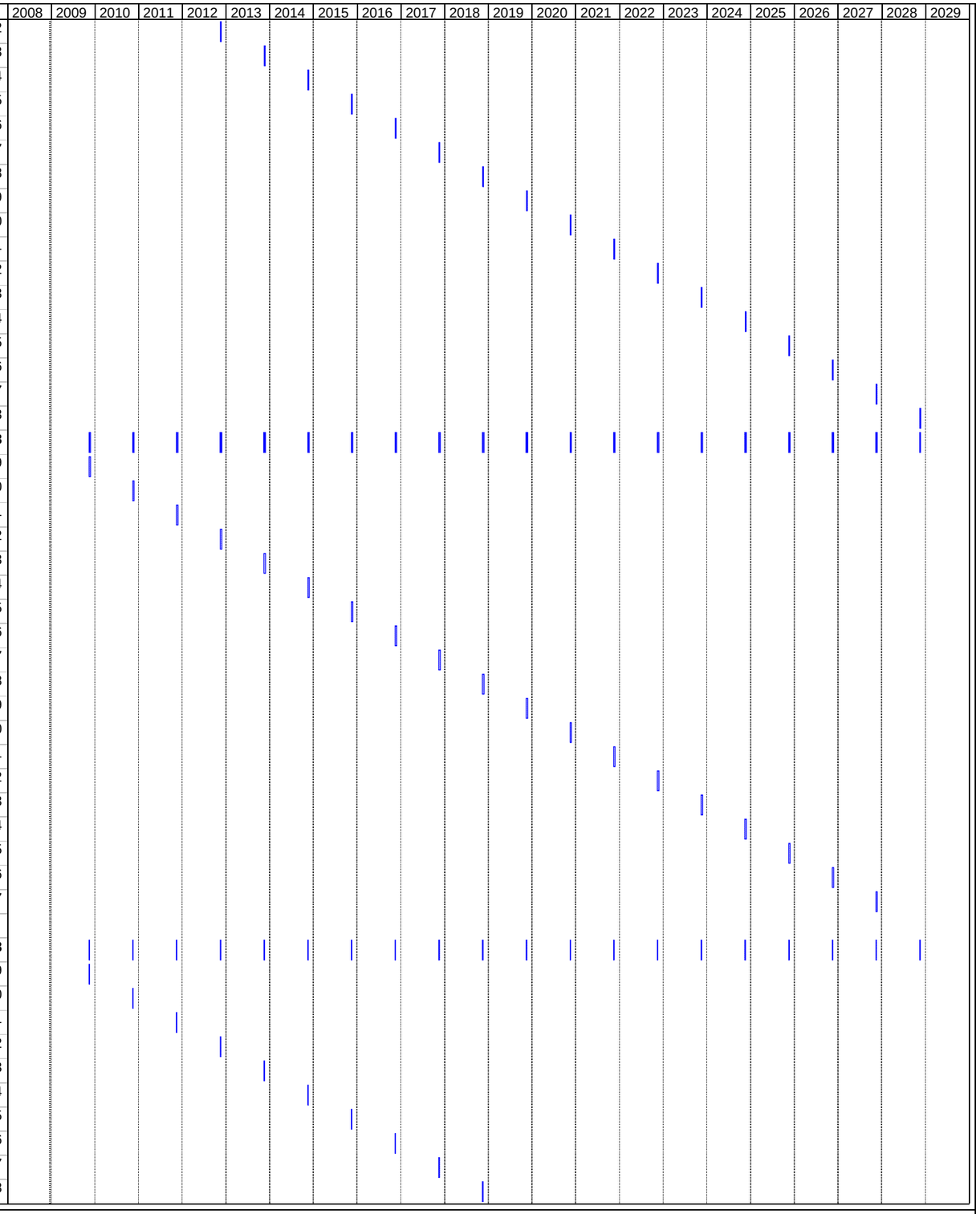
ID	Task Name	Duration	Start	Finish
1	Community Lands Environmental Management Plan	1 day	Thu 1/10/09	Thu 1/10/09
2	Post Construction start	0 days	Mon 15/06/09	Mon 15/06/09
3	**Post Construction Measures following each stage**	**4970 days**	**Mon 16/11/09**	**Fri 1/12/28**
4	**Yearly Weed Management**	**4970 days**	**Mon 16/11/09**	**Fri 1/12/28**
5	Yearly Weed Management 1	12 days	Mon 16/11/09	Tue 1/12/09
6	Yearly Weed Management 2	12 days	Tue 16/11/10	Wed 1/12/10
7	Yearly Weed Management 3	12 days	Wed 16/11/11	Thu 1/12/11
8	Yearly Weed Management 4	12 days	Fri 16/11/12	Mon 3/12/12
9	Yearly Weed Management 5	12 days	Mon 18/11/13	Tue 3/12/13
10	Yearly Weed Management 6	12 days	Mon 17/11/14	Tue 2/12/14
11	Yearly Weed Management 7	12 days	Mon 16/11/15	Tue 1/12/15
12	Yearly Weed Management 8	12 days	Wed 16/11/16	Thu 1/12/16
13	Yearly Weed Management 9	12 days	Thu 16/11/17	Fri 1/12/17
14	Yearly Weed Management 10	12 days	Fri 16/11/18	Mon 3/12/18
15	Yearly Weed Management 11	12 days	Mon 18/11/19	Tue 3/12/19
16	Yearly Weed Management 12	12 days	Mon 16/11/20	Tue 1/12/20
17	Yearly Weed Management 13	12 days	Tue 16/11/21	Wed 1/12/21
18	Yearly Weed Management 14	12 days	Wed 16/11/22	Thu 1/12/22
19	Yearly Weed Management 15	12 days	Thu 16/11/23	Fri 1/12/23
20	Yearly Weed Management 16	12 days	Mon 18/11/24	Tue 3/12/24
21	Yearly Weed Management 17	12 days	Mon 17/11/25	Tue 2/12/25
22	Yearly Weed Management 18	12 days	Mon 16/11/26	Tue 1/12/26
23	Yearly Weed Management 19	12 days	Tue 16/11/27	Wed 1/12/27
24	Yearly Weed Management 20	12 days	Thu 16/11/28	Fri 1/12/28
25	**Revegetation / Rejuvenation**	**4970 days**	**Mon 16/11/09**	**Fri 1/12/28**
26	Revegetation / Rejuvenation 1	12 days	Mon 16/11/09	Tue 1/12/09
27	Revegetation / Rejuvenation 2	12 days	Tue 16/11/10	Wed 1/12/10
28	Revegetation / Rejuvenation 3	12 days	Wed 16/11/11	Thu 1/12/11
29	Revegetation / Rejuvenation 4	12 days	Fri 16/11/12	Mon 3/12/12
30	Revegetation / Rejuvenation 5	12 days	Mon 18/11/13	Tue 3/12/13
31	Revegetation / Rejuvenation 6	12 days	Mon 17/11/14	Tue 2/12/14
32	Revegetation / Rejuvenation 7	12 days	Mon 16/11/15	Tue 1/12/15
33	Revegetation / Rejuvenation 8	12 days	Wed 16/11/16	Thu 1/12/16
34	Revegetation / Rejuvenation 9	12 days	Thu 16/11/17	Fri 1/12/17
35	Revegetation / Rejuvenation 10	12 days	Fri 16/11/18	Mon 3/12/18
36	Revegetation / Rejuvenation 11	12 days	Mon 18/11/19	Tue 3/12/19
37	Revegetation / Rejuvenation 12	12 days	Mon 16/11/20	Tue 1/12/20
38	Revegetation / Rejuvenation 13	12 days	Tue 16/11/21	Wed 1/12/21
39	Revegetation / Rejuvenation 14	12 days	Wed 16/11/22	Thu 1/12/22
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44	Revegetation / Rejuvenation 19	12 days	Tue 16/11/27	Wed 1/12/27
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46	**Maintenance of APZ's**	**4964 days**	**Mon 16/11/09**	**Thu 23/11/28**
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48	Maintenance of APZ's 2	6 days	Tue 16/11/10	Tue 23/11/10
49	Maintenance of APZ's 3	6 days	Wed 16/11/11	Wed 23/11/11



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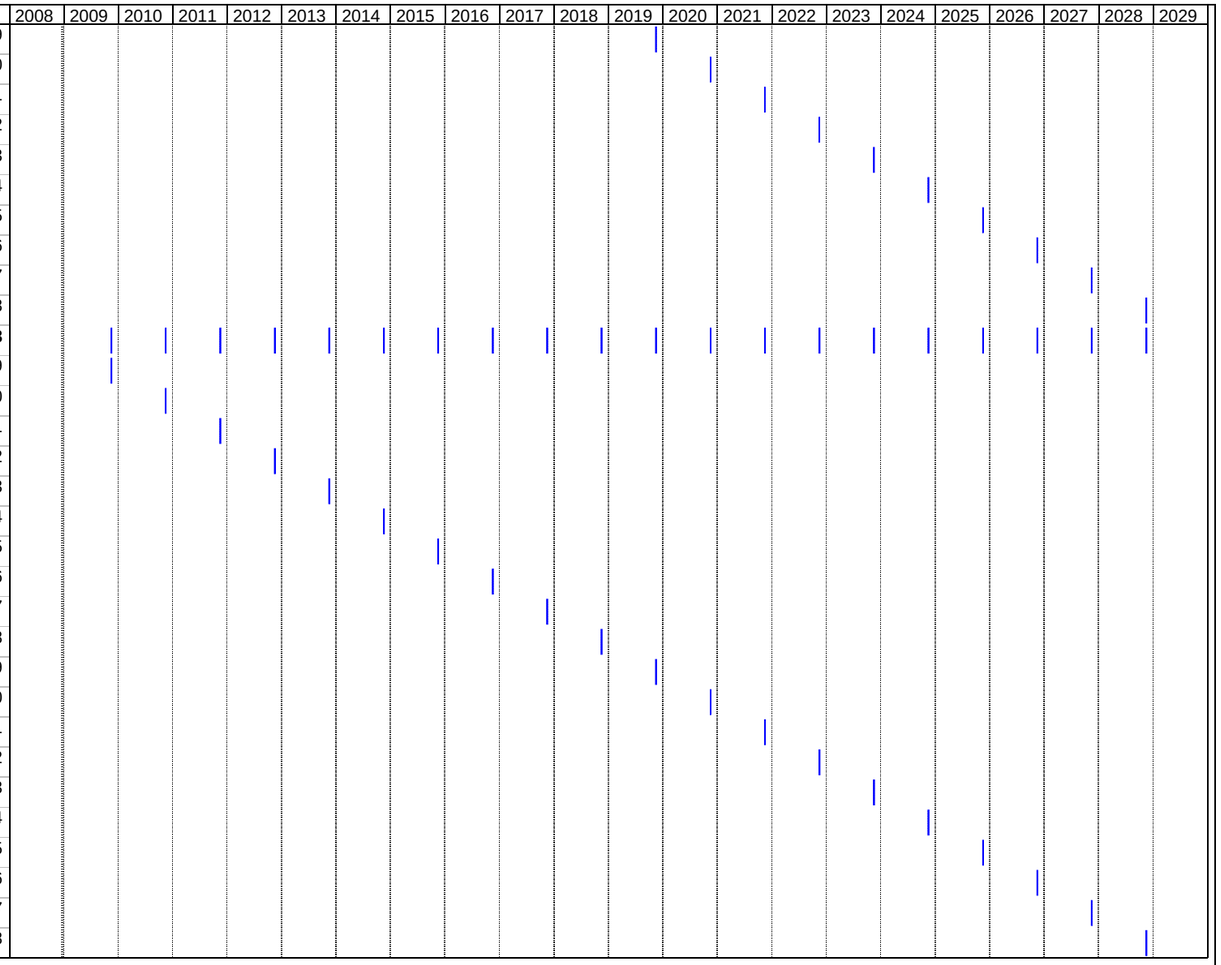
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55	Maintenance of APZ's 9	6 days	Thu 16/11/17	Thu 23/11/17
56	Maintenance of APZ's 10	6 days	Fri 16/11/18	Fri 23/11/18
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66	Maintenance of APZ's 20	6 days	Thu 16/11/28	Thu 23/11/28
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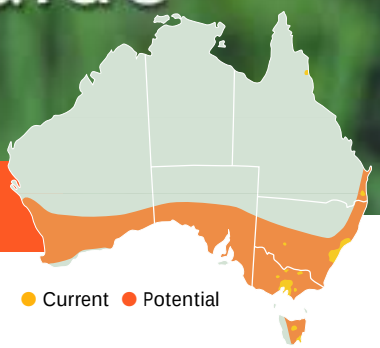
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Annex E

Weed Profiles and Fact Sheet

Weed Management Guide

Alligator weed –
Alternanthera philoxeroides



Alligator weed (*Alternanthera philoxeroides*)

The problem

Alligator weed is a *Weed of National Significance.* It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts. It is an especially troublesome weed because it invades both land and water, and is very hard to control.

When growing on land it displaces other more favourable plants such as crops or native vegetation, and can be harmful to animals. When growing in fresh water, alligator weed can cover the entire water surface, preventing flow, blocking up drainage channels and potentially increasing flood damage. Weed mats can also reduce oxygen exchange, affecting instream plants and animals and reducing water quality.

Alligator weed caused the failure of small crop and turf farms in parts of the lower Hunter region in New South Wales. Another infestation, in Barren Box Swamp, would have cost irrigation farmers in the Murrumbidgee Irrigation Area up to $250 million annually if left unchecked. So far, more than $3 million has been spent controlling this infestation alone.

The weed

Alligator weed can grow with roots embedded in the bank or on the bottom of shallow water bodies, or float freely on the water surface. It spreads its leaves across the water surface, forming dense mats. The long spreading stems are hollow, helping it to float. The roots are thin and stringy, and trail in the water from the joints between plant segments (the nodes).



Infestations can take over wetlands such as creeks and drainage channels and spread onto adjacent land.
Photo: Graham Prichard

When growing on land alligator weed is quite different in structure. The stems are shorter and barely hollow. Reddish-brown tap roots can reach depths exceeding 500 mm.

Whether it grows in water or on land, the shiny, dark green leaves occur in opposite pairs along the stem. The leaves are 20–70 mm long and 5–40 mm wide, with smaller veins almost perpendicular to a characteristic mid-line along the length of the leaf. The silvery-white flower is small (12–14 mm wide) and papery, with a short stalk growing from either the axil (where the leaf joins the stem) or the very end of the stem.

Key points

- Alligator weed poses a significant economic and environmental threat.
- It can grow in water or on land, and has been mistakenly grown in the past as a food.
- Prevention is the most cost-effective form of weed control. Quarantine, early detection and good hygiene within infestations will prevent its spread.
- Mechanical and chemical control, integrated with biological control, is effective on established aquatic growth forms.
- However, care must be taken because it spreads easily from fragments.
- Ongoing follow-up control will be required.

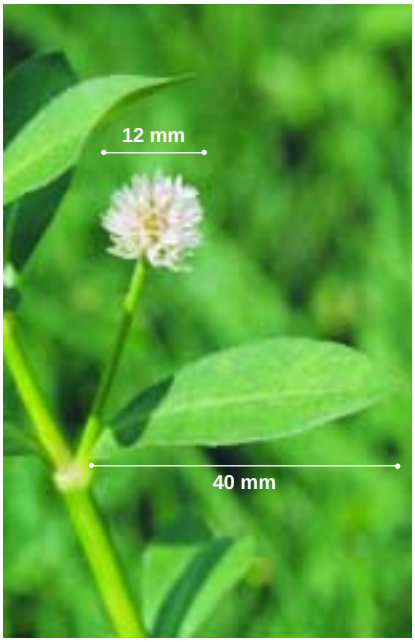
Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Growth calendar

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
New growth									■	■	■	
Active growth	■	■	■						■	■	■	■
Flowering	■	■	■									
Seed formation	No viable seed yet found in Australia											
Seed drop												
Germination												

■ General growth pattern

Growth in alligator weed commences during spring and continues in the warmer weather. New stems formed in spring grow quickly during summer, producing flowers by mid-summer. Flowering continues until the weather becomes cooler and the days shorter. In cooler climates leaves drop off and frost kills off most of the exposed vegetation during winter. However, some roots, rhizomes and protected stems survive and recommence growth during the following spring.



Silvery-white flowers are borne on short stalks during mid-summer.
Photo: Colin G. Wilson

How it spreads

Alligator weed does not produce viable seed in Australia, although it can in its native range. It spreads in Australia through vegetative reproduction, when fragments containing at least one node are moved from one place to another and take root in suitable habitat. It is commonly spread downstream when the plant is broken up into smaller fragments (eg by floods, or following mechanical or chemical control). Movement between river catchments is most commonly due to human activities. It has been spread in garden mulch and landfill, and attached to machinery and vehicles (eg bulldozers, trailers, boats and other watercraft). Animals may also spread the fragments (eg by transport of nesting material by ducks or in cows' hooves).



In water fine roots grow from the nodes.
Photo: Rebecca Coventry

It is believed that alligator weed first reached Australia near Newcastle in the 1940s in ballast. It has since spread to infest many waterways in New South Wales, including the lower Hunter region, Barren Box Swamp, the Sydney region, Griffith, Albury (which threatens the Murray River) and infestations in Brisbane, Cairns and Canberra.

Where it grows

One of the reasons that alligator weed poses such a dramatic threat is its ability to live in both aquatic and terrestrial habitats. It can tolerate brackish (slightly salty) water but thrives in nutrient-rich water. Ideal terrestrial habitats include places that are regularly inundated or that have high rainfall or irrigation. Alligator weed can survive in tropical and sub-tropical regions such as Darwin and Brisbane, and also cooler climates such as Victoria and Tasmania where the survival of some stems and rhizomes over winter allows it to regenerate during the warmer months.

Alligator weed is native to temperate regions of South America, especially Argentina. It is now found as a serious weed throughout tropical and warm-temperate regions, including the US, China, India, South-East Asia and New Zealand.

Potential distribution

The potential range of alligator weed, based on climate, includes waterways throughout most of southern Australia, extending south from Bundaberg in Queensland, through New South Wales, Victoria, Tasmania and South Australia, and north to Kalbarri in Western Australia. However, a different model predicts that alligator weed could also survive in the tropics, which may explain an infestation surviving in Cairns.

What to do about it?

Early detection is most cost-effective

Alligator weed has rarely, if ever, been successfully eradicated once it has infested a water body, despite numerous costly attempts. For this reason, the highest priority for the management of alligator weed in Australia is an effective system of early detection and eradication before infestations become established.



In the past alligator weed was mistaken as a traditional Sri Lankan herb and planted in gardens around Australia.
Photo: Lalith Gunasekera

The success of an early detection and eradication program depends on:

- maintenance of quarantine to prevent further introductions
- enhanced awareness and education to reduce the risk of spread
- the identification and monitoring of high-risk sites
- adherence to weed hygiene protocols (eg not removing material from infestations, carefully washing down equipment after contact with alligator weed)
- coordination between stakeholders and local and state/territory governments.

Some successes with small infestations

Much of this work is ongoing but significant inroads have recently been made. For example, alligator weed was being cultivated in backyards and mistakenly used in traditional Sri Lankan cooking instead of another herb known as 'mukunewenna' or 'pononcarni'. A campaign was initiated to educate the Sri Lankan community about the dangers of alligator weed, to eradicate infestations and to replace it with a less weedy species. In Victoria 784 backyard infestations were identified following an awareness campaign that included newspaper articles, radio segments, leaflets and fridge magnets. By working closely with the Sri Lankan community, the infestations have been controlled via repeated herbicidal treatments. An Australian native species, common joy weed *Alternanthera denticulata*, has been accepted as a suitable replacement.

Don't try and treat alligator weed on your own

The successful control of alligator weed in backyard situations has been achieved using the considerable experience and resources of local councils and state/territory weed management agencies. However, there is still much that is unknown about alligator weed. For example, the effectiveness of different herbicides in different environments is still being examined. For these reasons, and because it can spread so easily from small fragments, you must contact your local council or state/territory weed management agency to help you control alligator weed.



In aquatic situations the hollow stem helps floatation.
Photo: Rebecca Coventry

It is extremely difficult to control alligator weed in aquatic situations

In some aquatic habitats, alligator weed infestations can be reduced with weed harvesters or by manual removal, but small fragments are inevitably left behind or dislodged. These fragments readily create new infestations. Therefore, any living plant material must be very carefully disposed of to prevent further spread.

In water alligator weed can be treated with a registered herbicide. However, this rarely kills the entire plant, which often breaks up into smaller pieces. These smaller pieces can drift downstream and lead to new infestations. Additionally, there are restrictions on the use of herbicides in waterways, including concerns about impacts to non-target plants and the environmental health of waterways.

Therefore, both the chemical and mechanical control of alligator weed in aquatic habitats is extremely difficult and can lead to further downstream infestations.



Alligator weed has an extensive root system when growing on land.
Photo: Graham Prichard

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control alligator weed and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed directly onto water.

…and on land

When it grows on land, alligator weed can be controlled with repeated herbicide treatments. The Queensland Department of Natural Resources and Mines suggests three treatments during the growing season, each consisting of two applications separated by one week. Ideally, the last treatment should be undertaken close to the start of winter to target the rhizomes, which would otherwise allow the weed to survive through winter.

However, there are problems in this approach, including concerns about using herbicides near waterways, expense, and the difficulty of targeting alligator weed when other desirable species are also present.

Physical removal is also difficult because of the depth that roots and rhizomes can reach. It is recommended that all weed material be removed to a depth of one metre, and then be disposed of by deep burial. This is obviously a difficult and time-consuming task requiring mechanical assistance.



Flowering alligator weed in paddocks of the Lower Hunter, NSW, in February.
Photo: Mic Julien

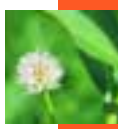


Adult biocontrol agents (the alligator weed flea beetle *Agasicles hygrophila*) feed on leaves and stems.
Photo: Graham Prichard

Biological control can help manage alligator weed

Three insects have been released in Australia to control alligator weed. The aquatic alligator weed flea beetle *Agasicles hygrophila*, has been quite successful in controlling alligator weed growing in the water. It was first released in 1977 in New South Wales. The adults and larvae reduce the growth of alligator weed by feeding on the underside of the leaves and aerial parts of the plant.

Unfortunately, biological control does not yet offer a cure to the alligator weed problem. The flea beetle is only effective in warm, temperate areas that allow it to breed up to high numbers in early summer, and it does not attack alligator weed growing on land. Therefore, the search continues for new biological control agents in alligator weed's native range, particularly for agents to control the weed in cooler climates and when it grows on land.





Mechanical removal of alligator weed requires careful hygiene to prevent the spread of small fragments.
Photo: Brian Worboys

Given the difficulties and expense associated with chemical and mechanical control, biological control agents are an attractive option to tackle alligator weed in the long term. However, biological control is a complex process, requiring success at a number of separate stages. Once identified, suitable agents must be approved for release, reared in captivity and then become established in the field. The hope for future biological control agents must therefore be balanced by the possibility that they may not be available or successful.

Legislation

In all states and territories, landholders are obliged by law to control or eradicate alligator weed and to limit its spread and impacts. Most regions restrict its importation. Check with your local council or state/territory government agency about its requirements for alligator weed control.

Acknowledgments

Information and guide revision: Mic Julien (CSIRO/Weeds CRC), Rebecca Coventry (NSW Dept of Agriculture), Richard Carter (NSW Dept of Agriculture/ Weeds CRC), John Wilson (CSIRO/Weeds CRC), Nimal Chandrasena (Sydney Water), Andrew Storrie (NSW Dept of Agriculture/ Weeds CRC) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.

...case study

Integrated management of alligator weed in Botany Wetlands in Sydney

Sydney Water provides drinking water and wastewater services to over four million people in the Sydney, Blue Mountains and Illawarra areas, including the Botany Wetlands which are situated within the metropolitan area of Sydney.

The Botany Wetlands are ecologically and aesthetically significant, but are also historically important as they served as a drinking water supply for Sydney in the mid 1800s. Alligator weed was first noted in waterways around 1985, but only occasionally treated with herbicides until the mid 1990s, by which time the infestation was out of control and posed a significant threat to the wetlands.

Sydney Water has since introduced an integrated weed management approach to deal with alligator weed. This combines vigilant and systematic monitoring for any new infestations, with regular application of suitable herbicides for both terrestrial and aquatic infestations and manual removal of floating masses. Other active management strategies include the lowering of water levels to allow better control, the large scale planting of native water plants in treated areas, and the controlled burning of sedges and rushes in selected infested areas. Additionally, in order to minimise environmental damage from chemicals, herbicides are not applied when the biological control agents are most active.

In terms of actual control efforts, herbicides are applied as spot-treatments to persistent patches at monthly intervals during cooler months, and more frequently in the warmer months (September–May). New infestations are treated with herbicides or are removed by hand picking as soon as practicable, with the ultimate aim of preventing further downstream spread. Disposal of collected live plant material is by burial in the sand in selected locations, following drying and herbicide treatment.

It is estimated that, on average, 90–95% of the previous alligator weed infestation has been controlled and removed since the adoption of the new integrated management plan in 1997. Although this is a relatively successful result, the inability to completely eradicate the weed from the wetlands reflects its resilience to current control measures and its ability to spread even when being carefully managed. It must also be recognised that the current gains made on alligator weed in the Botany Wetlands have been achieved through diligent and committed action, continual assessment, persistent management intervention and investment of labour and other resources.



Impacts of alligator weed include flooding due to blocked drains.
Photo: Rebecca Coventry



How to control alligator weed

Quick reference guide

Preventing spread

The main aim of alligator weed management in Australia is to prevent its spread from core infestations into new areas by:

- preventing new plant material entering Australia
- using weed hygiene protocols, such as washing contaminated equipment
- educating people to recognise it and respond to outbreaks.

The importance of monitoring

Early detection offers the only likelihood of finding infestations that are small enough to hope to eradicate. Monitoring of likely areas is therefore crucial to successful alligator weed management.

The limitations of current control techniques

Available management techniques for controlling alligator weed include:

- mechanical (eg weed harvesters in water bodies)
- physical (eg digging all material out to a depth of one metre)
- chemical (several herbicides registered for use on land or water)
- biological (eg the flea beetle attacks alligator weed growing in water).

Unfortunately each of these techniques has its limitations. Mechanical, physical and chemical control can all leave small fragments behind and actually increase the spread of alligator weed. These techniques therefore require a great deal of care and should only be conducted with the assistance of experts.

Other issues with these techniques include expense, the intensity of work required (eg spraying land infestations requires three treatments of two sprayings each), concern over residual herbicides in and around waterways and effects on non-target plants and animals, the difficulty of disposing of collected material and the need for continual follow-up work.



This simple screen has effectively prevented the spread of alligator weed into nearby wetlands. Photo: Graham Prichard



Control options

Type of infestation	Best way to control
Backyard infestations	Backyard infestations should be reported to your local council or state/territory weed management agency. Herbicides have been used successfully in different regions, but will require many repeated treatments. Care must be taken to prevent the spread of weed through fragments escaping from the garden.
In a waterway	Alligator weed in waterways should be reported to your local council or state/territory weed management agency. Herbicides are most effective when above water vegetation is greatest. Manual or mechanical removal may also be possible. If not already present, flea beetles should be introduced. Integration of all of these techniques will ultimately provide the best results.
On land	Alligator weed on land should be reported to your local council or state/territory weed management agency. Effective herbicides are available; however, treatments must be repeated frequently during the growing season. Biological control does not yet impact on land infestations, but other management techniques such as revegetation or physical removal are useful.

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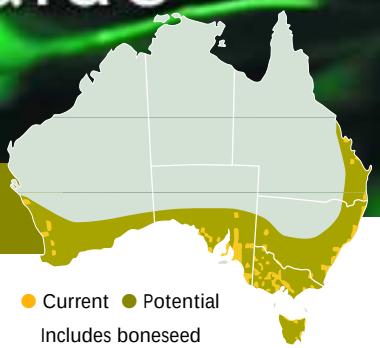
CRC Weed management

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Weed Management Guide

Bitou bush – *Chrysanthemoides monilifera* ssp. *rotundata*



Bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*)

The problem

Bitou bush is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Bitou bush threatens coastal dune vegetation along Australia's east coast. It can outcompete and in many cases totally replace native flora, and it invades undisturbed as well as disturbed areas. Infestations of bitou bush drastically alter the environment for many native birds and animals. It can also create a favourable environment for other highly invasive weeds, such as asparagus fern, lantana and glory lily.

Ironically, one of the plants being choked by bitou bush along the New South Wales coast, golden wattle (*Acacia longifolia*) has become a major pest of coastal dunes in South Africa, where it was introduced to serve much the same purpose as bitou bush in Australia.

The weed

Bitou bush is a perennial, evergreen shrub, normally 1–2 m high although it can form canopies up to 10 m high. Unlike its close relative boneseed (*Chrysanthemoides monilifera* ssp. *monilifera*), which grows as an erect bush, bitou bush is a sprawling shrub.



Bitou bush aggressively invades both intact natural bushland and disturbed areas, particularly coastlines.
Photo: Paul Weiss

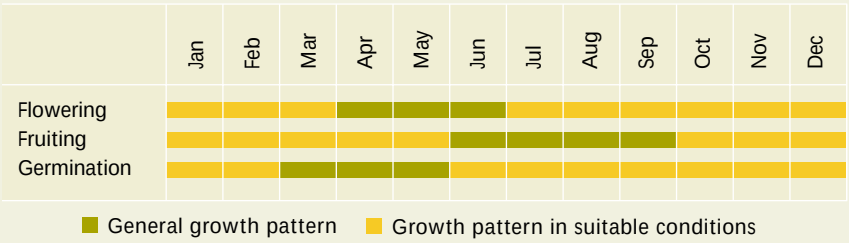
Its stems are branched and woody and the upper stems are often purple. The leaves, which are about 20–80 mm long, oval to oblong in shape and tapering at the base, alternate along the stems. Unlike boneseed, which has leaves with serrated edges, bitou bush has leaves with smooth edges. Bitou bush also has an extensive root system and appears more aggressive and more difficult to control than boneseed. The yellow, chrysanthemum-like flowers, up to 20 mm in diameter, are clustered at the ends of the branches. The small berries have green, fleshy skin that changes to brown and black on maturity. The fruit contains a single egg-shaped seed 5–7 mm long which is dark brown to black when dry.

Key points

- Prevention and early intervention are the most cost-effective forms of weed control. It is vital to keep clean areas free of bitou bush.
- Bitou bush infestations leave a large and persistent seedbank in the soil, so for long-term control infested areas must be treated repeatedly for several years.
- Integrated management using a range of control measures (eg mechanical, chemical and biological control, and the careful use of fire and/or grazing) is required to successfully control bitou bush.
- Monitor treated areas annually to detect and eradicate regenerating seedlings before they have a chance to produce seed.

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Growth calendar



Seeds germinate at any time of the year but mostly in autumn. Most seeds remain viable for at least two years. The seedlings grow rapidly during winter and a few plants may flower in the first year, particularly on burnt areas where there is little competition. However, plants are usually at least 18 months and sometimes three years old before flowering. Bitou bush can flower almost year round, but peak flowering occurs between April and June, unlike boneseed which forms flowers in late winter and spring. Bitou bush fruits ripen during winter and the start of spring.

On the south coast of New South Wales, seedlings usually reach flowering age after three years (earlier if growing in burnt or favourable conditions), while on the north coast growth is much more rapid and flowering within one year is more usual.

How it spreads

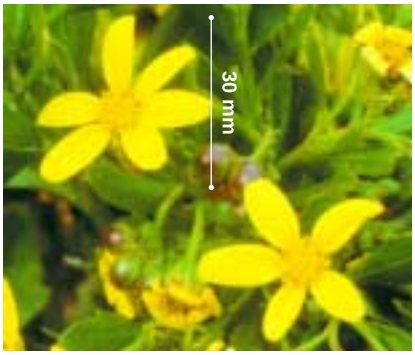
Bitou bush spreads primarily by seed, with each plant producing up to 50,000 seeds a year. In established infestations, soil seedbanks can contain up to 5000 seeds per square metre. Soil disturbance (eg after bulldozing), fire and ingestion of seed by birds and animals promote seed germination but seeds can still germinate in undisturbed situations.

Birds are important in spreading seed as they readily eat the fruit and then pass the seed, sometimes many kilometres from the original source. Rabbits and foxes also eat the fruit and spread the seed in their droppings. Seeds are also spread by water, in ocean currents or through coastal creeks and waterways. Human activities can lead to the spread of bitou bush by vehicles and equipment. On a local scale, seeds may be spread in windblown sand.

Bitou bush can resprout after fire, slashing and herbicide application.



Flowering can occur year round. This specimen was flowering in November near Byron Bay, NSW.
Photo: Kate Blood



The closely related boneseed has 5–8 yellow petals on its flowers and serrated-edged leaves. For more information see other guide in this series.
Photo: Colin G. Wilson

Where it grows

Bitou bush was first recorded in Australia near Newcastle, New South Wales, about 1908, probably introduced through dumping of ships' ballast. From 1946 to 1968 it was planted along the coast to revegetate areas after sandmining. It was also planted on sand dunes near Menindee in western New South Wales where a small infestation still persists.

Bitou bush is naturalised in all states and territories except the Northern Territory. It is mainly restricted to coastal ecosystems with summer rainfall, similar to its range in South Africa.

Bitou bush grows in a range of environments – from open exposed dunes to shaded forests. It is tolerant of shade, salinity, strong wind, wind-blown sand and water, drought, low nutrients and, to some extent, disturbances such as fire. It grows poorly in wet or swampy soils and has a low tolerance to frost.

A recent survey recorded bitou bush on 900 km, or 80%, of the NSW coastline, with an estimated 36, 000 ha infested. Around Sydney there are mixed populations of boneseed and bitou bush. National containment zones for bitou bush have been established in New South Wales on the far north coast and the south coast. In Queensland bitou bush occurred on coastal sandmining areas



Bitou bush threatens coastal dunes and rainforests across southern Australia.
Photo: John Vranjic

but has been targeted for eradication for the past decade. Smaller isolated infestations occur on Lord Howe Island and near Melbourne.

Potential distribution

Bitou bush is spreading further into the understorey of forests and woodlands next to the coastal strip. Recent mapping has recorded infestations up to 10 km inland. There are still large areas outside its current distribution which are potentially at risk, including the whole of Tasmania and much of southern Australia.



The sprawling bitou bush plants have branched, woody stems, which are often purple near the top.
Photo: Kate Blood

What to do about it

Preventing spread

It is important to keep clean areas free of bitou bush. Once an infestation is established, preventing the spread of seeds into surrounding areas should be a priority. This means destroying established plants before they flower and produce fruit.

Any bitou bush plants in gardens should be destroyed since they represent a seed source and hence potential for further spread.

Much of southern Australia including the whole of Tasmania is climatically suitable for bitou bush

Raising awareness amongst recreational vehicle users is important, particularly in coastal areas where seed may be spread by their activities.

Management strategies

In order to minimise the amount of seed produced, it is necessary to detect as many plants as possible. In areas where access is difficult, tracks may need to be cut to make control efforts easier. The greatest difficulty is the large area infested and the rapid reinvasion of an area after initial attempts at control. A sustained control effort is required for up to ten years.

Bitou bush responds much more quickly than native plants after burning or land clearing, and with a large seed bank in the soil it will quickly form a dense growth of seedlings, swamping native species.

Shallow roots make mechanical control easier

Unlike many other woody weeds, bitou bush has a shallow root system with no distinct taproot, so pulling the bushes is possible. Seedlings and plants up to 1 m in height can be hand pulled.

Bitou bush does not persist when grazed or cultivated. Slashing alone is not effective as regrowth occurs from the stump, but applying herbicide to stems immediately after cutting should prevent regrowth. The removal of adult plants stimulates seed germination so new seedlings must be removed before they produce further seeds.

Herbicides are effective

Herbicides registered for bitou bush can be applied in winter at low rates that effectively kill the weed, yet have minimal impacts on coastal vegetation. However, in northern parts of the weed's range where it matures more quickly, two spraying programs a year may be necessary to prevent seeding.

Herbicides registered for bitou bush can be applied from the air, from the ground or by a cut and paint method. Plants coated with dust or seaspray (eg those close to tracks or the beach) will be less affected by herbicides.

Isolated plants can be treated with herbicide applied by spot spraying. As infestations become larger, a strategically staged approach for removal is advisable to ensure that treated areas are not reinfested.

In New South Wales low dosages of herbicides have been applied from helicopters in winter, allowing large areas to be treated rapidly with minimum impact on native species. Reports indicate better than 95% control.

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control bitou bush and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

There are several effective biological control agents

The lack of natural enemies attacking bitou bush in Australia is one of the reasons it has become a serious weed. In classical biological control these natural enemies are introduced into Australia if they are shown not to attack Australian native species or other valuable plants. Biological control is a slow process and will not eradicate bitou bush. It is useful as part of an integrated approach and in areas where the application of conventional control methods is inappropriate due to economic, practical or environmental constraints.

Since 1987, when the first biocontrol agents for bitou bush and boneseed were released in Australia, seven control agents have been released. Two are well established and require no further distribution: the bitou tip moth (*Comostolopsis germana*) which destroys developing leaves, buds and flowers and reduces seed production; and the bitou seed fly (*Mesoclanis polana*) which destroys developing seeds. Leaf-feeding beetles (*Chrysolina* and *Cassida* spp.) were also released but have either not established or are colonising only slowly.

In 2001 the bitou leaf rolling moth (*Tortrix* sp.) was released on boneseed in the You Yangs in Victoria and on bitou bush in New South Wales. Although it has failed to establish on boneseed, it has established well at two sites on bitou bush. Another agent, the boneseed leaf-buckle mite, is being tested for release.

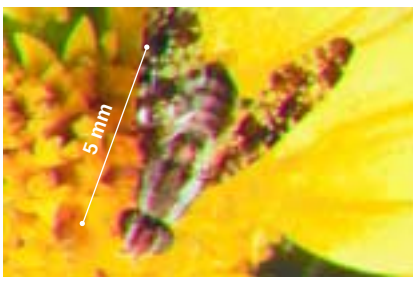
Fire can kill mature bitou bush

Intense fire kills most mature bitou bush, although a small proportion resprout. Fire also kills bitou bush seeds in the litter and topsoil and stimulates germination of seeds from lower in the soil profile. These new seedlings must be removed before they produce further seeds.

Trials have shown that the seedbank in the soil is significantly reduced following burning of mature plants previously killed with herbicide. In areas where a large proportion of the remnant vegetation is known to be fire-sensitive, fire should not be used. Fire can also cause other problems such as increased erosion potential, increased traffic and access by humans and pest animals, and further invasion by weeds. Note that permission of the landowners and a permit from the relevant state or territory fire authority are generally required to authorise the use of fire, and that the fire should be undertaken by properly trained and equipped personnel.

Grazing

Cattle eat bitou bush and this limits its spread onto grazed properties next to heavily infested areas. But grazing in many bitou bush infested areas is not appropriate due to problems associated with stock, such as browsing of native plants, erosion from stock movement and the spread of other undesirable weeds.



The bitou seed fly (*Mesoclanis polana*) destroys developing seeds.
Photo: Weeds CRC



The caterpillar stage of the bitou leaf rolling moth (*Tortrix* sp.).
Photo: Royce Holtkamp

...case study

Restoration of native vegetation at Iluka Bluff on the north coast of New South Wales

A collaborative project at Iluka Bluff on the north coast of New South Wales is helping to restore a badly degraded, bitou-infested coastline.

Iluka Bluff is next to the largest remaining coastal rainforest in New South Wales, the Iluka Rainforest World Heritage Area.

With funding from the Commonwealth Government's Natural Heritage Trust, the Iluka Land and Dune Care Group and the New South Wales National Parks and Wildlife Service (NPWS) began working in 1996 to restore the natural vegetation of the Iluka Bluff area.

Most of the 5 ha project site consisted of dense bitou on the Iluka Bluff headland with small areas of remnant kangaroo grass (*Themeda triandra*) on the eastern and southeastern slopes. The beachfront in the project site was almost exclusively bitou bush as well.

The project involved a number of weed control methods and also saw a new biological control agent, the bitou bush seed fly (*Mesoclanis polana*), established at the site.

The initial treatments for the dense bitou infestations used a Greencorp team to cut access tracks to clear the way for high volume spraying, which was done by contractors and NPWS staff. Bitou amongst the sensitive remnant grassland was either hand removed or cut and painted, with limited spraying.

Several months later, the dead standing mass on the hillside was burnt under controlled conditions. This was done to make follow-up treatment easier, and to destroy a portion of the bitou seedbank and stimulate the remaining seedbank to germinate. Afterwards, mats of cut tea-tree were placed on the bare hillside to help reduce erosion risks.

The bitou on the beachfront was sprayed and, after a suitable time, crushed with a tractor. Areas on the hillside and the beachfront with little native regeneration were then planted by the landcare group and other volunteers. Since then the site has been treated periodically to control regrowth of bitou and other weeds.

As a result of this work, native vegetation cover from natural regeneration and plantings is now dominant over 40% of the 5 ha site.

The project has complemented other regeneration work in the rainforest and has played a large part in Iluka Bluff being named as New South Wales' cleanest beach for 2002.

case study

Integrated management

Wherever possible, an integrated management approach needs to be adopted using several control measures. As with most weed control programs in natural ecosystems, natural regeneration or over-sowing with locally collected seed of native species is an important part of the rehabilitation process. If bitou bush is eradicated without follow-up, other weeds such as glory lily quickly fill the gaps.



Rainforests require special treatment

A combination of spot spraying, mechanical removal and biocontrol may be the most appropriate for rainforest infestations. Fire is not recommended because of the sensitive nature of rainforest plants to burning. The number of new weed seedlings in the forest may be low, as bitou bush does not flower well under heavy shade conditions. Treat vigorous infestations of bitou bush surrounding the rainforest.

Disposal

The stands of dead bitou bush left after spraying can be removed by trampling, compacting or, if appropriate, fire. If they are left standing they may provide some protection to dune environments until they eventually decompose. Small amounts of bitou bush removed by hand pulling or mechanical clearing can also be left to decompose but, if possible, the seeds should be removed and burnt.

Legislation

The Australian Quarantine and Inspection Service prohibits the entry of bitou bush into Australia. The plant is declared in New South Wales, Queensland, South Australia, Victoria and Western Australia. Landholders in these states are required to control it. Check with your local council or state/territory government agency about the latest requirements for bitou bush control.

Acknowledgments

Information and guide revisions: Richard Carter (NSW Agriculture/Weeds CRC), Nigel Ainsworth (DPI Vic/Weeds CRC), Jeff Thomas (NSW NPWS), Royce Holtkamp (Agriculture NSW/Weeds CRC), Rhonda James (Coordinator North Coast NSW Bitou Bush Strategy), Paul Downey (NSW NPWS) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.



In northern parts of its range, two spraying programs a year may be needed to prevent bitou bush seeding.
Photo: Rhonda James

How to control bitou bush

Quick reference guide

Bitou bush – *Chrysanthemoides monilifera* ssp. *rotundata*



Applying herbicide to stems immediately after cutting should prevent regrowth.
Photo: Rhonda James

For large infestations

A sustained control effort is required for large infestations. Hand pull seedlings and plants up to 1 m tall. For larger plants, apply a recommended herbicide immediately after cutting. Match treatment areas to the resources available for follow-up works. Under the right conditions, infested areas can be burnt to encourage germination of the seedbank. New seedlings must be removed before they flower.

For small infestations

Destroy established plants before they flower and produce fruit, to prevent the spread of seed. Treat isolated plants with a recommended herbicide applied by spot spraying.

In rainforests

A combination of spot spraying, mechanical removal and biocontrol may be the most effective for rainforest infestations. Keep soil disturbance to a minimum to reduce the risk of stimulating germination.

Treat healthy infestations of bitou bush near the edges of the rainforest. Once bitou bush is removed, fast-growing rainforest species will regenerate.

Revegetation in other areas

Once bitou bush is controlled other weeds may invade, so only tackle areas where follow-up control is possible. Follow up with direct seeding or planting of indigenous species.

Follow-up control

Because of the large and persistent seedbanks in the soil, follow-up control is required for about ten years.

Disposal

Remove seeds and burn them. Stands of dead bitou bush can either be left until they decompose or are physically removed.



Control options

Type of infestation	Herbicide	Biological	Physical	Burning
Large infestation – large area, many plants	Spray to kill seedlings before flowering. Contact authorities for information about registered herbicides.	The bitou tip moth and bitou seed fly are distributed along most of the range of bitou bush.	Hand pull or cut woody plants in spring.	Fire can be used to reduce the large soil seedbank.
Isolated plants or small infestations	Spot spray or use cut and paint treatment.	Not suitable.	Remove plants before they set seed.	Not suitable.
Rainforests	Spray to kill seedlings before flowering. Contact authorities for information about registered herbicides.	Use in combination with spot spraying and mechanical removal.	Hand pull or cut woody plants in spring.	Not recommended because of sensitive nature of rainforest plants to burning.

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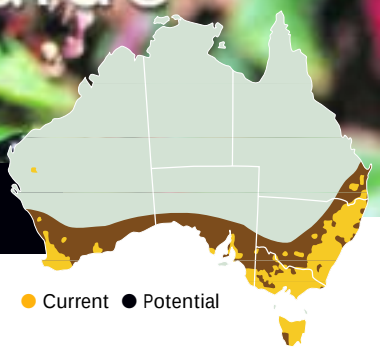
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Weed Management Guide

Blackberry –
***Rubus fruticosus* aggregate**



Blackberry (*Rubus fruticosus* aggregate)

The problem

Blackberry is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Blackberry has invaded the banks of watercourses, roadsides, pastures, orchards, plantations, forests and bushland throughout temperate Australia. On farms blackberries reduce pasture production, restrict access to water and land, and provide food and shelter for pest animals such as foxes. In some cases the cost of plantation forestry may be increased, especially during establishment, because blackberries impede access for manual operations.

Other impacts are increased fire hazards caused by the large amount of dead material present in blackberry thickets and a substantial decrease in property values where heavy infestations occur. Control costs are often high.

Weeds such as blackberries also affect tourism, reducing the natural attraction of the bush and hindering recreational activities where thickets prevent access to natural features.

The weed

The name 'blackberry' covers at least 14 different but closely related species, some of which may be hybrids, that have become naturalised in Australia.



Blackberries hinder recreational activities by preventing access to natural features: Loddon River in central Vic.
Photo: Kate Blood

Blackberry is a perennial, semi-deciduous shrub with prickly stems (canes) that take root where they touch the ground, often forming thickets up to several metres high. It varies from sprawling to almost erect. The stems, which grow up to 7 m long, may be green, purplish or red, and are generally thorny and moderately hairy. Young canes emerge from buds on the woody root crown each spring and grow very rapidly (50–80 mm a day).

Leaves are usually dark green on top with a lighter green underside. The leaf veins and stalks are covered with short prickles. Clusters of flowers are white or pink.

The berries change colour from green to red to black as they ripen. The plant is semi-deciduous and sheds its leaves in winter.

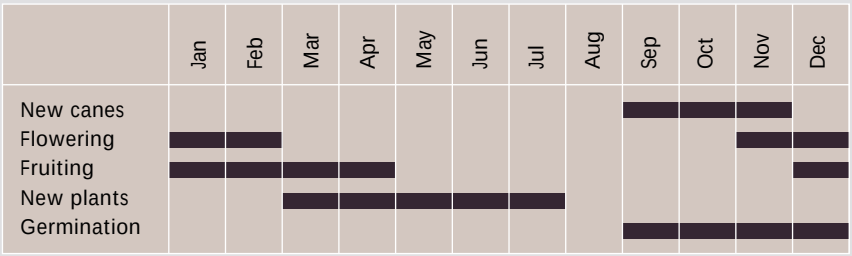
Key points



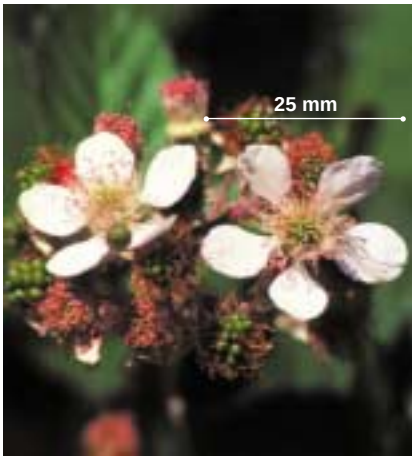
- At least 14 different but closely related species of blackberry are naturalised in Australia.
- Some species could spread further within the climatic limits of blackberry's range.
- Blackberry management programs must be planned and sustained over a number of years.
- Biological control will not eradicate blackberry, but will slow the rate of spread and allow more time for control by other means. Rust has been the most successful biocontrol so far.
- In revegetation programs, native seedlings that are able to germinate and actively grow over winter have a competitive advantage.

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Growth calendar



Blackberry has a two-year growth pattern. Young canes start growing in spring, flowering occurs from late November to late February and fruiting from late December to April. New (daughter) plants develop at the tips of first-year canes throughout autumn and winter. Most germination takes place during spring and early summer.



Blackberry plants produce clusters of white or pink flowers.
Photo: Kate Blood

How it spreads

One berry may contain as many as 80 seeds which are easily spread by birds, mammals (especially foxes) and water. Bushwalkers and other recreational users can also spread seeds, as can moving soil from one place to another. Blackberry roots can be spread to clean areas by cultivation.

Blackberry will persist indefinitely in an area unless it is treated. Plants that die are replaced by seedlings or daughter plants produced by nearby individuals. Plants may produce up to 13,000 seeds per square metre.



Where it grows

About 8.8 million ha of Australia is infested with blackberry, which thrives in a wide range of habitats. It can dominate pastures and native ecosystems as well as invade disturbed sites in urban areas. In badly affected areas, dense infestations often fill whole gullies and can extend for a width of tens of metres along both sides of streams.

The plant is restricted to temperate climates with an annual rainfall of at least 700 mm, and can occur at any altitude in Australia. Blackberry plants grow above the snowline in Victoria at about 1950 m altitude.

Potential distribution

Blackberry has probably reached the climatic limits (in terms of temperature and rainfall) of its potential range in Australia. However, individual species may spread further within these climatic limits. A few scattered infestations exist outside of the projected range under ideal conditions in Western Australia.



Berries change colour from green to red to black as they ripen.
Photo: Kate Blood



Blackberry bushes often form thickets up to several metres high.
Photo: John Hosking

What to do about it

The major challenges in managing blackberry are to prevent its spread, control and reduce existing infestations, and rehabilitate treated areas to prevent reinfestation.

In its long history as a noxious weed, blackberry has been managed by a range of control techniques, including burning, slashing, grazing, grubbing, chemical spraying and biological control.

Blackberry management programs must be planned and sustained over a number of years to prevent the rapid return of the infestation.

Apply herbicides to healthy plants

In general, the best time to spray blackberry is during the flowering–fruiting period, but the effective spraying season can start before flowering and extend long after fruiting, into autumn.

It is easy to kill young blackberry seedlings with herbicide. However, well established blackberry thickets have a large number of root crowns of different ages, and the older and bigger ones are usually hard to kill.

If using herbicides taken up by the leaves, avoid slashing in the season before application; it can reduce the effectiveness since only the new canes will be available to take up the herbicide.



The prickly stems, known as canes, may grow up to 7 m long. The leaves are usually dark green on top with a lighter green underside.
Photo: John Hosking

Do not apply herbicides to stressed plants. Conditions such as drought or severe low or high temperatures can decrease the effectiveness of herbicide action. As a guide, look at the tips of the canes. In times of active growth (the best time to spray) these will be producing fresh new leaves, and any new growth should be healthy, not wilted.

The success of herbicide treatment can also vary between the different groups of blackberry. Some produce fewer crowns per square metre than others and fewer canes per crown. Other features such as larger leaves and canes and hairier leaf surfaces (which may reduce absorption) can also affect herbicide uptake.

Methods of herbicide application

High-volume spraying is recommended for spot spraying, particularly in dense infestations or large blackberry thickets. If using this method, spray the inside of bushes first, ensuring good coverage of stems and leaves. Then spray outside leaves, runners and tips. Take particular care with this method because it is very easy to overdose and affect off-target species or contaminate waterways. Likewise, mist blowers or air blast sprayers can be effective but allow little control over spray distribution due to spray drift. None of these methods are suitable for use near susceptible native species.

In remote areas where water for herbicide application is not available, pellets or granular herbicides can be effective. These are applied to the soil surface and the chemical is leached by rain into the root zone where the roots take it up. This method is not suitable for use near native vegetation. Results of some trials have shown that slashing before application of granular herbicide gives better results than using granules alone.

The use of a gas-powered gun has been suggested as a method which enables very accurate application of herbicide onto target plants. It can be used to control scattered blackberries to a height of 1.5 m. Knapsack units are most suitable for spraying small scattered bushes and seedlings.

For small areas of high conservation significance, the ‘cut and paint’ method is recommended. This involves cutting blackberry canes close to ground level and immediately painting cut stems with herbicide. However, it should be used only on small plants and retreatment is likely to be necessary.

Slashing will not kill blackberry

Although cutting blackberry plants off at ground level does not kill them, slashing can help open up dense stands for follow-up control by other methods.

Regular (fortnightly or monthly) slashing or mowing forces the plant to regrow, using up root reserves and making it weaker. Slashing in summer can enhance the effect of blackberry leaf rust because regrowth stimulated by the slashing is very susceptible to the rust fungus.

Hand weeding

This is only effective in very small infestations. Even seedlings and small plants are difficult to pull out by hand. If possible, all of the root system should be removed using a mattock or shovel because blackberry will regrow from any root fragments left in the soil.

Dense infestations may require mechanical control

In dense infestations mechanised weeding with large earthmoving equipment may sometimes be necessary. Remove plants and surface soil with a bulldozer (‘scalping’) to ensure crowns and most of the roots are dug out. Afterwards, rake roots and leave them to dry out in the sun or collect them in piles for burning. Regrowth from crowns, root fragments and seed is inevitable, so follow-up treatment and site rehabilitation are essential.

Grazing with goats

Goats at high stocking rate can be used to control blackberry in pasture but their use must be continuous to prevent regrowth occurring.



Regrowth is inevitable after mechanical removal so follow-up treatment is necessary.
Photo: Ian Walton, DPI Vic

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.a	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

For up-to-date information on which herbicides are registered to control blackberry and the best application methods and dosages, contact your state or territory weed management agency or local council. This information varies from state to state and from time to time. Contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

Biological control with the blackberry leaf rust

The program with the greatest likelihood of success in the foreseeable future includes biological control, particularly on large, inaccessible infestations of blackberry. The blackberry leaf rust *Phragmidium violaceum*, which attacks the leaves, is now present throughout all areas of southern Australia where blackberries are a problem. It affects the leaves and can also grow on flowers, unripe fruit and young canes. The rust is harmless to native *Rubus* species and varieties of commercial raspberry and brambleberry such as loganberry, boysenberry and youngberry. The rust alone will not eradicate blackberry but it slows its rate of spread and allows more time for control by other means.

The rust appears as purple-brown blotches, 2–3 mm in diameter, on the upper surface of the leaf. Corresponding powdery yellow or sticky black pustules of spores appear on the leaf's lower surface.

Epidemics of rust caused by summer spores initially kill leaves in summer and autumn, forcing the plants to grow new leaves, which in turn are attacked by the rust. Rust epidemics result in fewer fruit and seeds, shorter canes and fewer new plants.

This continuous attack on the leaves weakens plants by depleting root reserves. Light can start penetrating the thicket, which helps revegetation by other plants, especially in autumn and winter. Competing plants can then grow through the blackberry and in turn limit its growth by shading.

The blackberry rust has been so effective in the Gippsland region of Victoria that farmers complained about having to re-do their fencing when blackberry hedges fell down! However, the rust seems to be severe only in regions where the annual rainfall is greater than 800 mm and the average daily maximum temperature for January is close to 20ºC.

Different blackberry species vary in their susceptibility to the rust, from very susceptible to highly tolerant. The effectiveness also varies between years, according to seasonal conditions. A sufficiently high level of infection is not always present early enough to prevent seed production and tip rooting of canes. Although the rust has had a big impact on the more common and widespread blackberry strains, some less widespread groups are resistant, giving them an advantage, and resulting in their gradual takeover and a continuation of the overall blackberry problem.



Slashing can help open up dense stands of blackberry for follow-up control by other methods. Photo: Adam Whitchurch, DPI Vic

Blackberry control strategies must address all the strains present in a region. Management actions which target only some of the species will result in one strain replacing another, with no net decrease in blackberry cover. For example, while the blackberry leaf rust is successfully controlling one species in the Strzelecki Ranges of Victoria, another rust resistant group is rapidly spreading to fill the niche.



To address this issue, additional rust strains are being tested in CSIRO's quarantine facility in Canberra before their expected release throughout Australia during 2003–04. Matching virulent rust strains to susceptible blackberry species is essential for successful biological control. Just as important are suitable weather and blackberry growing conditions for development of rust disease.

Although rust epidemics can look spectacular, blackberry is a very vigorous plant and can survive repeated attacks over a number of years before its root system begins to be depleted. It can take up to five years of rust infection for large well-established blackberry infestations to open up enough to allow other plants to grow through.

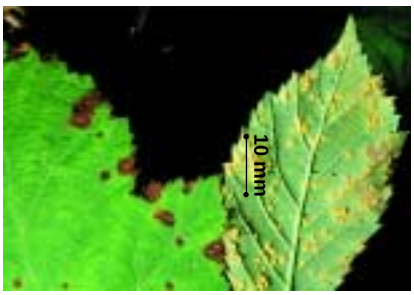
Integrated control

Blackberry should be inspected during summer–autumn and herbicide treatment planned for any infestations that are not attacked heavily by rust. Research has shown that spraying herbicides after the rust has killed some leaves gives equal or better control than application earlier in the season.

Where rust is having little impact, the use of herbicides is usually necessary since mature blackberry is able to regenerate readily from roots following burning or slashing.

Use of competitive native species

Maintaining good quality groundcover can help control blackberry seedlings. If rapid regeneration of fast-growing native species can be achieved, these can out-shade seedlings and outcompete them for water and nutrients. Blackberry roots do not develop much over winter so native seedlings able to germinate and actively grow during this period will have a definite competitive advantage.



The blackberry rust appears as purple-brown blotches on the upper leaf (*left*) and powdery yellow or sticky black pustules of spores on the lower surface (*right*).
Photo: John Hosking

Careful use of prescribed fire

This is used mainly as a follow-up to herbicide application to clear areas of dead canes and re-establish access for rehabilitation of the treated area.

Follow-up

Once an area has been treated it will be necessary to monitor it for many years and destroy new plants.

Legislation

Blackberry is declared noxious in all states and territories except the Northern Territory. Landowners are required to control it. Check with your local council or state/territory government agency about its requirements for blackberry control.

Acknowledgments

Information and guide revision: John Moore (Agriculture WA/Weeds CRC), Kathy Evans (DPIWE Tas/Weeds CRC), Sarah Keel (DPI Vic), Charlie Salonen (CALM WA) and John Thorp (National Weeds Management Facilitator).

Maps: Australian Weeds Committee.



...case study

Keeping Western Australia's Porongurup National Park blackberry free

In Western Australia's Porongurup National Park an integrated approach has been adopted to tackle blackberries, involving government departments, landholders and volunteer groups.

The aim of the program, which is targeting satellite infestations on the northeastern edge of the park, is to move the blackberry front 20 km away from the park. This involves controlling infestations both on farms (to stop them entering the park) and in the park (to stop them spreading to farmland).

Agriculture WA provides herbicide to landholders, who contribute the labour.

"While from an individual point of view, there may not be a great incentive to get rid of blackberries, the community is proud of the park, and neighbours will put pressure on each other to clear up infestations", says coordinator of the program, John Moore of Agriculture WA.

The program runs training days and equipment is available for loan. The landowners include hobby farmers with small holdings where infestations are too large to tackle using hand-held equipment.

The program includes a number of approaches, including the use of specific herbicides for large infestations, which are different from herbicides used in gardens, vineyards and other sensitive areas. Some people don't want to use herbicides at all so they may be using other techniques such as mowing, cultivation, burning or grazing with goats before seed sets.

Landholders can see the impact of blackberries and where they have been controlled in the park. For example, in some unsprayed areas tall karri (*Eucalyptus diversicolor*) trees rise through the blackberries, which dominate the undergrowth. In comparison, native grasses and understorey plants are growing in some sprayed areas where all blackberries and a small amount of native vegetation have been killed.



How to control blackberry

Quick reference guide



Prevention

Keep uninfested areas clear of blackberry and remove isolated plants before they have a chance to seed.

Herbicide control

Consult a specialist for advice on registered herbicides in your state or territory (see the contacts table on p. 4). Apply herbicide to actively growing plants – look at the tips of the canes and spray when they are producing fresh new leaves.

Physical control

Slashing can help open up dense stands for follow-up control by other methods, and in summer can enhance the effect of blackberry leaf rust.

Mechanical control is difficult and most of the root system must be removed for effective control – blackberry will regrow from any root fragments left in the soil. In dense infestations bulldozers may be used to remove plants but follow-up treatment is essential.

Biological control

Biological control offers the greatest likelihood for success in large, inaccessible infestations. The existence of at least 14 different groups or strains of blackberry in Australia makes biological control difficult as some groups are more susceptible to the blackberry leaf rust than others.

Rust fungi have established well in some high rainfall areas but have failed to have an impact elsewhere. Additional rust strains are being tested in quarantine and are expected to be released in 2003–04.



Blackberries are easily spread by birds, mammals and water.
Photo: Kate Blood



The blackberry rust is most effective during late summer and autumn in cool, moist environments such as Gippsland, Vic.
Photo: El Bruzzese, DPI Vic

Control options

Control option	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herbicide application	✓	✓	✓	✓					✓	✓	✓	✓
Mechanical removal (incl. grazing)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Burning			✓	✓	✓	✓	✓	✓	✓	✓		
Biological control (release rust)	✓										✓	✓

✓ Optimum times for blackberry control methods

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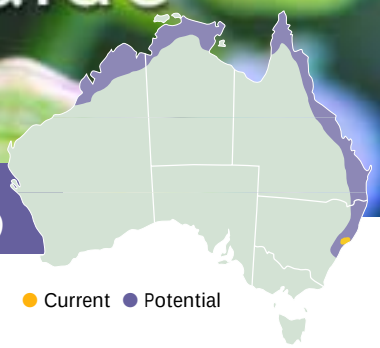
CRC Weed management

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Weed Management Guide

Chinese violet
(*Asystasia gangetica* ssp. *micrantha*)



Chinese violet (*Asystasia gangetica* ssp. *micrantha*)

The problem

Asystasia gangetica subspecies (ssp.) *micrantha* is on the *Alert List for Environmental Weeds*, a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems.

A. gangetica ssp. *micrantha* is a form of Chinese violet. As an environmental weed, it smothers other ground plants and displaces vegetation, which reduces the availability of habitat for native plants and animals and therefore reduces biodiversity.

It is a major weed overseas, particularly in Malaysia, Indonesia and the Pacific islands. In these places it infests plantations, particularly oil-palm crops, and competes effectively for soil nutrients, reducing productivity and increasing crop management costs. It could also become an agricultural weed in Australia.

Another closely related species, *Asystasia gangetica* ssp. *gangetica*, has also become naturalised in the Northern Territory and Queensland.

The weed

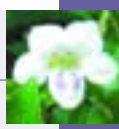
A. gangetica ssp. *micrantha* is a perennial creeper that grows rapidly, up to 0.5 m high alone but to 3 m high on supporting vegetation. It forms roots when the nodes (the joins between segments on the stem) make contact with moist soil, ultimately forming mats or a sprawling mass of stems similar to those of *Tradescantia fluminensis*, commonly known as wandering creeper.

Both the leaves and the stems have scattered hairs. Occurring in opposite pairs, the leaves are oval, sometimes nearly triangular in shape, paler on the underside, and may be up to 25-165 mm long and 5-55 mm wide. White bell-shaped flowers, 20–25 mm long, have purple blotches in two parallel lines inside. The seed capsules are about 30 mm long, club-shaped (the neck is attached to the stem) and contain four flattened seeds held in place by conspicuous hooks.



The two parallel purple stripes within the white flower are a distinctive feature of *A. gangetica* ssp. *micrantha*.
Photo: Graham Prichard, Port Stephens Council, NSW

Key points



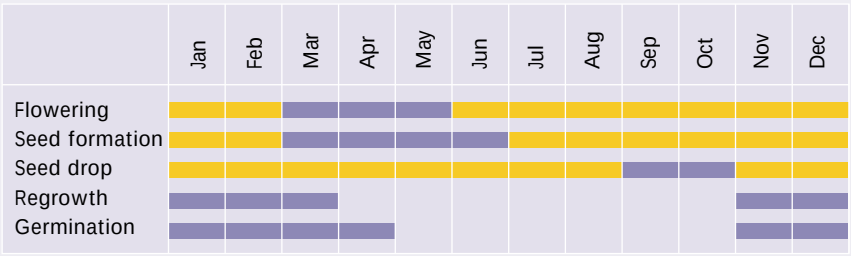
- *Asystasia gangetica* ssp. *micrantha* is a mat-forming creeper which can smother more desirable plants.
- Prevention and early intervention are the most cost-effective forms of weed control.
- Avoid creating bare areas where *A. gangetica* ssp. *micrantha* and other weeds can invade.
- If you see a plant that may be *A. gangetica* ssp. *micrantha*, contact your local council or state or territory weed management agency. Do not attempt control on your own, as it can spread very easily from both seeds and stems.

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Alert List For Environmental Weeds ALERT



Growth calendar



A. gangetica ssp. *micrantha* can flower and fruit year round. In the Port Stephens area in New South Wales, it grows rapidly following germination and throughout flowering and seed capsule production. In the final stage of its life cycle, the plant dies back to ground level after most of the ripe capsules have released their seeds. Winter frosts kill the above-ground plant parts but plants regrow the following spring from basal shoots.

In tropical climates plant growth is probably continuous, especially in moist conditions or following rainfall.



The seeds are released when the seed capsules dry out.
Photo: Graham Prichard, Port Stephens Council, NSW

How it spreads

A. gangetica ssp. *micrantha* spreads by seeds, which are released explosively from drying capsules, and by trailing stems that can produce roots when nodes make contact with moist soil. The main method of dispersal over long distances is by human activities, such as mining, gardening, landscaping and roadworks. The dumping of garden waste is thought to have caused most of the outbreaks in New South Wales, although it has also spread at a great rate from garden plantings.

Where it grows

A. gangetica ssp. *micrantha* grows in tropical and subtropical areas. It is native to India, the Malay Peninsula and Africa. It was first recorded as naturalised in Australia at Boat Harbour, north of Newcastle, New South Wales, in 1999. Infestations have now been identified at nearby Anna Bay and Fern Bay. These infestations are spread over a distance of 9 km and range in size from 2 square metres to several hectares. Most of the infestations are small and occur on vacant residential land, along fencelines and in neglected garden beds. Several larger outbreaks are present along roadsides and on crown land.

In all these cases the plant is found on coastal sandy soils but it is thought to tolerate a wide range of soil types. It prefers full sun or part shade. Plants in deep shade do not thrive and become spindly, awaiting a break in the canopy. Often, plants in more exposed sites show some yellowing of the leaves, especially during winter.

A. gangetica ssp. *micrantha* was cultivated in the Darwin Botanic Gardens but it appears to have been eradicated by persistent manual removal and by allowing other plants to outcompete it in shady areas.



Most infestations north of Newcastle, NSW, occur on vacant residential land, along fencelines, and in abandoned flower beds and adjacent bushlands.
Photo: Andrew Storrie, NSW Agriculture

Why we need to be 'alert' to *A. gangetica* ssp. *micrantha*

Both subspecies of *A. gangetica* are problem weeds throughout much of South-East Asia, including Malaysia, Indonesia, Papua New Guinea and the Pacific islands. They both grow widely as weeds in rubber, oil-palm, coffee and other crops, but *A. gangetica* ssp.

Another subspecies of *Asystasia gangetica*

A. gangetica ssp. *gangetica* is less weedy and is planted widely in Australia. Its flowers are 30–40 mm long and blue–mauve in colour, whereas *A. gangetica* ssp. *micrantha* has slightly shorter flowers that are mainly white. *A. gangetica* ssp. *gangetica* is naturalised at Port Douglas in Queensland and at Bartalumba Bay and Groote Eylandt in the Northern Territory. There is also at least one Australian native species of *Asystasia* (*A. australasica*), which occurs in northern Queensland.

micrantha is particularly troublesome in oil-palm plantations. If it became established in Australia, it could potentially affect crops such as soybeans, vegetables, cut flowers and oil-teatree. Its success over a wide geographical range is due to its fast establishment, rapid growth rate, early flowering and high seed production.

As an environmental weed, it could have similarly significant effects, smothering native vegetation and destroying the habitat of many birds and animals. It has shown a tolerance to a range of subtropical and tropical climates, and could be suited to a large part of Australia's environment.

What to do about it

Prevention is better than the cure

As with all weed management, prevention is better and more cost-effective than control. The annual cost of weeds to agriculture in Australia, in terms of decreased productivity and management costs, is conservatively estimated at $4 billion. Environmental impacts are also significant and lead to a loss of biodiversity. To limit escalation of these impacts, it is vital to prevent further introduction of new weed species, such as *A. gangetica* ssp. *micrantha*, into uninfested natural ecosystems.



A. gangetica ssp. *gangetica* has purple flowers. It is naturalised across parts of northern Australia. Photo: Colin G. Wilson

Early detection and eradication are also important to prevent infestations of *A. gangetica* ssp. *micrantha*. Small infestations can be easily eradicated if they are detected early but an ongoing commitment is needed to ensure new infestations do not establish.

The Alert List for Environmental Weeds

The Federal Government's *Alert List for Environmental Weeds* was declared in 2001. It consists of 28 weed species that currently have limited distributions but potentially could cause significant damage. The following weed species are therefore targeted for eradication:

Scientific name	Common name	Scientific name	Common name
Acacia catechu var. *sundra*	cutch tree	*Koelreuteria elegans*	Chinese rain tree
Acacia karroo	Karroo thorn	*Lachenalia reflexa*	yellow soldier
Asystasia gangetica ssp. *micrantha*	Chinese violet	*Lagarosiphon major*	lagarosiphon
Barleria prionitis	barleria	*Nassella charruana*	lobed needle grass
Bassia scoparia	kochia	*Nassella hyalina*	cane needle grass
Calluna vulgaris	heather	*Pelargonium alchemilloides*	garden geranium
Chromolaena odorata	Siam weed	*Pereskia aculeata*	leaf cactus
Cynoglossum creticum	blue hound's tongue	*Piptochaetium montevidense*	Uruguayan rice grass
Cyperus teneristolon	cyperus	*Praxelis clematidea*	praxelis
Cytisus multiflorus	white Spanish broom	*Retama raetam*	white weeping broom
Dittrichia viscosa	false yellowhead	*Senecio glastifolius*	holly leaved senecio
Equisetum spp.	horsetail species	*Thunbergia laurifolia*	laurel clock vine
Gymnocoronis spilanthoides	Senegal tea plant	*Tipuana tipu*	rosewood
Hieracium aurantiacum	orange hawkweed	*Trianoptiles solitaria*	subterranean cape sedge

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au

The above contacts can offer advice on weed control in your state or territory. If using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.



Flowers, leaves, and ripe and unripe seed capsules of *A. gangetica* ssp. *micrantha*.
Photo: Graham Prichard, Port Stephens Council, NSW

Quarantine to prevent further introductions

The importation of either subspecies of *Asystasia gangetica* into Australia is not permitted because of the risk of further spread, and the potential introduction of new genetic diversity that could make future control more difficult.

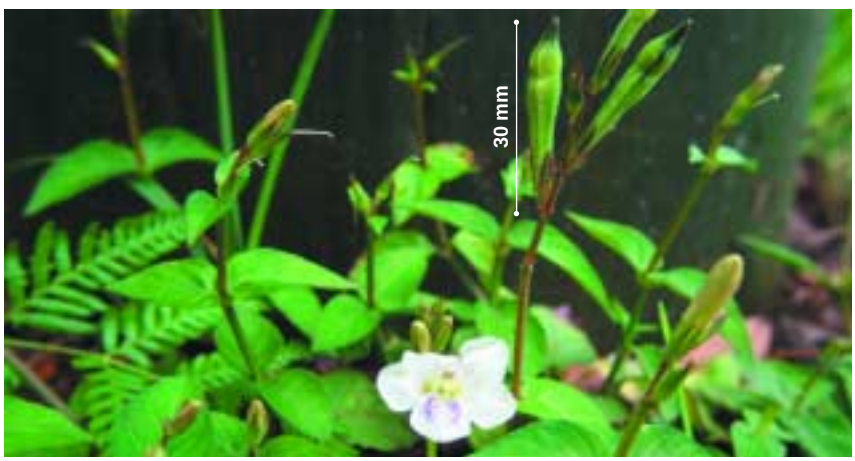
Do not buy seeds via the internet or from mail order catalogues unless you check with quarantine first and can be sure that they are free of weeds like *Asystasia gangetica* ssp. *micrantha*.
Call 1800 803 006 or see the Australian Quarantine and Inspection Service (AQIS) import conditions database <www.aqis.gov.au/icon>. Also, take care when travelling overseas that you do not choose souvenirs made from or containing seeds, or bring back seeds attached to hiking or camping equipment. Report any breaches of quarantine you see to AQIS.

Raising community awareness

Some 65% of weeds, including *A. gangetica* ssp. *micrantha*, which have recently established in Australia have escaped from plantings in gardens and parks. The detrimental impacts of these weeds far outweigh any potential horticultural benefits. The public should be made more aware of these impacts, and other issues such as how to identify *A. gangetica* ssp. *micrantha* and what to do if they find it.
A. gangetica ssp. *micrantha* is easiest to identify when in flower. It has white flowers with two parallel purple lines on raised ridges on its inside. The leaves and stems have scattered hairs, and hooks on the seeds are also distinctive.

New infestations of *A. gangetica* ssp. *micrantha*

Because there are relatively few *A. gangetica* ssp. *micrantha* infestations, and it can potentially be eradicated before it becomes established, any new outbreaks should be reported immediately to your state or territory weed management agency or local council. Do not try to control *A. gangetica* ssp. *micrantha* without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread the weed and worsen the problem.



A. gangetica ssp. *micrantha* is one of many environmental weeds that have spread into bushland from initial plantings in gardens.
Photo: Graham Prichard, Port Stephens Council, NSW





Methods to control *A. gangetica* ssp. *micrantha*

Management of the soil seedbank is the key to control of established infestations of *A. gangetica* ssp. *micrantha*. This will involve persistent follow-up for several years in cooperation with your state or territory weed management agency or local council.

Hand weeding requires extreme care

Stems of *A. gangetica* ssp. *micrantha* break up easily and the plant can propagate from cuttings, so unless done carefully, hand pulling can cause infestations to spread. Because plant material may contain seeds, it is important to bag all cuttings for disposal. Hand pulling seedlings and small plants is suited to small infestations with easy access.

Seek help in disposing of plants

Much of the spread of *A. gangetica* ssp. *micrantha* has been attributed to the incorrect disposal of plant parts. Extreme care must be taken when disposing of hand-pulled plants, especially if seeds are present. Seed may also be inadvertently moved in contaminated soil. The best disposal methods which will kill seeds cheaply and easily are still being investigated. Use a conservative approach and contact your local council or state/territory weed management agency for specific advice before attempting to dispose of *A. gangetica* ssp. *micrantha*.

Herbicides are being trialled for suitability

Maintaining groundcover and competitive desirable species is important, so get advice before spraying. Trials are being carried out by the NSW Department of Agriculture to identify suitable selective herbicides for *A. gangetica* ssp. *micrantha*. Work to date indicates that it is susceptible to a wide range of selective broadleaf herbicides (those that do not kill grasses).



Infestations smother other ground vegetation: Anna Bay, north of Newcastle, NSW.
Photo: Andrew Storrie, NSW Agriculture

Herbicides to control *A. gangetica* ssp. *micrantha* are registered for 'off-label' minor use through the permit system of the Australian Pesticides and Veterinary Medicines Authority (APVMA) <www.apvma.gov.au> until October 2008. For more information, contact the APVMA (by phone: (02) 6272 5852 or email: contact@apvma.gov.au), your local council weeds officer or state or territory weed management agency.

Other control options

Slashing prior to seed set may help control *A. gangetica* ssp. *micrantha*. However, equipment must be carefully cleaned to prevent further spread. Cultivation should be avoided due to the risk of spreading plant fragments.

The effect of fire on the soil seedbank is unknown and it is not being used as a strategy to manage existing infestations.

There are no known biological control agents in Australia for this species. Biological control is a slow process and is normally intended to control a weed rather than eradicate it.

Revegetation to prevent reinfestation

Competition from other vegetation can help suppress seedling germination. Planting alternative indigenous groundcovers and avoiding bare ground wherever possible can help prevent *A. gangetica* ssp. *micrantha* taking hold.

Legislation

All subspecies of *Asystasia gangetica* have been added to the list of prohibited imports and can no longer be brought into Australia. Although *A. gangetica* ssp. *micrantha* is not declared as a noxious weed, it is marked for eradication by its inclusion on the *Alert List for Environmental Weeds*.

Acknowledgments

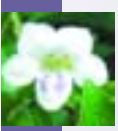
Information and guide revision: Graham Prichard (Port Stephens Council), John Hosking (NSW Agriculture/Weeds CRC), Barbara Waterhouse (AQIS/Weeds CRC), Andrew Storrie (NSW Agriculture/Weeds CRC), Richard Carter (NSW Agriculture/Weeds CRC), Bob Trounce (NSW Agriculture) and John Thorp (National Weeds Management Facilitator).

Maps: Data used in the compilation of actual and potential distribution maps provided by Australian herbaria via Australia's Virtual Herbarium and Sainty and Associates P/L, respectively.



If you find a plant that may be *A. gangetica* ssp. *micrantha*

Q u i c k r e f e r e n c e g u i d e



Identification

You will first need to confirm its identity. Contact your state or territory weed management agency for help in identifying the plant. You will need to take note of the characteristics of the plant in order to accurately describe it. Some important features of *A. gangetica* ssp. *micrantha* are:

- white bell-shaped flowers, 20–25 mm long, with purple stripes in two parallel lines on the inside
- club-shaped seed capsules
- opposite leaves with an oval, sometimes nearly triangular, shape and up to 165 mm long. The leaves and stems have scattered hairs.

Reporting occurrences

Once identified, new occurrences of *A. gangetica* ssp. *micrantha* should be reported to the relevant state or territory weed management agency or local council, who will offer advice and assistance on its control. Because *A. gangetica* ssp. *micrantha* represents such a serious environmental and economic threat to Australia, its control should be undertaken with the appropriate expertise and adequate resources.

Follow-up work will be required

Once the initial infestation is controlled, follow-up monitoring and control will be required to ensure that reinfestation does not occur. Monitor treated areas monthly to detect and eradicate seedlings before they have a chance to produce seed.

Collecting specimens

State or territory herbaria can also identify plants from good specimens. These organisations can provide advice on how to collect and preserve specimens.

State/Territory	Postal Address	Phone	Web
Australian National Herbarium	GPO Box 1600 Canberra, ACT, 2601	(02) 6246 5108	www.anbg.gov.au/cpbr/herbarium/index.html
National Herbarium of New South Wales	Mrs Macquaries Rd Sydney, NSW, 2000	(02) 9231 8111	www.rbgsyd.nsw.gov.au
National Herbarium of Victoria	Private Bag 2000 Birdwood Avenue South Yarra, Vic, 3141	(03) 9252 2300	www.rbg.vic.gov.au/biodiversity/herbarium.html
Northern Territory Herbarium	PO Box 496 Palmerston, NT, 0831	(08) 8999 4516	http://www.nt.gov.au/ipe/pwcnt/
Queensland Herbarium	c/- Brisbane Botanic Gardens Mt Coot-tha Rd Toowong, Qld, 4066	(07) 3896 9326	www.env.qld.gov.au/environment/science/herbarium
South Australian Plant Biodiversity Centre	PO Box 2732 Kent Town, SA, 5071	(08) 8222 9311	www.flora.sa.gov.au/index.html
Tasmanian Herbarium	Private Bag 4 Hobart, Tas, 7000	(03) 6226 2635	www.tmag.tas.gov.au/Herbarium/Herbarium2.htm
Western Australian Herbarium	Locked Bag 104 Bentley DC, WA, 6983	(08) 9334 0500	http://science.calm.wa.gov.au/herbarium/

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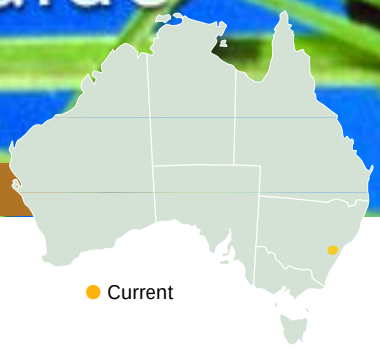
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CRC Weed management

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Weed Management Guide



Cyperus (*Cyperus teneristolon*)

The problem

Cyperus teneristolon is on the *Alert List for Environmental Weeds*, a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems.

There is no well-established common name for this species in Australia although 'cyperus' has been suggested. As many species share the common name cyperus, it has been decided to refer to the species here by its scientific name to prevent confusion.

C. teneristolon has become a significant weed of crops of the East African highlands, in particular Kenya. As it is a weed in overseas agricultural areas with climatic and environmental conditions similar to those that occur in Australia, it is seen as a potential threat to Australia's environment and agricultural productivity.



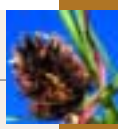
C. teneristolon has the potential to become a significant weed of crops in Australia. The population at Yosemite Creek, Katoomba, NSW is pictured here.
Photo: John Hosking, NSW Agriculture

The weed

C. teneristolon is a perennial sedge which grows to 500 mm high. Sedges are evergreen plants with triangular stems that generally grow in damp areas. The species name *teneristolon* refers to the long and delicate stolons (ground-covering stems) that sprout new plants. The main flowering spike is egg-shaped, purple to black in colour, and made up of many tiny flowers (an 'inflorescence'), or spikelets, to 3 mm long with a distinctive point. The shape and colour of the inflorescence distinguishes *C. teneristolon* from all other sedge species. The fruit, produced from the mature flower, is dry, contains one seed and does not split open to release the seed when on the plant.

The leaves are 1–3 mm wide, have roughened margins and are bright green in colour. The roots are fibrous and the plant has an extensive rhizome system (underground stems) which supports its regrowth each season and helps it spread.

C. teneristolon has been observed breaking through special weedproof matting in a revegetation area alongside a creek line, suggesting the plant may potentially be an aggressive invader.



Key points

- Prevention and early intervention are the most cost-effective forms of weed control.
- *Cyperus teneristolon* is a problem overseas in environments similar to parts of Australia. For this reason it needs to be eradicated before it gets a chance to establish.
- It is capable of adapting to a variety of conditions and has the potential to invade creek systems in the Blue Mountains National Park and surrounding agricultural lands.
- *C. teneristolon* has three modes of reproduction: via rhizome, stolons and seed.

Natural Heritage Trust
Helping Communities Helping Australia
An Australian Government Initiative

Alert List For ALERT Environmental Weeds

Growth calendar

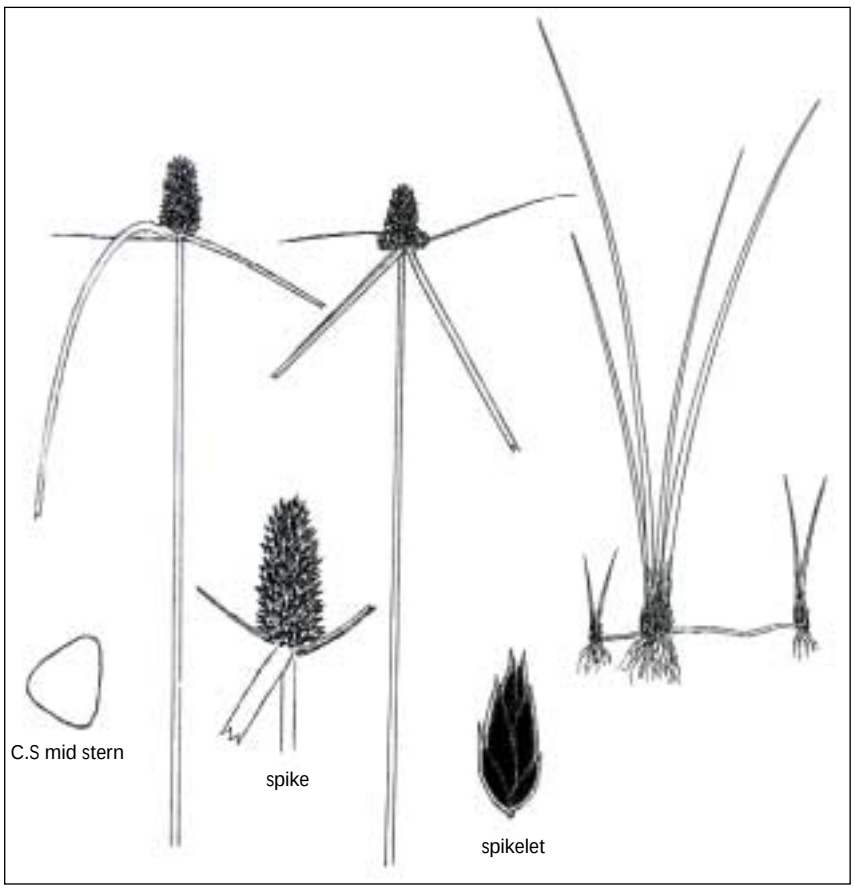
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flowering	■	■										■
Germination									■	■	■	
Regrowth									■	■	■	

■ General pattern of growth

Not much is known about the life cycle of *C. teneristolon* in Australia. The following information was obtained from its overseas locations, and from casual observations made in its current habitat in the Blue Mountains. Because *C. teneristolon* is a sedge, and from a tropical region, it does not go dormant during the winter, but slows its growth in cool periods. It regrows and germinates during the spring months, and flowers in the summer.

How it spreads

C. teneristolon is thought to have been introduced into the Australian natural environment by the dumping of garden plants at the Blue Mountains refuse tip. However, no source plant has ever been found. *C. teneristolon* is capable of spreading vegetatively, by its rhizome and stolon systems, and by seed. Its invasion of Yosemite Creek downstream from its source may have been via the movement of seed carried in the water. The whole spike will fall as one unit and eventually release the fruit (a nut) and the enclosed seed.



The roots of *C. teneristolon* are fibrous and the plant has an extensive rhizome system (underground stems) which supports its regrowth each season and helps it spread. Image not to scale.
Photo: Van Klaphake

The stolons spread the plant by clambering across the ground and forming new populations nearby. Rhizomes sprout new growth similarly, producing detached clumps. It is also possible for the stolons and rhizomes to break off and propagate in downstream locations, making the risk of spread even greater.

Where it grows

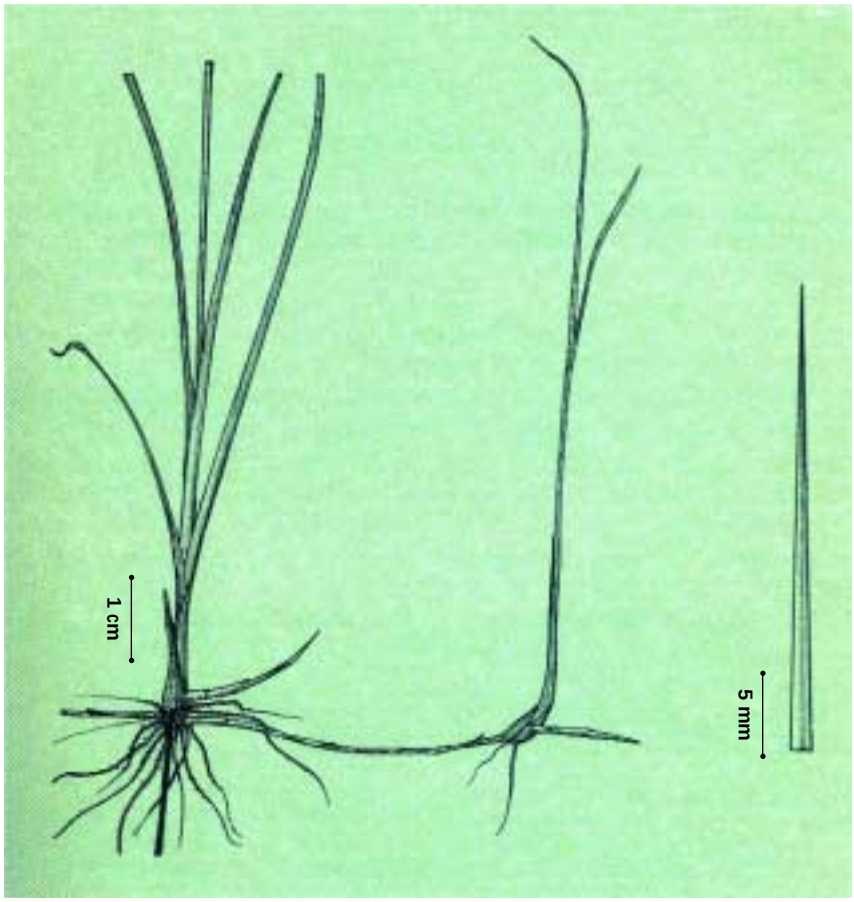
The only known occurrence of *C. teneristolon* in Australia invades a 2 km section of the Yosemite Creek in the Minnehaha Reserve of the Blue Mountains, New South Wales. It was first recognised as naturalised in Australia in February 2000, believed to be sourced from a refuse tip upstream of the current infestation.

C. teneristolon is native to Ethiopia and neighbouring countries, extending to South Africa. The Ethiopian climate is monsoonal, and temperatures range between approximately 20°C in the highlands and 40°C in the far eastern section of the country, where near-desert conditions exist. Most of the country is characterised by a high plateau (from 1500 m) and mountain ranges (up to 2440 m). Both native and naturalised populations of *C. teneristolon* suggest that it prefers highland areas with soils that are sandy and poor in nutrients.

C. teneristolon was able to naturalise after being dumped at a refuse tip in NSW

It has become a localised weed of crops in the semi-arid Kenyan and Tanzanian highlands, but has also invaded damp rocky outcrop areas of Natal, South Africa. The plant is therefore capable of adapting to varied environmental conditions but shows a preference for damp open areas or rock outcrops. This is very similar to its current habitat in the Blue Mountains. *C. teneristolon* grows beneath an overstorey of eucalypt along Yosemite Creek but will also grow in full-sun environments.





C. teneristolon is a perennial sedge with triangular stems that generally grows in damp areas.
Photo: Food and Agriculture Organisation of the United Nations

Why we need to be 'alert' to *C. teneristolon*

As it is a weed of both semi-arid agricultural crops and damp grasslands, the potential for its distribution in Australia is wide. *C. teneristolon* has spread 2 km from its source since approximately 1999, and may continue to threaten native ecosystems downstream if not managed. In Australia it has only been reported as occurring in relatively isolated patches. However, widespread invasion has been observed overseas. References to the weed in the report 'Kenyan Agricultural Research for Plant Protection' describe *C. teneristolon* as widespread and naturalised within the country's agricultural and natural areas, necessitating herbicide control.

The location of *C. teneristolon* in the greater Blue Mountains National Park should make it a priority for control while it is still at a manageable level. Manual removal has been undertaken in revegetation areas with some success, but its

The Alert List for Environmental Weeds

The Federal Government's *Alert List for Environmental Weeds* was declared in 2001. It consists of 28 weed species that currently have limited distributions but potentially could cause significant damage. The following weed species are therefore targeted for eradication:

Scientific name	Common name	Scientific name	Common name
Acacia catechu var. *sundra*	cutch tree	*Koelreuteria elegans* ssp. *formosana*	Chinese rain tree
Acacia karroo	Karroo thorn	*Lachenalia reflexa*	yellow soldier
Asystasia gangetica ssp. *micrantha*	Chinese violet	*Lagarosiphon major*	lagarosiphon
Barleria prionitis	barleria	*Nassella charruana*	lobed needle grass
Bassia scoparia	kochia	*Nassella hyalina*	cane needle grass
Calluna vulgaris	heather	*Pelargonium alchemilloides*	garden geranium
Chromolaena odorata	Siam weed	*Pereskia aculeata*	leaf cactus
Cynoglossum creticum	blue hound's tongue	*Piptochaetium montevidense*	Uruguayan rice grass
Cyperus teneristolon	cyperus	*Praxelis clematidea*	praxelis
Cytisus multiflorus	white Spanish broom	*Retama raetam*	white weeping broom
Dittrichia viscosa	false yellowhead	*Senecio glastifolius*	holly leaved senecio
Equisetum spp.	horsetail species	*Thunbergia laurifolia*	laurel clock vine
Gymnocoronis spilanthoides	Senegal tea plant	*Tipuana tipu*	rosewood
Hieracium aurantiacum	orange hawkweed	*Trianoptiles solitaria*	subterranean Cape sedge

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au

The above contacts can offer advice on weed control in your state or territory. If using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

presence near a creek line does present a threat to downstream areas. Care needs to be taken to avoid any damage to native vegetation.

What to do about it

Prevention is better than the cure

As with all weed management, prevention is better and more cost-effective than control. The annual cost of weeds to agriculture in Australia, in terms of decreased productivity and management costs, is conservatively estimated at $4 billion. Environmental impacts are also significant and lead to a loss of biodiversity. To limit the escalation of these impacts, it is vital to prevent the further introduction and establishment of new weed species, such as *C. teneristolon*.

Small infestations may be eradicated if they are detected early, but an ongoing commitment is needed to ensure new infestations do not establish. In Kenya this weed has been successfully controlled using herbicides, but no herbicide is registered to control *C. teneristolon* in Australia.



The shape and colour of the flower spikelets (inflorescence) distinguishes *C. teneristolon* from all other sedge species.
Photo: John Hosking, NSW Agriculture





Quarantine to prevent further introductions

No importation of *C. teneristolon* into Australia is permitted because of the risk of further spread, and the potential introduction of new genetic diversity that could make future control more difficult.

Do not buy seeds via the internet or from mail order catalogues unless you check with quarantine first and can be sure that they are free of weeds like *C. teneristolon*. Call 1800 803 006 or see the Australian Quarantine and Inspection Service (AQIS) import conditions database <www.aqis.gov.au/icon>. Also, take care when travelling overseas that you do not choose souvenirs made from or containing seeds, or bring back seeds attached to hiking or camping equipment. Report any breaches of quarantine you see to AQIS.

Raising community awareness

Some 65% of weeds which have recently established in Australia, including *C. teneristolon*, have escaped from plantings in gardens and parks. The detrimental impacts of these weeds far outweigh any potential horticultural benefits. The public should be made more aware of these impacts, and of other issues such as how to identify *C. teneristolon* and what to do if they find it.

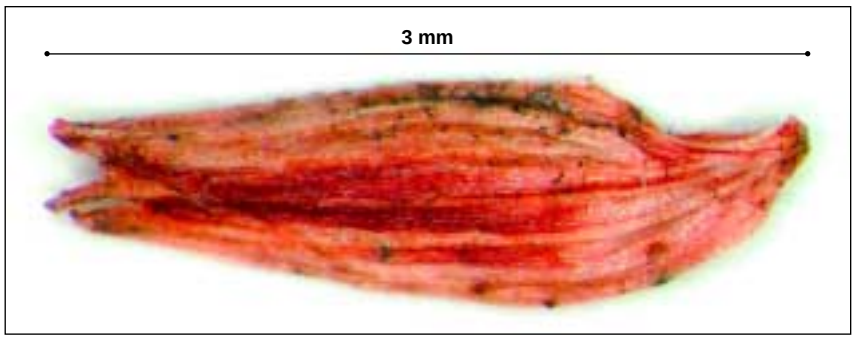
C. teneristolon can be identified by its purple to black egg-shaped flower spikes that are made up of many tiny individual flower spikelets in an inflorescence. It has slender stolons that connect the individual plants together and its leaves are 1-3 mm wide. *C. teneristolon* has an extensive underground rhizome system which supports its growth each season and helps it spread.

New infestations of *C. teneristolon*

Because *C. teneristolon* has naturalised in only one known location, it can still be eradicated. Any new outbreaks should be reported immediately to your state or territory weed management agency or local council. Do not try to control *C. teneristolon* without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread a weed and worsen the problem.



The flower of *C. teneristolon* is an egg-shaped purple to black-coloured spike consisting of many tiny spikelets.
Photo: NCW Beadle Herbarium, University of New England, NSW



Many of these tiny spikelets (inflorescence) make up the main flower spike of *C. teneristolon.*
Photo: NCW Beadle Herbarium, University of New England, NSW

Legislation

There is no legislation to control *C. teneristolon* but it is on the Federal Government's *Alert List for Environmental Weeds*, meaning that it is marked for eradication and should not be imported into Australia.

Acknowledgments

Information and guide revision: Tanya McLean (Bushcare Coordinator for the Blue Mountains), John Hosking (NSW Agriculture/Weeds CRC), Jeremy Bruhl (University of New England).

Map: Base data used in the compilation of distribution map provided by Australian herbaria via Australia's Virtual Herbarium.



If you find a plant that may be cyperus

Quick reference guide

Identification

If you suspect a plant to be *C. teneristolon*, you will first need to confirm its identity. Contact your state or territory weed management agency for help in identifying the plant. You will need to take note of the characteristics of the plant in order to accurately describe it. Features to aid in the identification of *C. teneristolon* include:

- purple to black egg-shaped flower heads
- slender stolons connecting the plants together
- leaves 1–3 mm wide.

Reporting occurrences

Once identified, new occurrences of *C. teneristolon* should be reported to the relevant state or territory weed management agency or local council, who can offer advice and assistance on its control. Because *C. teneristolon* represents a potentially serious environmental and economic threat to Australia, its control is a matter that should be undertaken with the appropriate expertise and adequate resources.

Follow-up work will be required

Once the initial infestation is controlled, follow-up monitoring and control may be required for some years.



Collecting specimens

State or territory herbaria can also identify plants from good specimens. These organisations can provide advice as to how to best collect and preserve specimens.

State/Territory	Postal Address	Phone	Web
Australian National Herbarium	GPO Box 1600 Canberra, ACT, 2601	(02) 6246 5108	www.anbg.gov.au/cpbr/herbarium/index.html
National Herbarium of New South Wales	Mrs Macquaries Rd Sydney, NSW, 2000	(02) 9231 8111	www.rbgsyd.nsw.gov.au
National Herbarium of Victoria	Private Bag 2000 Birdwood Avenue South Yarra, Vic, 3141	(03) 9252 2300	www.rbg.vic.gov.au/biodiversity/herbarium.html
Northern Territory Herbarium	PO Box 496 Palmerston, NT, 0831	(08) 8999 4516	http://www.nt.gov.au/ipe/pwcnt/
Queensland Herbarium	c/- Brisbane Botanic Gardens Mt Coot-tha Rd Toowong, Qld, 4066	(07) 3896 9326	www.env.qld.gov.au/environment/science/herbarium
South Australian Plant Biodiversity Centre	PO Box 2732 Kent Town, SA, 5071	(08) 8222 9311	www.flora.sa.gov.au/index.html
Tasmanian Herbarium	Private Bag 4 Hobart, Tas, 7000	(03) 6226 2635	www.tmag.tas.gov.au/Herbarium/Herbarium2.htm
Western Australian Herbarium	Locked Bag 104 Bentley DC, WA, 6983	(08) 9334 0500	http://science.calm.wa.gov.au/herbarium/

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Fireweed

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INTRODUCTION

Fireweed, or variable groundsel, is a name that refers to a number of important weed species of the genus *Senecio* within the *Asteraceae* (daisy/thistle) family.

In coastal New South Wales, the most common species of fireweed is *S.madagascariensis*, a plant native to south-eastern Africa. Recent trial work by I.J. Radford funded by the Dairy Research and Development Corporation and the Meat and Livestock Corporation has shown that *Senecio madagascariensis* in Australia and Madagascar have similar chromosome counts. However, Australian fireweed populations, using isozyme studies, were most closely related to *S.madagascariensis* from Natal and Eastern Cape than Madagascar.

Another species, *S.lautus*, does occur, but only as a minor part of the fireweed population. *S.lautus* is native to Australia, and is found mainly in bushland or undisturbed sites, and is more widely distributed throughout Australia in alpine, arid and coastal environments.



Photo: R Watson

Many thousands of hectares of pastures in coastal districts of NSW become infested with fireweed during the autumn to spring period.

Fireweed is an invasive plant, quickly colonising heavily grazed, or neglected pastures, and cultivated, or disturbed, land during the autumn to spring period. It competes strongly with existing pasture plants for light, moisture and soil nutrients, particularly phosphorus and nitrogen. This competition can lead to the further deterioration of pastures and a reduction in overall grazing area.

Fireweed can sometimes be poisonous to livestock, particularly cattle and horses.

DESCRIPTION

Fireweed, *S.madagascariensis*, has a variable growth habit and leaf structure, growing from 10–50 cm high. In coastal districts the most common form of fireweed is a low, heavily branched, short-lived perennial bush.

Although leaf shape and structure can vary, leaves are generally bright green, alternate, narrow with serrated, entire or lobed margins. The broader leaves are usually clasped around the stem and are 2–6 cm long, occasionally reaching 8–10 cm on vigorous and older plants.

Flowers are small, yellow and daisy-like, from 1–2 cm in diameter and can number from 2–200 per plant in a loose cluster at the end of the branches. Petal numbers are usually a constant 13. Plants flower mainly from April-September, with individual plants often having a wide range of flowering stages at any one time.

Seeds are small (1–3 mm long), light and slender. They are cylindrical in shape, with a downy surface and attached to a pappus of fine, silky white feathery hairs. The plant produces large quantities of seed over a long period.



Photo: JJ Dellow

Fireweed plants can have a wide range of flowering stages at any one time, but each flower always has 13 petals.

Each flower produces between 100–150 seeds. Therefore, a single large plant has the ability to produce around 25,000–30,000 seeds with a high viability.

Fireweed has a shallow, branched tap root with numerous fibrous roots, growing from 10–20 cm deep.

LIFE CYCLE

Fireweed is highly adaptable to changes in the environment. Under normal or favourable seasonal conditions, the plant can behave as a short-lived perennial. In an extremely dry season or in an arid environment however, it behaves as an annual.

In the field, many stages of development of the plant (seedlings to flowering plants) can be seen at almost any time of the year.

Germination of seed depends mostly on rainfall but is also stimulated by light and by mild-warm temperatures.

Optimum temperatures for germination of fireweed occur between 15–27°C, with greatly reduced germination at lower or higher temperatures. Most rapid germination occurs between 20–25°C.

As these temperatures indicate, fireweed can germinate over much of the year. Most seed, however, germinates from March to June, with the young plants developing rapidly. Plants can produce flowers 6–10 weeks after emergence.

Seeds can germinate immediately after they are released from the flower head. The plant is therefore able to produce several generations in one season. The seed has a germination percentage soon after maturity of around 90%.

Germination of seed is affected by soil depth, with seedling emergence not occurring below 2 cm.

It is not known how long seed will remain viable in the field, but observations of recently disturbed paddocks and subsequent infestations suggest it can be a number of years.

In most districts, fireweed ends its life cycle from spring onwards. This occurs when the top growth of most of the advanced plants, dies off during the summer. The perennial root system however remains and can produce new and rapid regrowth from the crown in the following autumn. In some situations, plants can continue to grow throughout the year.

DISTRIBUTION

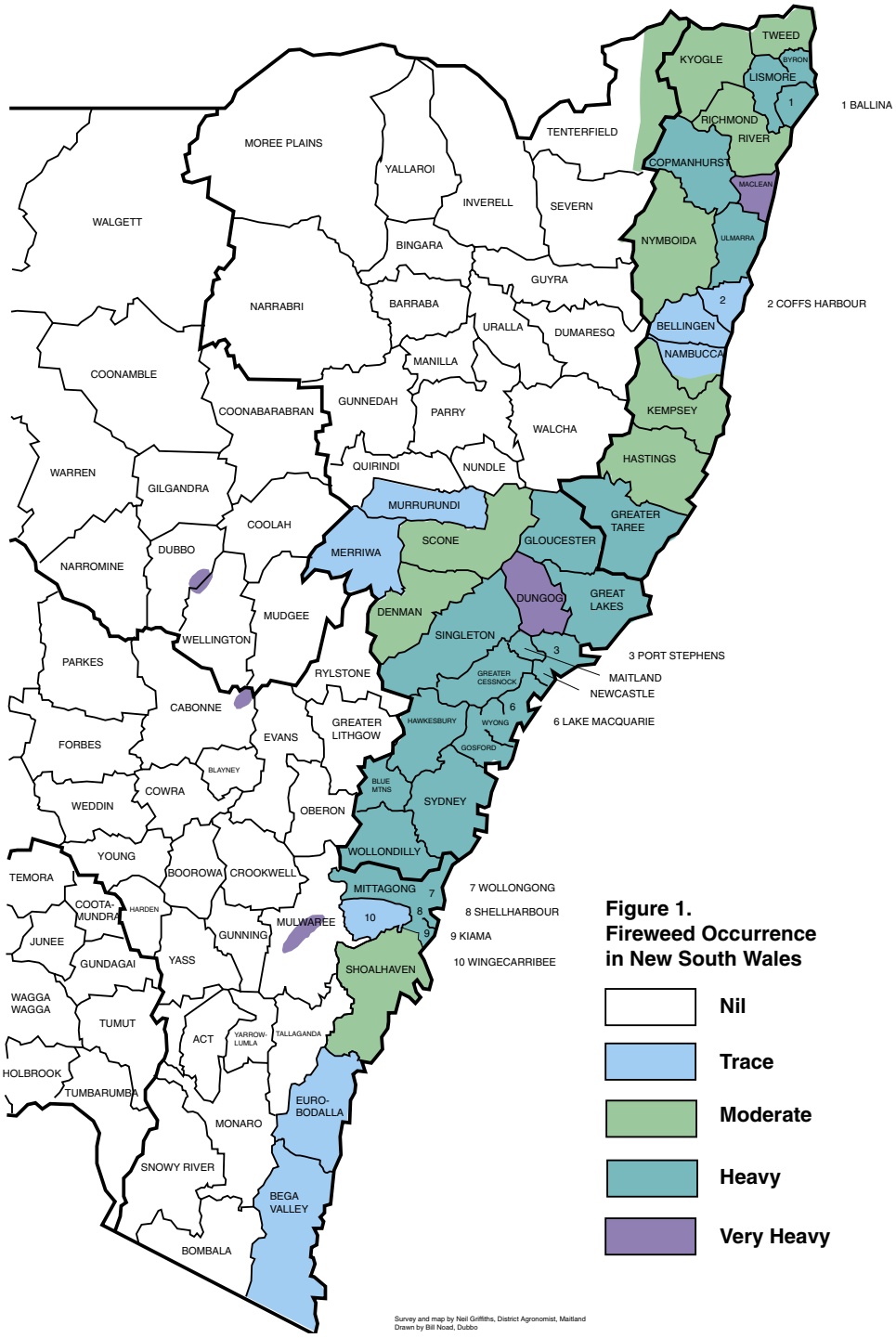
Fireweed is a serious weed of coastal pastures in New South Wales and is increasingly a problem (see Figure 1). It is especially abundant in the Richmond, Manning and Hunter valleys, in the Sydney metropolitan area, and between Wollongong and Berry on the South Coast.

Fireweed is a declared noxious weed in 16 local government areas. The weed has spread as far south as Bega and is known to occur in south-eastern Queensland. Survey work has also shown the weed can occur on the Northern and Southern Tablelands.

Fireweed grows on a wide range of soils from high fertility, self-mulching clay soils to low fertility, acid sandy soils. It is most prolific in well-drained, lighter-textured, acid soils of low-medium fertility. It will not survive in poorly drained or waterlogged situations.

SPREAD

The light, fluffy seeds are easily spread by wind. Dispersal of large amounts of seed by wind is considered to be the major factor responsible for the weed's rapid spread over large areas and long distances.



They can also be spread in hay and grain products, on clothing and vehicles, and by livestock, birds and other animals.

Fireweed also has the ability to grow vegetatively. Stems may take root at the nodes when in contact with moist soil.

FIREWEED POISONING

Fireweed is responsible for many cases of poisoning resulting in ill-thrift in livestock. This is because it contains pyrrolizidine alkaloids that are toxic. These chemicals produce a characteristic type of liver damage. All growth stages and parts of the plant contain these chemicals. Hay or silage contaminated with fireweed can be toxic, as can stands of the plant that have dried off in summer.

There are three sets of circumstances where ingestion of fireweed by livestock is difficult to avoid:

- where there is a severe shortage of other feed (often in winter on the coast when fireweed is prolific) and fireweed is the only feed available;
- where the pasture is so heavily infested with young fireweed plants that they cannot be avoided by grazing livestock;
- where a paddock with a thick stand of fireweed is slashed and then grazed by stock immediately afterwards.

Cattle and horses are most susceptible to the toxic liver damage from fireweed. Young, hungry stock are in the highest risk category. Normally, cattle and horses avoid fireweed when adequate pasture is available but may eat the weed when the quality of pasture is low.

Sheep and goats readily eat fireweed. They find the plant highly palatable and often eat fireweed in preference to other plants. Paddocks that are grazed with sheep or goats are kept relatively free of fireweed.

Sheep and goats are 20 times more tolerant of pyrrolizidine alkaloids than are either cattle or horses. This is because they have a specific bacterium in their rumen that enables them to detoxify much of the alkaloids.

Although fireweed is much less toxic to sheep and goats, it can cause some liver damage in them if large quantities are eaten over long periods, e.g. consecutive seasons or years.

Pastures contaminated with fireweed should not be baled or made into silage. A program to remove the existing fireweed plants should be carried out prior to any hay making or silage operations.

SYMPTOMS OF POISONING

Symptoms of poisoning with fireweed in cattle and horses primarily are loss of appetite and ill-thrift. Sometimes other liver related signs will include: aimless wandering, loss of muscular co-ordination, apparent blindness, photosensitisation, jaundice, abdominal straining, dullness and chronic scouring. Severe liver damage due to the pyrrolizidine alkaloids can result in death.

The most common effect attributed to fireweed in cattle is ill-thrift in young stock.

A condition in cattle on the Central Coast of New South Wales, commonly called coastal ill-thrift, is probably due to a combination of mineral deficiencies, internal parasites and fireweed toxicity. However, on fireweed-infested properties where mineral deficiencies and internal parasites are not a problem, young stock can still fail to thrive. Varying degrees of chronic liver damage are normally seen in these animals.

There is no effective treatment for fireweed poisoning. The control measure that most benefits livestock is a reduction in the quantity of fireweed in grazing pastures.

WHEN FIREWEED IS A PROBLEM

Losses of up to 62% in pasture productivity have been recorded in fireweed infested pastures monitored from August-September.

A combination of unfavourable pastoral and seasonal conditions such as drought, overgrazing or poor pasture management enables fireweed to take over run-down pastures.

While it grows in all types of pasture and on all aspects, fireweed density is influenced by the quality of ground cover and competition provided by pasture plants.

Fireweed is also encouraged by pastures that have been trampled by stock such as in stock camps, holding paddocks, or through heavy stocking rates.

Areas that have been cultivated or disturbed are also vulnerable. Fireweed is generally not a problem in irrigated pastures, which are normally intensively managed with more vigorous growth and better cover.

Fireweed seed is readily dispersed by wind. Therefore the potential for reinfestation is always present in fireweed districts.

CONTROL

An integrated approach is the best means to control fireweed in pastures. This approach includes grazing strategies, such as not overgrazing pastures and using sheep and goats with other livestock to control fireweed. Other strategies include: fertiliser application at appropriate times, upgrading pastures via direct drilling or oversowing, and strategic herbicide applications.

Effective control of fireweed in every situation is not always economic or practical. Any effective control program though must be thorough and systematic. It is also preferable to manage a small area correctly, than to poorly manage a large area. Follow-up control methods and management will also be essential if initial control is to be successful.

Control methods

Early removal. Isolated plants can be pulled out by hand or spot-sprayed before they set seed. Uprooted plants should then be placed in a large plastic bag, such as an old fertiliser bag, and burnt. If left in the paddock, these uprooted plants can still produce viable seeds and propagate from cut or broken stems in contact with the soil.

Pasture improvement and management. A vigorous permanent pasture provides the best control of fireweed. This can be achieved by sowing suitable competitive pasture species, appropriate grazing management and fertiliser applications. A dense autumn-winter cover will reduce fireweed populations. This can be achieved by: sowing winter pasture species, allowing standover of summer pasture feed, or combinations of winter/summer pastures.

Suitable summer-growing species include kikuyu, paspalum, setaria and Rhodes grass. These summer pastures can be 'locked up' over the period February-April to develop a thick sward that will compete directly against germinating fireweed seedlings.

Establishing these pastures requires good management, (see Agfact P2.2.6 *Eight steps to successful pasture establishment*).

Research conducted at Taree has shown that Setaria/white clover pastures can effectively control fireweed over winter-spring. Appropriate establishment methods were important to gain maximum pasture plant density and ground cover (see Table 1), however, a fully prepared seedbed can encourage germination of fireweed seeds. Where cultivation may encourage fireweed germination or on non-arable country, pasture establishment in badly infested paddocks can be strategically achieved by broadcasting the pasture seed onto a chemical seedbed.

Table 1. Establishment methods for *Setaria*, Taree district, as a competitor for fireweed

Establishment method	Ground cover %	
	(after 1 year)	(after 2 years)
Broadcast	0	0
Aerator	0.4	11
Chisel plough	2	26
Herbicide only	13	49
Herbicide + mulch	9	44
Herbicide + aerator	6	42
Herbicide + direct drill	10	40
Seedbed (chisel plough)	24	64
Seedbed (rotary hoe)	25	58

NB. Excellent coverage of all plots by white clover kept fireweed under control throughout winter and spring.

In suitable areas, winter-spring growing pasture species such as phalaris, fescue, ryegrass, white clover and subterranean clover will also compete directly with fireweed over winter.

Phalaris and fescue with Haifa white clover and subterranean clover is an ideal permanent pasture to compete against fireweed south of the Hunter Valley.

It is relatively slow to establish and may require bromoxynil herbicide treatment in the initial stages of development to control fireweed infestations. The phalaris and fescue develop into large, tussocky plants that provide direct competition for fireweed.

Perennial ryegrasses, including Kangaroo Valley and Victorian ryegrasses, also provide direct competition to fireweed. Very vigorous annual and biennial ryegrasses like Concord, Surrey, Flanker and Eclipse provide even greater competition. These can be direct drilled, broadcast or mulch-sown into semi-dormant paspalum, couch and kikuyu pastures for greater winter feed and fireweed control with outstanding results.

Incorporating pasture, management and, where necessary, herbicides, are essential for controlling fireweed. A pasture should be vigorously growing

before spraying with a herbicide. This will guarantee competition for the next generation of fireweed plants that will germinate when the larger weeds have been killed.

Maintaining soil fertility and correcting soil problems such as acidity are important in establishing and maintaining a permanent competitive pasture. Paddocks that have had a heavy fireweed infestation, and which are then heavily fertilised without pasture improvement, are especially prone to further invasion. It is therefore very important that fertiliser is only applied to improved or competitive pasture species. Ryegrass and phalaris are competitive against fireweed as well as barley grass which has the same growth habit as fireweed and provides good competition in winter and spring.

Careful grazing management to maintain pasture density and a moderate body of pasture litter, will reduce fireweed seed germination and suppress seedling growth and development. Lenient grazing management is very important for native and unimproved pasture to ensure the pasture has a sufficient groundcover and a competitive advantage. Where pasture vigour declines because of drought or over-grazing, a reinfestation of fireweed is likely.

When pasture becomes less vigorous it is important to correct the cause of the decline before upgrading or resowing the pasture. Problems of soil fertility, and possibly, acidity should be examined and overcome to ensure that a competitive permanent pasture can be established and maintained.

Applications of superphosphate fertilisers can encourage fireweed in the short-term, particularly if the area is disturbed by pasture renovation and establishment practices. Topdressing, however is necessary for the build-up of soil fertility and helps to establish and maintain productive permanent pasture. This type of pasture must be the aim for long-term control of fireweed.

Soil phosphorus levels are critical to maintain a vigorous pasture on the coast. Annual applications of 125–250 kg/ha of single superphosphate or the application of 20 cubic metres/ha of broiler manure every second or third year will give excellent results. Annual single applications of 125–250 kg/ha superphosphate will result in more productive pastures than heavier applications made less frequently.

Maintaining other soil components, including nitrogen, potassium, pH and a correct cation balance are also important. For many coastal soils which tend to be acidic, and particularly where



Photo: H Allan

Direct drilled Tetila and Concord ryegrass competing against a dense establishment of fireweed.

pH sensitive species are sown, liming may be necessary to maintain an optimum pH for pasture growth.

Consult your local district agronomist for specific advice on the most appropriate pasture and fertiliser recommendations and pasture establishment techniques for your situation.

Cultivation. A large proportion of fireweed-infested areas are non-arable due to slope and/or soil type. For arable areas however, cultivation followed by a cropping program and/or pasture improvement can be effective. Cultivation also allows effective lime incorporation. Lime topdressed onto existing pastures is slow to penetrate into the top 10 cm of soil and is generally far less effective than incorporated lime.

Cultivation in February-March is ideal as it usually stimulates a massive germination of seed. While a number of cultivations can be necessary to reduce fireweed soil seed reserves, it must be remembered that overcultivation can damage soil structure. It is important to have rain after each cultivation to get as many seeds to germinate as possible.

The initial cultivation should be at least 15 cm deep to completely bury any seed deposits. After pasture has been sown, strategic applications of herbicides may be necessary to kill fireweed seedlings.

Chemical control. (Also refer to the NSW DPI publication *Noxious and environmental weed control handbook 2004–2005*). There are currently a number of registered herbicides that are effective on fireweed. Before spraying, check paddocks during early autumn-winter for fireweed seedlings and regrowth, particularly after a good fall of rain.

Spray fireweed with registered herbicides during the small seedling-early flowering stages of growth. Early autumn-winter is best when fireweed plants are young and actively growing. At this

stage, lower rates of herbicide are sufficient to kill seedlings. Isolated plants that survive can be pulled out by hand or spot sprayed. Follow-up treatment can also be necessary to deal with regrowth and seedlings that appear after spraying.

Selective herbicides (see NSW DPI publication *Noxious and environmental weed control handbook 2004–2005*) are effective when used in conjunction with good management practices. For example, improved winter pastures of ryegrass and clover can be sprayed in May to kill small fireweed seedlings before they flower and set seed. This reduces reserves of fireweed seed in the ground. Also at this stage, the lower rates of the selective herbicide will give an excellent kill of fireweed.

Subsequently, topdressing these ryegrass pastures with nitrogen fertilisers produces a flush of growth that inhibits further fireweed growth over winter.

Weed wiping equipment using appropriate herbicides has also given excellent results in trials at Taree where fireweed had been taller than pasture in trials. The trial area was initially grazed by cattle. One pass of a ropewick applicator produced a 70% kill while two passes in different directions resulted in a 95% kill. Most fireweed plants died within three weeks of treatment.

Generally, multi-rope, carpet wipers or rotary wipers are more effective than simple ropewick applicators. One pass of these applicators usually produces similar results to two passes of a simple ropewick applicator.

Slashing/mulching. Slashing or mulching a fireweed paddock from mid-September onwards to control fireweed has proven effective on the Central Coast in paspalum/kikuyu paddocks. By mid-September, when fireweed has developed into a large plant, slashing or mulching can damage plants sufficiently to allow the summer growing pasture to out compete fireweed. This control method is not recommended for summer growing pastures over autumn and winter because fireweed can recover more quickly than the pasture.

Slashing or mulching ryegrass pastures that have been grazed in autumn, winter and spring at six-weekly intervals and topdressed with nitrogen will reduce fireweed growth and seedling establishment. However, fireweed is generally not a problem in these situations.

A danger of slashed or mulched fireweed is that it wilts and can become more attractive to stock, with a greater concentration of plant toxin. Slashing is therefore less desirable than mulching as it leaves a windrow which stock can readily graze. Mulching, however, cuts plants into smaller pieces that are spread more evenly over the paddock, minimising the poisoning risk.

After slashing or mulching, fireweed-infested paddocks should not be grazed for at least two weeks.

Biological control. Various naturally occurring diseases and insects have been found attacking, and sometimes destroying fireweed plants. The most damaging insects are the chrysomelid beetle, *Chalcolampra* sp., larvae and adults of which defoliate plants, and two native moths, magpie moth, *Nyctemera amica*, which may defoliate plants and blue stem borer, *Patagoniodes farinaria*, which may ringbark plants causing plant death. These insects tend to damage plants late in the season after many seeds have matured.

Other insects which can be reared from plants but do not appear to cause a lot of damage are a stem mining fly, *Melanagromyza seneciophila*, a leaf mining fly, *Chromatomyia syngenesiae* (commonly known as cineraria leafminer), two gall forming fly species, *Sphenella ruficeps*, which form galls in flower heads and *Trupanea prolata* which forms galls in stems and flower heads, and two seed head feeding bugs, *Nysius clevelandensis* (commonly known as grey cluster bug) and *Nysius vinitor* (commonly known as Rutherglen bug).

In wet conditions the rust, *Puccinia lagenophorae*, may damage or destroy plants. Another disease, *Albugo tragopogonis*, sometimes forms blisters on fireweed.

All these insects and diseases are also present on the closely related native *Senecio lautus* complex.

Biological control of fireweed using introduced insects from Madagascar has been attempted but all insects tested to date have fed on the native *Senecio lautus* complex. This means that these insects are unlikely to be approved for release.

Grazing. Experience and observations in a number of districts indicate that sheep and goats will graze fireweed, sometimes in preference to other plants. In appropriate situations, they can provide an effective level of control. In the Upper Hunter and many inland districts where sheep enterprises are more common, fireweed invasion has been prevented and infestations totally controlled as a result of integrating sheep grazing of pasture. This has proved to be a simple, cheap and effective control program.

Paddocks stocked with sheep and goats are usually free of fireweed. However, once sheep and goats are removed, fireweed can reinvade. Cattle and horses, by avoiding the weed, actually encourage it.

In the Gippsland area of Victoria, many dairy farmers carry some sheep, usually crossbred wethers, for the sole purpose of controlling ragwort (*Senecio jacobaea*), a weed very closely related to fireweed.

Sheep and goats, by eating fireweed seedlings and large plants, prevent further seeding and therefore reduce the problem. They are also less affected by fireweed toxins, unless they eat the plant in large quantities or over two or more successive seasons. Flock composition should be altered regularly to avoid poisoning of animals. Sheep used for fireweed control should be replaced. Only sheep destined for slaughter, or wool cutting wethers, should be used, not breeding stock. Crossbred or British bred sheep are considered more suitable for the coastal environment. Blood tests for liver function can be carried out on a few representative animals to determine the need for replacement.

Problems associated with this control method do exist. For example, running sheep under coastal conditions can lead to an increased incidence of parasites and diseases. Ticks can also be a problem for sheep and goats in many coastal areas.

Improved and additional fencing or yards may also be required to successfully run sheep or goats. Wild dogs can be a problem in many districts and may require measures to limit their impact.

Stocking rates should also be carefully managed in order to suppress fireweed, but not overgraze pastures.

FURTHER INFORMATION

For further information on identification and control of fireweed, contact your nearest NSW DPI district agronomist. For further information on fireweed poisoning, contact your Rural Lands Protection Board District Veterinarian.

ACKNOWLEDGEMENT

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Disclaimer

The information contained in this publication is based on knowledge and understanding at the time of writing (February 2001). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up-to-date and to check currency of the information with the appropriate officer of New South Wales Department of Primary Industries or the user's independent adviser.

Always read the label

Users of agricultural (or veterinary) chemical products must always read the label and any Permit, before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the Permit by reason of any statement made or omitted to be made in this publication.

Pasture improvement

Pasture improvement may be associated with an increase in the incidence of certain livestock health disorders. Livestock and production losses from some disorders are possible. Management may need to be modified to minimise risk. Consult your veterinarian or adviser when planning pasture improvement.

The *Native Vegetation Act 2003* restricts some pasture improvement practices where existing pasture contains native species. Inquire through your office of the Department of Natural Resources for further details.

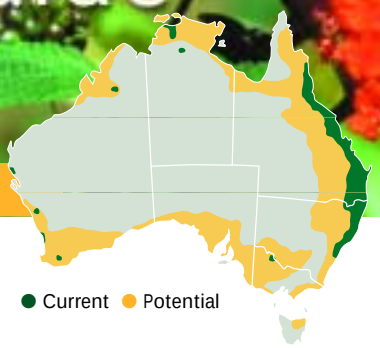
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ISSN 1832-6668

Job No 6333

Weed Management Guide

Lantana – *Lantana camara*



Lantana (*Lantana camara*)

The problem

Lantana is a *Weed of National Significance*. It is regarded as one of the worst weeds in Australia because of its invasiveness, potential for spread, and economic and environmental impacts.

Lantana forms dense, impenetrable thickets that take over native bushland and pastures on the east coast of Australia. It competes for resources with, and reduces the productivity of, pastures and forestry plantations. It adds fuel to fires, and is toxic to stock.

Lantana is a serious threat to biodiversity in several World Heritage-listed areas including the Wet Tropics of northern Queensland, Fraser Island and the Greater Blue Mountains. Numerous plant and animal species of conservation significance are threatened. It is listed as the most significant environmental weed by the South-East Queensland Environmental Weeds Management Group.

It is a problem in gardens because it can cross-pollinate with weedy varieties to create new, more resilient forms.

The weed

There are two main forms of lantana in Australia: a cultivated form planted in gardens and a weedy variety found in bushland and pastures. The cultivated form of lantana is non-thorny, produces few seeds and is compact in shape. The weedy form is a prolific seeder with straggly, thorny stems. Both forms include many varieties, which differ from each other in shape, flower colour, prickliness, response to enemies and toxicity.



Lantana is a significant weed of woodlands and pastures east of the Great Dividing Range.
Photo: Qld DNRM

Weedy lantana is a much branched, thicket-forming shrub, 2–4 m tall. The woody stems are square in cross-section and hairy when young but become cylindrical and up to 150 mm thick with age. The ovate (ie tear-shaped) leaves (20–100 mm long) occur in opposing pairs along the stem. The leaves are rough and finely hairy and emit a pungent odour when crushed. Each flower head is made up of 20–40 flowers, ranging in colour from white, cream or yellow to orange, pink, purple and red. The fruit has many berries, which ripen from green to shiny purple-black and contain a single pale seed. Lantana has a short taproot and a mat of many shallow side roots.

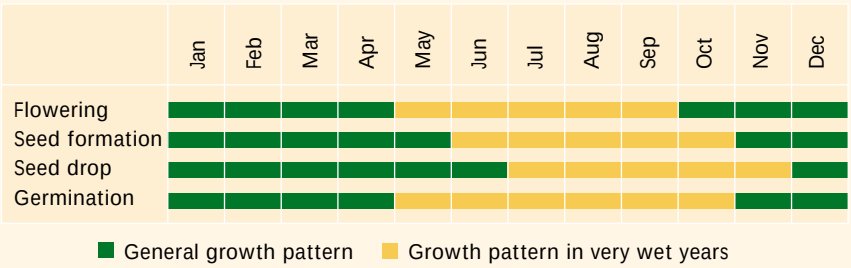
Key points



- Lantana is a thicket-forming shrub that has spread from gardens into pastures, woodlands and rainforests on the east coast.
- It typically invades disturbed land and river margins, extending its range in response to rainfall.
- It threatens agriculture and pastoral production, forestry and biodiversity of conservation areas, and may be toxic to stock.
- The highest priority for lantana control is preventing its spread into northern Australia and west of the Great Dividing Range.
- Integrated control should combine fire, mechanical, chemical and biological methods, and revegetation.

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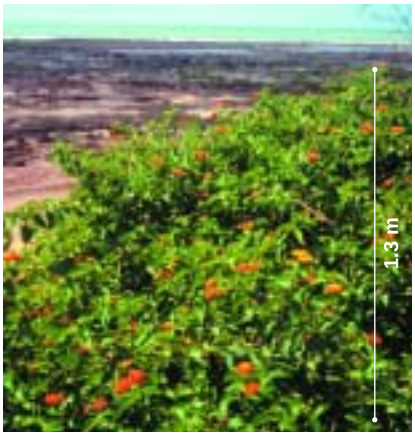
Growth calendar



Lantana flowers whenever the soil is moist and the air is warm and humid. For much of its range along the Queensland and New South Wales coasts, this results in almost continuous flowering and fruiting. Further inland, peak flowering occurs several weeks after soaking rain (25 mm or more) and is usually accompanied by good fruit set.

Germination most frequently occurs following the first summer storms, but may occur at any time of the year when sufficient moisture is present. Initial seedling growth is slow until the roots become established, after which close stems intertwine and begin to form thickets. Flowering does not usually commence until early in the following summer and then continues until March or April.

Lantana can resprout from the base if the shoot dies, extending the life of individual plants.



Flowering lantana infestation in Darwin, NT, in December.
Photo: Colin G. Wilson

How it spreads

Lantana spreads in two ways. Layering is a form of vegetative reproduction where stems send roots into the soil, allowing it to quickly form very dense stands and spread short distances. Also, birds and other animals such as foxes consume and pass the seed in their droppings, potentially spreading it over quite large distances. The germination rate of fresh seed is generally low, but improves after being digested.

Butterflies, bees and other insects are attracted by the nectar and pollinate lantana flowers. About half of the flowers produce seeds, typically 1–20 seeds on each flower head. Mature plants can produce up to 12,000 seeds every year. Seeds are thought to remain viable for several years under natural conditions.

Lantana is allelopathic and can release chemicals into the surrounding soil which prevent germination and competition from some other plant species.

First recorded in the Adelaide Botanic Gardens in 1841, lantana spread to east coast gardens and was recorded as a weed in Brisbane and Sydney in the early 1860s. It is now found across four million hectares of land east of the Great Dividing Range, from Mount Dromedary in southern New South Wales to Cape Melville in northern Queensland. Isolated infestations exist in the Top End of the Northern Territory, around Perth in Western Australia, and on Lord Howe and Norfolk Islands. Although present Australia wide as a garden ornamental, it has not naturalised to any serious extent elsewhere.



When ripe, birds and animals consume fruit and spread seed.
Photo: Colin G. Wilson

Where it grows

Lantana can grow in high-rainfall areas with tropical, subtropical and temperate climates. It does not tolerate salty or dry soils, waterlogging or low temperatures (<5ºC). It thrives on rich, organic soils but also grows on well-drained clay and basalt soils. Sandy soils tend to dry out too rapidly for lantana unless soil moisture is continually replenished. It has been reported at altitudes up to 1000 m in Queensland.

Lantana invades disturbed sites, especially open sunny areas, such as roadsides, cultivated pastures and fencelines. From there it can invade the edges of forests, but it does not fare as well under a heavy canopy as it is not very shade tolerant. Therefore, it is not a problem in intact tropical rainforest but can quickly spread there if the canopy opens out.

Lantana occurs naturally in Mexico, the Caribbean and tropical and subtropical Central and South America. It is considered a weed in nearly 50 countries.

Another weedy species of lantana

Another species of lantana is a popular ornamental that is considered a weed when present in natural ecosystems. Creeping lantana (*Lantana montevidensis*) occurs in coastal and subcoastal Queensland and as far south as Sydney. It is fairly similar to *Lantana camara* but does not have thorns, has mainly pink or purple flowers and trails along the ground, only growing to a height of half a metre. It is also toxic and readily displaces native vegetation.



Creeping lantana (*Lantana montevidensis*) is naturalised in coastal and subcoastal Qld and only grows to a height of half a metre. It is toxic and readily displaces native vegetation. Photo: John Swarbrick

Potential distribution

Lantana may be able to spread west of the Great Dividing Range, and could expand its range throughout southern Victoria, South Australia and southwestern Western Australia.

What to do about it

Lantana is extremely widespread and abundant. Because it is so well established on the east coast, and prevention of spread is the most cost-effective weed management tool, the highest priority for lantana management is to prevent its spread into uninfested areas. This will require three main actions.

1. Restricting further importation of lantana into Australia. Any new varieties brought in could escape cultivation and naturalise, or could cross-breed with naturalised varieties, leading to hardier new varieties more resistant to control.
2. Restricting the sale and use of lantana in gardens as these are potential sources of new infestation and new varieties. There are native and less weedy exotic ornamental alternative species.
3. Strategically controlling infestations that threaten areas where lantana is not yet a weed. Control methods are outlined below.

Integrated management

An integrated approach that uses a variety of control methods gives best results when dealing with lantana. A range of methods including herbicides, mechanical removal, fire, biological control and revegetation should be used. Best results are obtained by working from areas of light infestation towards heavier infestation, and long-term follow-up control is required after initial attempts. Minimise both disturbance to land and excessive use of fire to retain vigorous native vegetation and reduce the opportunity for lantana to become established.

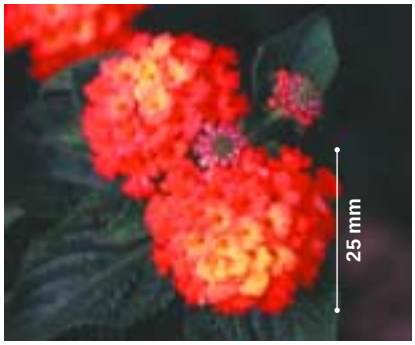
Herbicide control – effective but expensive

There are many herbicides registered for lantana control and three main application techniques. Spraying the entire plant (foliar spraying) usually kills plants that are less than 2 m high. Herbicides applied to the lower bark of the stems (the basal bark technique) or immediately painted onto a freshly cut stump (the cut-stump technique) are useful for larger plants. Both of these techniques are time consuming because they require treatment of each stem, which can be difficult to access in large stands of lantana. High costs make herbicide control uneconomical for large infestations, except when there are no other options (eg on steep slopes, where helicopter spraying may be required).

For best results, integrate fire, mechanical, chemical and biological control and revegetation

Herbicides, especially those that are foliar applied, are most effective when plants are actively growing. With lantana, best results are obtained six weeks after good rains (at least 35 mm) when minimum temperatures exceed 15ºC. In Queensland the spraying season generally lasts from early summer to autumn, but earlier control will potentially allow follow-up in the same growing season.







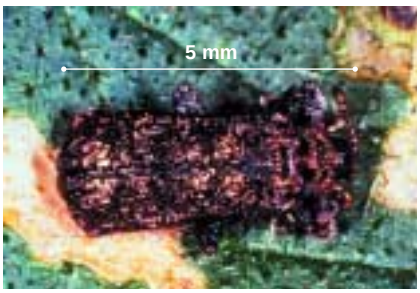
Lantana flowers can be one colour (*left*), or a mix of two (*centre*) or more colours (*right*). Photos: Kate Blood (left and middle). Colin G. Wilson (right)

Weed control contacts

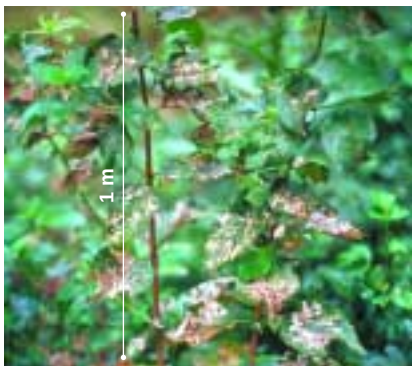
State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au
Australia wide	Australian Pesticides and Veterinary Medicines Authority	(02) 6272 5852	contact@apvma.gov.au	www.apvma.gov.au

Note that herbicides vary in their effectiveness on different lantana varieties. The red flowered varieties are normally the least susceptible to herbicides while the pink forms are the easiest controlled. Consult your local council or state/territory weed management agency about which herbicides and applications are most suitable for your infestation of lantana. State and territory contact details are listed above, including contacts for the Australian Pesticides and Veterinary Medicines Authority, which hosts the PUBCRIS database. This database contains information on all herbicides that are registered for use on weeds in each Australian state and territory.

When using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.



Both adults (*above*) and larvae of the leaf-mining beetle *Octotoma scabripennis* feed on lantana leaves. It is present in most lantana infestations, particularly where it is shady and wet in subtropical, coastal areas.
Photo: J. Wright, Qld DNRM



Damage to lantana leaves caused by the leaf-mining beetle *Octotoma scabripennis*.
Photo: Michael Day, Qld DNRM

Mechanical and physical control – suitable for small infestations

Lantana can be removed mechanically or physically in several ways, including stickraking, bulldozing, ploughing and grubbing. These techniques are mainly suited to medium-sized infestations and require extensive follow-up, as they invariably lead to regrowth if the rootstock is not removed, or seedling germination when heavy machinery disturbs the soil. Any soil disturbance should be avoided on steep inclines or in gullies. A permit may be required if native plants are to be affected by mechanical control – check with your local council or state/territory weed management agency.

Fire – inexpensive but caution must be exercised

Fire is often used prior to mechanical or herbicide control to improve their effectiveness, or as a follow-up to such methods. It can also provide some control when used on its own under the right conditions. It is most effective when fires are hot and the lantana is actively growing. In southeastern Queensland best results from fire are achieved during early summer. In New South Wales controlled burns are used opportunistically, mainly in late winter and spring before conditions become too dry and fires could escape control.

Fire is relatively inexpensive and well suited to dense infestations, but the risks to people and property must be carefully managed. Burning is not recommended in rainforest and vine thickets because they are highly sensitive to fire. Disturbance in these habitats may actually promote lantana if the canopy is opened up. A permit may be required to burn – check with your local council or state/territory weed management agency.

Biological control

In 1902 the first attempt at biological control of a weed targeted lantana in Hawaii. In Australia biological control agents were first introduced in 1914; so far, 30 species have been introduced. Research into biological control is ongoing, and several agents are currently being examined for suitability of release.



Of the 16 species that have established, four insects have had a major impact on lantana. They are:

- a sap-sucking bug (*Teleonemia scrupulosa*) (Sydney to northern Queensland).
- a leaf-mining beetle (*Uroplata girardi*) (northern Queensland to Sydney).
- a leaf-mining beetle (*Octotoma scabripennis*) (Sydney to south of Rockhampton).
- a seed-feeding fly (*Ophiomyia lantanae*) (southern New South Wales to northern Queensland).

The biological control agents vary in their effectiveness against the many different types of lantana. For example, lantana can drop its leaves when stressed, depriving some agents of their food.

Revegetation – useful in pastures and forests

Revegetation of a treated site is a key component of a lantana management program. Revegetation helps to reduce erosion, adds fuel for future burning in pastures and is vital in limiting the re-establishment of lantana and other weeds. Sowing an improved pasture that outcompetes and smothers lantana seedlings is assisted by withholding grazing for the first six months, and only allowing light grazing for the next 12–18 months. In forested areas either planting trees or encouraging naturally occurring seedlings will help to shade out lantana in the longer term. Check with your local council or state/territory weed management agency about appropriate species for revegetating pastures or forests in your area.

Follow-up

Follow-up control after an initial effort may include any or all of the above methods. Established pastures can be burnt to control significant lantana regrowth, and any small patches can be spot sprayed with a registered herbicide or grubbed out. In forested areas herbicides are recommended to control regrowth, typically requiring three follow-up sprays after the initial control effort.

Legislation

Landholders are required to reduce lantana infestations throughout some regions of Queensland, New South Wales and the Northern Territory. The sale of lantana in Queensland was banned in late 2003. Lantana importation is prohibited in Western Australia. Check with your local council or state/territory weed management agency for relevant details.

Acknowledgments

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Maps: Australian Weeds Committee.

...case study

Lantana control at Towra Point, Botany Bay, New South Wales



Towra Point Nature Reserve in Botany Bay contains habitats of high conservation status, including wetlands of international importance and open woodlands that are unique in the Sydney region. A coastal rainforest in the region was recently listed as an endangered ecological community under the New South Wales *Threatened Species Conservation Act 1995*. It includes the magenta brush cherry (*Syzygium paniculatum*), a vulnerable tree species.

By the 1990s, lantana made up almost 75% of the vegetation cover in some parts of the reserve and was limiting the regeneration of native species, particularly around a freshwater wetland called Weedy Pond. The Friends of Towra, a volunteer group, commenced weed control in the Weedy Pond rainforest in 1996. In 1998 the Sutherland Shire Environment Centre, working in conjunction with the National Parks and Wildlife Service, gained Coastcare funding to supplement the volunteer program.

Beginning in March 1998, weed control focused on a corridor connecting the rainforest and a casuarina/banksia forest, following up on previous control and initiating new efforts. Lantana was controlled by a combination of cut-stump herbicide application and manual removal of smaller plants. Other weeds were also controlled when they were encountered.

Work was undertaken about every two months throughout 1998 by volunteers and members of local community groups. Follow-up hand weeding and spot spraying, and further control of primary lantana infestations, were also undertaken throughout 1999. This work involved international backpackers, unemployed people from Green Corps 2000, students and personnel from private enterprise, all of whom volunteered their time. The total area cleared of lantana and other weeds was approximately 75 m wide and 100 m long.

In May 2000 the cleared areas were planted with native vegetation by local Cub Scouts and Venturers and members of the Friends of Towra. Approximately 200 banksias were planted. The training of volunteers and community groups on such issues as weed control techniques, bush regeneration and plant identification was another significant outcome.

At each quarterly follow-up visit to the site, approximately 24 man-hours are required to keep on top of any reshooting and newly germinated lantana, and encourage regeneration of native species. It is expected that lantana will become disadvantaged as canopy cover and shade increases, and less work will be required in the future.



How to control lantana

Quick reference guide



Minimise spread and future impacts

Although lantana is widespread on the east coast of Australia, it is still absent from parts of its potential range. These areas should be protected by:

- preventing the importation of further varieties and species of lantana
- stopping more planting of lantana in gardens
- strategically controlling infestations which threaten uninfested areas.

A control program for dense infestations in pastures

The Queensland Department of Natural Resources and Mines has produced a pest series fact sheet on lantana (PP#34). They advise that herbicides are too expensive to treat large lantana infestations.

A combination of fire and mechanical control makes spot treatment of small patches with herbicides more cost-effective. The following suggested control program for dense infestations in pastures is based on the fact sheet:

1. Exclude stock to allow a fuel load to build up.
2. Bulldoze, stickrake or plough the infestation to add to the fuel load.
3. Burn the infestation after obtaining a permit. Summer burns are more effective than winter burns.
4. Sow an improved pasture. Seek advice of local council or state/territory government agencies for selection of non-weedy pasture species.
5. Continue stock exclusion until pasture has established and set seed.
6. Burn the infestation again after obtaining a permit.
7. Spot spray or grub out any regrowth or seedlings. Spraying is most effective between summer and autumn.
8. Follow-up burning, spraying and/or grubbing will be required for several years.



Lantana can escape from garden plantings into surrounding bushland.
Photo: Tim Schultz

Control options

Type of infestation	Physical	Mechanical	Chemical	Fire	Biological
Small (few plants, small area)	Hand grubbing only suitable for seedlings. Wear gloves for protection from thorns.	Not suitable.	Spot spray plants less than 2 m in height between summer and autumn with a registered herbicide.	Not suitable.	There are four useful biological control agents. They are already distributed throughout their potential range.
Medium (medium density, medium total area)		Bulldoze, plough, stick-rake or slash infestations. Soil disturbance will lead to mass seed germination, so follow up with further controls. Do not use mechanical control in areas susceptible to erosion. A permit may be required.	Spraying is uneconomical for medium or large infestations. Helicopter spraying is used when there is no access for mechanical control, eg very steep slopes.	Under permit, burn in summer with good fuel load of grass and/or mechanically cleared lantana. Also use as follow-up. Do not burn in rainforests.	
Large (many plants, many ha)					

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CRC Weed management

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Annex F

Audit Checklists

FERN BAY SEASIDE VILLAGE CONSTRUCTION AUDIT CHECKLIST		
Date of Inspection:		
Inspected by:		
	Yes / No	**Comments / Action**
INDUCTIONS		
Site induction training for all personnel undertaken. Documented evidence kept and maintained of inductions.	☐ Yes ☐ No	
SEDIMENT CONTROLS		
Erosion and sediment control measures installed and maintained.	☐ Yes ☐ No	
Site checked for erosion.	☐ Yes ☐ No	
Topsoil / excess soil stockpiles separated in designated area and sediment control devices installed (eg diversion drains, silt fencing). Stockpiles compacted to reduce erosion and where stockpiling exceeds four months, stockpile is seeded to encourage vegetative growth.	☐ Yes ☐ No	
Disturbed areas re-seeded with a fast growing cover crop immediately following completion of earthworks.	☐ Yes ☐ No	
WATER QUALITY AND QUANTITY		
Drainage and sediment controls in place and in good order.	☐ Yes ☐ No	
Fuel or oil spills reported and cleaned up.	☐ Yes ☐ No	
Fuels / chemicals stored in bunded areas.	☐ Yes ☐ No	
AIR QUALITY		
Construction machinery not emitting excessive, visible smoke / fumes (for more than 10 seconds).	☐ Yes ☐ No	
On site dust suppression undertaken as required.	☐ Yes ☐ No	
All loads covered entering and leaving site.	☐ Yes ☐ No	
NOISE		
Plant and equipment maintained and kept in good working order	☐ Yes ☐ No	
Where practical, machines operated at low speed or power and switched off when not being used and not left idling for prolonged periods.	☐ Yes ☐ No	
Machines producing excessive noise (in comparison to industry standards) removed from the site or stood down until repairs / modifications made.	☐ Yes ☐ No	

Avoiding any coincidence of noisy plant working together in close proximity simultaneously near to sensitive receivers.	☐ Yes ☐ No	
Maximise the offset distance between noisy plant items and nearby noise sensitive receivers, orienting noisy plant or equipment away from sensitive areas.	☐ Yes ☐ No	
All work conducted within prescribed operating hours.	☐ Yes ☐ No	
FLORA AND FAUNA		
Clearing activities restricted to only those areas nominated on construction plans for each stage.	☐ Yes ☐ No	
Cleared vegetation chipped / mulched on site and reused in landscaping.	☐ Yes ☐ No	
Vehicle movements in uncleared areas restricted.	☐ Yes ☐ No	
Weed control undertaken as required to control spread of weeds on or off site.	☐ Yes ☐ No	
Ensure conservation areas adjacent to construction activities are protected with polyweb fencing or similar before commencing vegetation clearing. Maintain fencing during works to keep vehicles out of designated areas.	☐ Yes ☐ No	
Tree protection fencing installed around trees to be retained, including protection of tree root zone.	☐ Yes ☐ No	
Hollow bearing trees identified and marked in field prior to clearing.	☐ Yes ☐ No	
Inspection of tree hollows prior to clearing to determine use by fauna.	☐ Yes ☐ No	
Removal and release (nearby, on site) of fauna from hollows by experienced and licensed fauna expert.	☐ Yes ☐ No	
All felling of hollow bearing trees supervised by qualified fauna ecologist and in accordance with tree clearing protocol.	☐ Yes ☐ No	
Any injured wildlife reported to a fauna rescue organisation for rescue and care.	☐ Yes ☐ No	
Relocation of dead wood and dead mature trees to conservation areas and reserves on site (consistent with requirements of the Bush Fire hazard Assessment Report).	☐ Yes ☐ No	
REHABILITATION		
Rehabilitation undertaken immediately following completion of construction.	☐ Yes ☐ No	
Rehabilitated areas in good condition.	☐ Yes ☐ No	
WEEDS		
Weed control undertaken as required to control spread of weeds on or off site. Follow up control undertaken as required.	☐ Yes ☐ No	

Tyres of trucks entering and leaving the site are checked for weed seeds to limit spread of weeds.	☐ Yes ☐ No	
HERITAGE		
Stop work if Aboriginal sites located and consultation with DECC – NPWS undertaken as required.	☐ Yes ☐ No	
Aboriginal community consulted with during ground disturbing works.	☐ Yes ☐ No	
WASTE MANAGEMENT		
During clearing, vegetation will be stockpiled for mulching and use in landscaping on-site.	☐ Yes ☐ No	
Topsoil and excess fill will be reused on site wherever possible.	☐ Yes ☐ No	
Waste materials will be reused on site wherever possible prior to recycling or disposal and removed by licensed contractors.	☐ Yes ☐ No	
Provide an area for the segregation, storage and recycling of waste.	☐ Yes ☐ No	
No waste is buried on site.	☐ Yes ☐ No	
Fuels / waste oils stored in bunded area.	☐ Yes ☐ No	
ROADS AND TRANSPORT		
Ensure all vehicles access construction site via defined ingress and egress only.	☐ Yes ☐ No	
Machinery storage in designated area (within development footprint)	☐ Yes ☐ No	
COMPLAINTS AND INCIDENTS		
Complaints register maintained and complaints responded to.	☐ Yes ☐ No	
Incident register maintained and incidents responded to.	☐ Yes ☐ No	

FERN BAY SEASIDE VILLAGE - SHORT TERM MONITORING CHECKLIST

To be used:

1 week following revegetation works; and

6 months following weed control works (or prior to weeds setting seed)

Report is to be submitted to Community Association within one week of inspection.

Date of Inspection:		
Inspected by:		
	Yes / No	**Comments / Action**
REVEGETATION		
Plants in good condition?	☐ **Yes** ☐ **No**	
Mulch / woodchip in place?	☐ **Yes** ☐ **No**	
Stakes / tree guards in place?	☐ **Yes** ☐ **No**	
Is additional watering required?	☐ **Yes** ☐ **No**	
Any additional works required?	☐ **Yes** ☐ **No**	
Any plants that require replacing?	☐ **Yes** ☐ **No**	
WEED CONTROL		
Has previous weed control works been effective?	☐ **Yes** ☐ **No**	
Is follow up weed control works required? (including additional hand removal of seedlings, spraying, brush cutting etc)	☐ **Yes** ☐ **No**	
Follow Up Actions Required **(list actions identified above)**	**Timing** **(identify required timing of works)**	**Date of Next Inspection** **(insert date of next follow up inspection)**

Annex I

Community Management Statement

Approved Form 28

COMMUNITY LAND DEVELOPMENT ACT 1989

COMMUNITY LAND MANAGEMENT ACT 1989

COMMUNITY MANAGEMENT STATEMENT

WARNING

The terms of this Management Statement are binding on the Community Association, each subsidiary body within the Community Scheme and each person who is a proprietor, lessee, occupier or mortgagee in possession of a Community Development Lot, Precinct Development Lot, Neighbourhood Lot or Strata Lot within the Community Scheme.

PART 1

BY-LAWS-FIXING DETAILS OF DEVELOPMENT

These By-Laws relate to the control and preservation of the essence or theme of the Community Scheme and as such may only be amended or revoked by unanimous resolution of the Community Association in accordance with Section 17(2) of the Community Land Management Act 1989.

These By-Laws may relate to the control or preservation of the essence or theme of the development under the Community Scheme by specifying:

(a) any provisions limiting occupants under the Scheme to persons of a particular description; and

(b) the architectural, building or landscaping styles to be permitted; and

(c) the kind of materials that may be used in buildings and other structures; and

(d) any provisions requiring the specified Community Association Property to be used only for particular purposes; and

(e) any other kind of restrictions.

BY-LAW 1 ENVIRONMENTALLY AND ARCHEOLOGICALLY SENSITIVE DEVELOPMENT

1.1 The Community Association is charged with maintaining the integrity of the Community Scheme and complying strictly with all relevant Planning Instruments affecting the Community Scheme from time to time.

1.2 All Subsidiary Bodies must comply with the standards set by the Community Association.

BY-LAW 2 ARCHITECTURAL STANDARDS

2.1 The Architectural Standards and Landscape Standards bind:

(a) the Community Association;

(b) each proprietor or occupier of a Lot;

(a) each Subsidiary Body

(b) each mortgagee in possession of a Lot; and

(c) each lessee of a Lot

other than the Original Proprietor.

2.2 Any Subsidiary Body may determine its own standards provided that such standards are approved in accordance with By Law 3.

BY-LAW 3 AMENDING ARCHITECTURAL STANDARDS AND LANDSCAPING STANDARDS

Right of Community Association to amend

3.1 The Original Proprietor may from time to time create, adopt, add to or alter architectural standards for Community Property and any Lot in the Community Scheme.

3.2 No proprietor of a Lot other than the Original Proprietor or a Subsidiary Body is entitled to amend the standards in any way without the prior written consent of

(a) the Community Association or, where the Community Association has delegated the authority, that delegate; and

(b) the Original Proprietor.

3.3 If a Subsidiary Body seeks to add to or alter its respective architectural standards or landscape standards in accordance with these By-Laws then the Community Association must, within a reasonable time, deliver a copy of the alterations or additions to each Subsidiary Body and each proprietor of a Community Development Lot.

3.4 The proprietor of a Lot is entitled to an up-to-date copy of the Architectural Standards and Landscape Standards from the Community Association upon payment of a reasonable fee.

3.5 The landscape standards and architectural standards may be set for any Community Development Lot by the Original Proprietor, or the Community Association but only if the Original Proprietor gives its consent.

3.6 Any application for consent to amend standards must be accompanied with sufficient details to allow all parties to properly consider the application and proposed amendments.

3.7 The Original Proprietor may appoint a Design Review Committee. Where the Original Proprietor has appointed a Design Review Committee, the Design Review Committee shall exercise the powers and discretions given to the Original Proprietor contained in By-Laws 3.8 to 3.13.

3.8 No building modification, new construction or landscape modification may commence or take place until the plans and specifications for it have been approved by the Original Proprietor as to:

(a) suitability of design;

(b) colour and materials;

(c) quality of design, and materials;

(d) harmony of existing design and existing structures;

(e) location in relation to surrounding structures and topography;

(f) elevation in relation to existing structures and topography; and

(g) harmony with existing landscaping; or

for landscape modifications the suitability and quality of design, colour, plant species and landscape materials and features and the location and elevation and harmony in relation to surrounding structures and topography and the removal of or dealing with existing plants.

3. 9 Any plans and specifications submitted pursuant to By-Law 3.8 must be to the standard required from time to time by the Original Proprietor .

3.10 The decision of the Original Proprietor must be made on the basis of the By-Laws, the Architectural Standards and Landscaping Standards and any rules in force at the time of its decisions. Where the decision has been delegated to a consultant or a manager as the case may be, the consultant or the manager must base his, her or its decision on the same criteria.

3.11 The Original Proprietor may as a condition of any approval pursuant to this part require the payment of a bond to be held by the Community Association a security for any damage that an applicant. Its contractors, employees or agents may cause to Association Property.

3.12 If further information is required by the appropriate decision making body or officer then that additional material must be furnished. A decision may be made subject to conditions which may be imposed at the decision maker's discretion.

3.13 A decision of the Original Proprietor is binding on any applicant for a decision.

BY-LAW 4 MODIFICATIONS AND NEW CONSTRUCTIONS BY THE COMMUNITY ASSOCIATION

4.1 If the Community Association wants to make:

(a) a building modification;

(b) a landscape modification; or

(c) a new construction

to Community Property then it must comply with the Architectural Standards and Landscape Standards in force for Community Property and obtain any approvals required of any competent authority.

BY-LAW 5 ASSOCIATION PROPERTY

5.1 The proprietor or occupier of a Lot must not except with the approval of the Community Association leave anything on or obstruct the use of the Association property.

5.2 The proprietor or occupier of a Lot must not damage Association property of any kind.

5.3 The proprietor or occupier of a Lot must not except with the approval of the Community Association use any part of the Association property to the exclusion of any other person.

5.4 The proprietor or occupier of a Lot must give notice to the Community Association of any damage or defect in Association property immediately he or she becomes aware of it.

BY-LAW 6 CONSTRUCTION ON ASSOCIATION PROPERTY

6.1 The proprietor or occupier of a Lot must not, except with the approval of the Community Association:

(a) construct any building or other structure including without limitation a fence, screen, pergola or awning on Association property;

(b) attach any item as a fixture to Association property; or

(c) alter Association property

6.2 Any construction, attachment or alteration referred to in the preceding By-Law whether made with or without approval of the Community Association is at the risk of the person erecting it.

BY-LAW 7 NO INAPPROPRIATE USE

7.1 The proprietor or occupier of a Lot must not use anything on the Community Parcel for any purpose other than that for which it was constructed or provided without the approval of the Original Proprietor.

BY-LAW 8 CLEANLINESS

8.1 The proprietor of occupier of a Lot must keep the lot clean and tidy and in good repair and condition.

8.2 The Community Association may give notice to a proprietor or occupier of a Lot requiring him or her to comply with the terms of this By-Law.

BY-LAW 9 RESTRICTED USE OF PRIVATE MOTORISED TRANSPORT

9.1 No vehicle may be excessively noisy or emit excessive levels of exhaust or other fumes. No caravan, trailer or like equipment may be kept on Community Property without the written consent of the Community Association who is not obliged to favourably consider any such request.

PART 2

RESTRICTED COMMUNITY PROPERTY

These By-Laws may not be amended during the initial period, except by order of the Supreme Court or the Tribunal and may only be amended after the expiry of that initial period by special resolution and with the written consent of each person entitled by the By-Law to use the restricted Community Property in accordance with Section 54 of the Community Land Management Act 1989.

BY-LAW 10 DEVELOPMENT IN STAGES

10.1 Use of Community Property not referred to in By-Laws 11-14 inclusive and service lines owned by the Community Association is restricted to the proprietors for the time being of all Community Development Lots in the manner and for the purpose set out in the By-Laws whilst carrying out Development Activities on a Community Development Lot or the Community Property.

10.2 Restricted use of the Community Property referred to in this By-Law ceases when the proprietor for the time being of all Community Development Lots:

(a) registers at the Land Titles Office a Community, Precinct, Neighbourhood or Strata Plan in respect of the last Community Development Lot owned by it; or

(b) serves on the Community Association a notice informing the Community Association that the Development Activities on the Community Parcel have ceased.

10.3 Subject to By-Law 10.1 and 10.2, the use of the Community Property is restricted to the proprietors for the time being of a Community Development Lot and of a lot in any Subsidiary Scheme and all Authorised Persons.

BY-LAW 11 ACCESS WAYS

11.1 There are no Access Ways.

BY-LAW 12 ACCESS RIGHTS

12.1 The Original Proprietor and all persons authorised by it shall have the following rights for the purpose of enabling that proprietor:

(i) to complete the development of the Community Parcel as necessary and to carry out Development Activities on the Community Parcel; and

(ii) to carry out development on land adjacent to the Community Parcel:

(a)	Access rights:	complete and unrestricted access by foot and motor vehicle over Community Property.
(b)	Parking rights:	the right to park motor vehicles and equipment on Community Property.
(c)	Temporary Facilities:	the right to place on or attach to Community Property temporary offices, sheds, depots, buildings, materials, cranes and other equipment.
(d)	Right to install services:	the right to install services on Community property.

(e) Right to connect Services: the right to connect Services within Community Property.

(d) Right to attach signs: the right to attach and place marketing and advertising signs, placards, banners, notices or advertisements on Community Property.

(g) Right to conduct sales: the right to conduct sales whether by auction or otherwise on Community Property.

12.2 The matters set out under By-Law 14 pursuant to Clause 6 of Schedule 3 of the Development Act apply to end form part of this By-Law.

12.3 If the owner of a Community Development Lot requires access over an access way in a Subsidiary Parcel and registers a Precinct Plan, Neighbourhood Plan or a Strata Plan requiring access to and egress from the Precinct or Neighbourhood Parcel over such access ways in any Subsidiary Parcel such an access way will be allowed by the Precinct Association, Neighbourhood Association or Owners Corporation (as applicable) without fees.

12.4 The provisions of By-Law 14 apply even where the relevant Plan contemplates access way to be granted to development on land adjacent to the Community Parcel.

BY-LAW 13 PROVISION OF SERVICES

13.1 The Community Association will not provide any services to the exclusion of any other person.

BY-LAW 14 SCHEDULE 3 CLAUSE 6 MATTERS

14.1 Clause 6, Schedule 3 of the Development Act applies to and forms part of By-Laws 10-13 inclusive in this Part 2 unless the context indicates to the contrary.

14.2 The terms and conditions relating to use of the Community Property under By-Laws 10-13 inclusive are:

(a) all damage to or interference with the Community Parcel must be made good at the expense of the Original Proprietor as soon as possible after that damage or interference occur;

(b) interference with the use or enjoyment by proprietors or occupiers of Lots or of Association Property must, so far as it is consistent with the carrying out of Development Activities, be kept to a minimum;

(c) upon completion from time to time of Development Activities the relevant Community Parcel areas must be left in a clean and tidy condition; and

(d) access is limited to between the hours of 7:00am and 7:00pm Monday to Friday and 8:00am and 4:00pm on any other day.

14.3 The Community Association must levy a contribution for any costs associated in maintaining or holding the Community Property unless that cost is payable by the Original Proprietor under those By-Laws.

14.4 Access to Community Property is to be exercised by a public road system in and around the Community Parcel. If the Community Association restricts access to the Community Property under any By-Law then it shall make Security Keys available to the proprietors for the time being of all Community Development Lots or the Subsidiary Bodies, if appropriate.

PART 3

MANDATORY MATTERS

BY-LAW 15 COMMUNITY PROPERTY

15.1 Community Property comprises Lot 1.

The Access Ways

15.2 There are no Open Access Ways.

15.3 No part of the Community Property has been set apart as a Private Access Way.

Community Property and Special Features

15.4 The Community Association may contract persons to provide management, operational, maintenance and other services in connection with Community Property.

15.5 The Community Association is entitled to make Rules relating to the control, management and maintenance of the Community Property in accordance with the Management Act and By-Law 26.

15.6 The Community Association is entitled to make Rules relating to the use of Community Property including any special facilities in accordance with By-Law 26.

Internal Fencing

15.7 Fencing must be erected and maintained solely at the cost of the lot proprietor. Where any fence is a dividing fence, the cost of erection and maintenance of the fence must be shared equally between the lot proprietors, except where the adjoining proprietor is either the Original Proprietor or the Community Association. Neither the Original Proprietor nor the Community Association is obliged to contribute towards the cost of erection or maintenance of any such fencing.

15.8 Subject to By-Law 15.7, all other fencing must be maintained by the Community Association.

Storage and Collection of Garbage

15.9 The Community Association must provide on Community Property garbage bins for the storage of garbage which is generated on Community Property.

15.10 The Community Association must:

(a) deposit all garbage from Community Property and the property of Subsidiary Schemes into the garbage bins; and

(b) keep the area where the garbage bins are provided clean and tidy.

15.11 The Community Association is responsible to ensure that garbage from Association Property is either made available for collection by the local council in accordance with the Council's rules, regulations and ordinances or must otherwise arrange for the removal of garbage by private contractors.

Services

15.12 No Services will be provided by the Community Association.

15.13 If a Service is provided after the registration of the Management Statement and Prescribed Diagram, the Community Association must submit a later Prescribed Diagram to any Subsidiary body affected by the amendment to enable that Subsidiary body to:

(a) give its consent to the amendment if such consent is required;

(b) make available all necessary documents including the Certificate of Title for the Property of such Subsidiary Scheme to facilitate the registration of the amendment and thereafter the Community Association must register the later Prescribed Diagram.

Insurance

15.14 The community Association must review on an annual basis all insurances affected by it and the need for new or additional insurances.

15.15 Notice of an annual general meeting must include a form of motion to consider whether insurances affected by the Community Association should be confirmed, varied or extended.

15.16 The Community Association is charged to review and where necessary affect new insurances or vary or extend existing insurances where in the reasonable opinion of the Community Association there is an increase in risk or a new risk to Community Property.

15.17 A proprietor or occupier of a Lot must not, except with the approval of the Community Association do anything that might void or prejudice insurance effected by the Community Association or increase any insurance premium payable by the Community Association.

BY-LAW 16 EXECUTIVE COMMITTEE

Constitution

16.1 (a) The Executive Committee of the Association is constituted under and must be established in accordance with Division 2 of Part 2 of the Management Act.

(b) The Executive Committee may meet together for the conduct of business, adjourn and otherwise regulate its meetings as it thinks fit.

Chairman, Secretary and Treasurer

16.2 The chairman, secretary and treasurer of the Executive Committee shall also be respectively the chairman, secretary and treasurer of the Association.

Notice Board

16.3 The Executive Committee may fix a notice board to an accessible and prominent part of the Community Association Property.

Notice of Meeting

16.4 The Executive Committee must, not less than 72 hours (or such other period as the Association may decide) immediately before the Executive Committee holds a meeting, display on the notice board, if there is one, or give each proprietor of a Lot:

(a) a notice of its intention to hold the meeting; and

(b) the detailed agenda proposed for the meeting.

Agenda

16.5 The Agenda for a meeting of the Executive Committee must detail the business which is proposed to be dealt with at that meeting.

Meetings

16.6 Meetings of the Executive Committee may be held on or near the Community Parcel or such other place is convenient for the members of the Executive Committee.

16.7 A matter may not be dealt with, discussed or decided upon at a meeting of the Executive Committee unless details of the matters are set out in the agenda for the meeting.

16.8 The Secretary or, in his or her absence, any member of the Executive Committee, must if requested by not less than one-third of the members of the Executive Committee:

(a) convene a meeting of the Executive Committee within the time specified in the request or if no time is specified in the request, within fourteen (14) days of the request; and

(b) display on the notice board, if there is one or give each proprietor of a Lot a notice of the intention of the Executive Committee to hold the meeting and the agenda in accordance with By-Law 16.5.

16.9 If:

(a) a meeting of the Executive Committee is held before:

(i) proper notice of its intention to hold the meeting has been displayed on the notice board, if there is one, or given to each proprietor of a Lot; and

(ii) expiry of the period during which the notice must be displayed or given under By-Law 16.8(a); and

(b) prior to or at the meeting or the Executive Committee a member of the Association gives the Executive Committee a notice of intention to oppose the making of a decision on a matter,

then a decision made on that matter in the meeting must not be implemented:

(c) if during the period required under By-Law 16.8(a) for the display of the notice, a notice opposing the making of the decision is given to the Secretary by members of the Association who have a majority of the unit entitlements; or

(d) until the proper display or giving of the notice of intention and expiry of the period required by By-Law 16.8(a) if a notice opposing the making of the decision is not given prior to such expiry.

16.10 If a notice opposing the making of a decision is given under By-Law 16.9(c) then the decision made by the Executive Committee which was opposed must be revoked by the Executive Committee and be of not effect.

Voting in Writing

16.11 Where:

(a) each member of the Executive Committee has been served with a copy of any motion of a proposed resolution to be submitted at that meeting; and

(b) the proposed resolution has been approved in writing by a majority of the members of the Executive Committee,

then the resolution is, if a notice has not been given under section 38(3) of the Management Act, as valid as if it had been duly passed at a duly convened meeting of the Executive Committee, even though the meeting was not held.

Right of Proprietors to attend Meetings

16.12 A proprietor of a Lot, or where the proprietor is a corporation, the company nominee of the corporation, may attend a meeting of the Executive Committee but may not address the meeting unless authorised by a resolution of the Executive Committee.

Record of Minutes

16.13 Minutes of the meetings of the Executive Committee and all resolutions passed must be placed with the minutes of the General Meetings of the Association.

Display of Minutes

16.14 The Executive Committee must within seven (7) days after any meeting of the Executive Committee or the passing of a resolution:

(a) display on the notice board, if there is one or provide each proprietor of a Lot with a copy of the minutes of that meeting; or

(b) display on the notice board, if there is one, or provide each proprietor of a Lot with a copy of the resolution passed under By-Law 16.11.

If the Executive Committee elects to display a copy of the minutes or the resolution on the notice board then the copy of the minutes and the resolution must be displayed on the notice board for a period of at least fourteen (14) days.

Powers and duties of Secretary

16.15 The powers and duties of the Secretary of the Association are:

(a) preparing and displaying or distributing minutes of meetings and resolutions of the Association and the Executive Committee;

(b) giving on behalf of the Association and the Executive Committee, notices required to be given under the Management Act;

(c) maintaining the Association roll;

(d) making available for inspection, on behalf of the Association, the documents and records set out in Clause 1 of Schedule 4 of the Management Act;

(e) supplying on behalf of the Association, certificates in accordance with Schedule 4 of the Management Act;

(f) answering communications addressed to the Association or the Executive Committee;

(g) convening meetings of the Executive Committee and the Association (other than the First Annual General Meeting);

(h) performing and exercising matters of an administrative or secretarial nature which are associated with the functions and duties of the Association or the Executive Committee; and

(i) keeping records for the Association under:

(i) Part 3 of Schedule 1 of the Management Act; and

(ii) Part 3 of Schedule 3 of the Management Act.

Powers and duties of Treasurer

16.16 The powers and duties of the Treasurer of the Association include:

(a) notifying proprietors of Lots of contributions levied pursuant to the Management Act or the Management Statement and collecting all contributions;

(b) receiving, acknowledging, banking and accounting for all money paid to the Association;

(c) preparing any certificate applied for under and in accordance with Section 26 and Clause 2 of Schedule 4 of the Management Act;

(d) keeping the prescribed accounting records referred to in Clause 10 of Schedule 1 of the Management Act;

(e) preparing the prescribed financial statement referred to in Clause 11 of Schedule 1 of the Management Act;

(f) the functions set out in Clause 36(1) of the Management Act.

16.16 The Executive Committee and its members shall not be liable for any loss or damage which arises as a result of any act done by Executive Committee or the members in it, his or her respective capacity as the Executive Committee or member of the Executive Committee except fraud on the part of the Executive Committee or that member.

16.17 Members of the Executive Committee are not entitled to any remuneration for the performance of their functions but are entitled to reimbursement for reasonable out-of-pocket expenses incurred by them in the performance of their functions.

16.18 The Executive Committee may retain the services of independent consultants with special skills and expertise in:

(a) architecture;

(b) landscaping;

(c) engineering/servicing consultant;

(d) any other discipline relevant to the operation of the Committee to advise and assist it in performing its functions.

PART 4

OPTIONAL MATTERS

BY-LAW 17 MAINTENANCE OF VACANT LOTS

17.1 A proprietor of a Lot must:

(a) if that Lot is vacant, and until such time as building operations on that Lot commence:

(i) maintain that Lot to an acceptable standard;

(ii) keep the Lot free from debris and rubbish; and

(b) once building works commence on the Lot and until completion of the main residential building, do all things reasonably necessary to ensure that the main residential building and associated work is completed without delay and in an efficient manner.

BY-LAW 18 SERVICES

18.1 The proprietor or occupier of a Lot must not:

(a) carry out any works which interfere with Services unless the approval of the Community Association and any relevant authority has been first obtained in writing.; or

(b) obstruct access to, overload or damage Services.

18.2 Subject to any provision set out in Section 60 of the Management Act, the Association and persons authorised by it may enter a lot at any time in an emergency and otherwise at reasonable times to maintain repair alter add to increase or decrease the capacity of or renew any Service.

BY-LAW 19 ASSOCIATION MAY ENTER AND DO WORK

19.1 The Community Association may (but shall not be obliged to) at the cost of the proprietor of the Lot do anything on a Lot which should have been done by the proprietor or occupier of a Lot under the By-Laws and which has not been done or has not been done as required.

19.2 If the Community Association wishes to exercise its right under By-Law 19.1 then the Community Association may:

(a) give the proprietor or occupier of the Lot notice of its intention to enter and/or carry our work; and

(b) (with or without any persons authorised by the Community Association) enter the Lot at any time after the date specified in the notice given by the Community Association under By-Law 19.2 (a) and remain on the Lot for so long as is necessary to carry out or do the act or thing which is done.

BY-LAW 20 RIGHT TO RECOVER MONEY

20.1 The Community Association may recover any money owing to it under the By-Laws as a debt.

BY-LAW 21 CONTROL OF LESSEES/LICENSEES

21.1 A Proprietor whose Lot in whole or in part is the subject of a lease or licence agreement must:

(a) provide the lessee or licensee with a copy of this Management Statement;

(b) require the lessee or licensee to perform and observe the obligations on the part of the proprietor under the By-Law; and

(c) take all reasonable steps including, without limitation, any action available to him/her under the lease or licence agreement to ensure that the lessee or licensee of the Lot and any person on the Neighbourhood Parcel with the consent (express or implied) of the lessee or licensee complies with the By-Laws.

BY-LAW 22 PROPRIETOR AND OCCUPIER RESPONSIBLE FOR OTHERS

22.1 A proprietor or occupier of a Lot must take all reasonable steps to ensure that an Authorised Person complies with the By-Laws.

BY-LAW 23 REIMBURSEMENT OF COSTS, CHARGES AND EXPENSES

23.1 A proprietor or occupier of a Lot must pay or reimburse the Community Association on demand for the costs, charges and expenses of the Community Association in connection with the contemplated or actual enforcement, or preservation of any rights under the By-Laws in relation to the proprietor or occupier.

23.2 The costs, charges and expenses under By-Law 23.1 shall include, without limitation, those expenses incurred in retaining any independent consultant or other person to evaluate any matter of concern and administration costs in connection with those matters.

BY-LAW 24 THINGS DONE AT PROPRIETOR'S OR OCCUPIER'S COST

24.1 Any act or thing which a proprietor or occupier of a Lot is required to or may do under the By-Laws must be done at the cost of the proprietor or occupier.

BY-LAW 25 ASSOCIATION NOT LIABLE FOR DAMAGE

25.1 The Community Association is not liable for damage to or loss of property or injury to any person in or near the Community Parcel due to any cause other than the fraud of the Community Association or any employee or agent of the Community Association.

BY-LAW 26 RULES

26.1 The Association may with the consent of the Original Proprietor make Rules relating to the control, management, operation, use and enjoyment of the Community Parcel.

26.2 The Association with the consent of the Original Proprietor may at any time add to or alter the Rules.

26.3 The Association may not make a Rule or add to or alter a Rule so that it is or becomes inconsistent or in conflict with the Management Act, the Development Act or these By-Laws or any management agreement made by the Association and third parties.

26.4 Rules bind a proprietor, occupier, mortgagee in possession and lessee of a Lot and the Association.

BY-LAW 27 MAINTENANCE OF SUBSIDIARY ASSOCIATION PROPERTY

27.1 The Community Association shall be responsible for the maintenance and control of all association property of any Subsidiary Scheme provided that such association property shall pursuant to the by laws of the Subsidiary Scheme be available to the use and enjoyment of all proprietors of lots in the Community Scheme and its Subsidiary Schemes.

27.2 For the purposes of this By-Law, "maintenance" shall include the replacement of any association property for which the Community Association has responsibility pursuant to By-Law 27.1.

27.3 The Community Association shall pay for or reimburse all Subsidiary Schemes in respect of any insurance premiums in respect of the insurance required or considered prudent in respect of association property subject of By-Law 28.1.

BY-LAW 28 COMPLIANCE WITH REQUIREMENTS OF AUTHORITIES

28.1 A proprietor or occupier of a Lot must comply on time with all requirements and orders of authorities and all laws in connection with the Lot and use or occupation of the Lot.

BY-LAW 29 CERTIFICATE

29.1 A Certificate signed by the Association, its Managing Agent (if any) or the Secretary about a matter or a sum payable to the Association in connection with the By-Laws is, except in the case of manifest error, prima facie evidence of the amount or any other matter of fact stated in it.

BY-LAW 30 COMMUNICATIONS WITH ASSOCIATION

30.1 Complaints, notices or applications to or requests for consideration of matters by the Association must be in writing and forwarded to the Managing Agent of the Association or the Secretary if no managing agent is appointed.

BY-LAW 31 COMMUNICATIONS FROM ASSOCIATION

31.1 An approval, notice or authorisation by the Association under the By-Laws must be in writing.

BY-LAW 32 APPROVALS BY ASSOCIATION

32.1 The Association may give approval conditionally or unconditionally or withhold its approval under the By-Laws in its absolute discretion unless expressly provided otherwise in the By-Laws.

32.2 For the purposes of Clause 6 of Schedule 3 of the Development Act any management agreement entered into between the Community Association and a manager is deemed to be part of this Management Statement.

BY-LAW 33 RUN OFF

33.1 Neither the Community Association, any Subsidiary Association or owner of a Lot nor any other person or entity other than the Original Proprietor may prevent alter or hinder the natural flow of rainwater run off across the Community Association Parcel. The Original Proprietor may utilise the run off in such manner as it sees fit.

BY-LAW 34 GENERAL RESTRICTIONS

34.1 A proprietor or occupier of a Lot other than the Original Proprietor must not do or permit any of the following on the Community Parcel without the consent of the Original Proprietor:-

(a) park any vehicle, boat, trailer or caravan other than in a designated parking space;
(b) park any vehicle in excess of 3.5 tonnes except for the purpose of making deliveries or collecting items;
(c) create any noise or behave in a manner which is likely to interfere with the peaceful enjoyment of the proprietor or occupier of another Lot or lot in any Subsidiary Scheme;
(d) obstruct the lawful use of Community Property or the property of any Subsidiary Scheme;
(e) dress, speak or act in such a manner as is likely to cause offence to the proprietor or occupier of any Lot;
(f) operate or permit to be operated any device which interferes with any electronic equipment or appliance which is lawfully used by the Community Association, the association of any Subsidiary Scheme or a proprietor of any Lot;
(g) use a Lot for any illegal purpose;
(h) use any building constructed on a Lot as an exhibition home or for the promotion of the sale of homes: or
(i) display any sign, advertisement, hoarding or similar structure including any sign advertising a Lot to be for sale.

BY_LAW 35 POWERS OF THE ORIGINAL PROPRIETOR

35.1 All powers, discretions and exemptions given to the Original Proprietor by the By-Laws set out in this Management Statement shall terminate upon the first to occur of the following events:-

35.1.1 The Original Proprietor ceases to be the proprietor of a lot in the Community Scheme or any Subsidiary Scheme; or
35.1.2 The Original Proprietor gives notice to the Community Association in writing that it relinquishes all of its powers, discretions and exemptions.

35.2 The Original Proprietor may relinquishes all of its powers, discretions and exemptions in respect of a Subsidiary Scheme at any time by giving notice to the Community Association and to the relevant Subsidiary Scheme in writing.

35.3 Upon the termination of the Original Proprietor's powers, discretions and exemptions in respect of the Community Scheme or a Subsidiary Scheme, those powers, discretions and exemptions shall be exercised and held by the Community Association.

35.4 The Community Association may delegate any such power or discretion as it sees fit.

BY-LAW 35A OPEN SPACE

35A.1 The public shall not be prohibited from using that part of Lot 1 being formally known as Lot 6 DP 270466 for recreational uses.

35A.2 For that part of Lot 1 being formally known as Lot 6 DP 270466 the Community Association will continue to maintain the required insurance policies in accordance with Division 3 of Part 2 of the Community Land Management Act.

35A.3 For that part of Lot 1 being formally known as Lot 6 DP270466 the Community Association will continue to maintain the land in accordance with Part 2 of Schedule 1 of the Community Land Management Act.

35A.4 By-Law 35A.1 shall not be amended or revoked without the prior written consent of Port Stephens Council.

BY-LAW 35B COMMUNITY LANDS ENVIRONMENTAL MANAGEMENT PLAN

35B.1 In accordance with the Development Consent for the Fern Bay Seaside Village Estate the Community Association is responsible for the management and implementation of the Community Lands Environmental Management Plan. This Plan applies to all of the lands within the Fern Bay Community Estate.

35B.2 The objective of the Community Lands Environmental Management Plan is to prescribe management strategies and methods to mitigate impacts on natural and modified vegetation communities, threatened flora and fauna species and habitats that may occur within the Conservation Areas, Reserves and other areas throughout the Estate as a result of the development. This will be achieved by:

(a) Management of threatened species, including their habitat and endangered ecological communities;

(b) Management of retained habitat features within the development footprint, including during the construction phase;

(c) Management of specific habitat enhancement measures;

(d) Regeneration and landscaping works;

(e) Weed management;

(f) Pest animal control;

(g) Fencing;

(h) Bushfire management;

(i) Public access management; and

(j) Stormwater management.

35B.3 In accordance with Clause 4 of Schedule 1 of the Community Land Management Act the functions of the Community Association with respect to the Community Lands Environmental Management Plan are:

(a) Implementing the Community Lands Environmental Management Plan;

(b) Ensure that each Owner and Occupier of a Lot within the Community Scheme and any subsidiary scheme complies with the provisions of the Community Lands Environmental Management Plan;

(c) The Community Association may enter into a contract with suitable qualified persons in order to carry out the requirements of the Plan.

35B.4 The Community Lands Environmental Management Plan can only be amended by the Community Association passing a special resolution at a General Meeting and also obtaining approval from the relevant environmental authority.

BY-LAW 35C CULTURAL HERITAGE MANAGEMENT PLAN

35C.1 A Cultural Heritage Management Plan has been prepared and applies to the Cultural Heritage Reserve adjacent to Bora Street and the Plan will also apply to any other Cultural Heritage Reserve which is established within the Community Scheme.

The Community Association is responsible for the implementation of the Cultural Heritage Management Plan.

The objectives of the Management Plan are to:

(a) Protect the surface and subsurface archaeological deposit from disturbance associated with development and use of the area by Fern Bay Estate residents and visitors;

(b) Retain an area that preserves archaeological material in its natural context and provides an example of the type of environment occupied by Aboriginal people in the Fern Bay region; and

(c) Provide an appropriate place in which archaeological material from the Fern Bay Estate can be stored and protected.

In accordance with Clause 4 of Schedule 1 of the Community Land Management Act functions of the Community Association with respect to the Cultural Heritage Management Plan are:

(a) Implementing the Cultural Heritage Management Plan;

(b) Ensuring that each subsidiary scheme, Owner and Occupier of a Lot within the Community Scheme and any subsidiary scheme complies with the provisions of the Cultural Heritage Management Plan;

(c) The Community Association may enter into a contract with suitable qualified persons in order to carry out the requirements of the Plan.

The Cultural Heritage Management Plan can only be amended by the Community Association passing a special resolution at a General Meeting and also obtaining approval from the Worimi Local Aboriginal Land Council as well as the relevant Government authority.

BY-LAW 35D BUSHFIRE MANAGEMENT

35D.1 Certain parts of the Community Associated Property will be classified as asset protection zones. The Community Association will maintain these asset protection zones in accordance with the Bushfire Hazard Assessment Report that has been prepared by ERM for the Estate, together with the "Planning for Bushfire Protection" Guidelines. The Community Association is also to abide by the requirements of the Rural Fires Act 1997.

BY-LAW 35E GROUNDWATER MONITORING

35E.1 Seven groundwater monitoring boreholes have been placed throughout the Fern Bay Seaside Village Estate. These boreholes have been strategically located to allow monitoring of groundwater levels. After the development of the subdivision is complete the Community Association will monitor these boreholes on a quarterly basis to determine the level of the groundwater and its chemistry.

BY-LAW 35F MAINTENANCE MATTERS

35F.1 Notwithstanding By-Laws 35B, 35C, 35D, and 35E the Community Association is responsible for maintaining all of the Community Association property to high standard in accordance with the various management plans referred to in other By-Laws

35F.2 The only exception is that Port Stephens Council is responsible for the maintenance and operation of the stormwater treatment facilities which cater for runoff from the public road network.

PART 5

BY-LAW REQUIRED BY PUBLIC AUTHORITIES

There are no By-Laws required by public authorities.

BY-LAW 36 DEFINITION AND INTERPRETATION

36.1 **"**Annual General Meeting" means an annual general meeting of the Community Association other than the first annual general meeting.

"Architectural Standards" means the architectural standards created or adopted by the Original Proprietor as added to or altered as provided in these By-Laws.

"Association" means the community association.

"Association Property" means:

(a) in relation to the Community Scheme – the Community Property in the Scheme; or
(b) In respect of a Subsidiary Scheme- the association property of that Scheme.

"Authorised Person" means a person on a Community Parcel with the Consent express or implied of a proprietor or occupier of a Lot, the Community Association or a Subsidiary Body.

"By-Law" means a by-law included in the Management Statement.

"Community Association" means the corporation that:

(a) is constituted by Section 25 of the Development Act on the registration of the Community Plan; and

(b) establishes a Community Association by Section 5 of the Management Act.

"Community Development Lot" means a lot in the Community Plan which is not Community Property, a public reserve or a drainage reserve and is not land that has become subject to a subsidiary scheme or a Lot that has been severed from the Community Scheme.

"Community Parcel" means the land the subject of the Community Scheme.

"Community Plan" means Deposited Plan No.270466.

"Community Property" means the Lot shown in the Community Plan as Community Property.

"Community Scheme" means:

(a) the subdivision of land by the Community Plan;

(b) the subdivision of the land in the Community Plan by a Precinct Plan, Neighbourhood Plan or a Strata Plan; or

(c) the proposal in any related development contract; and

(d) the rights conferred and the obligations imposed by or under the Community Titles Legislation in relation to the Community Association, Community Property, the Subsidiary Schemes and persons having interests in, or occupying Lots.

“Community Titles Legislation” means the Development Act, the Management Act and any cognate legislation.

“Council” means the Council of the Shire of Port Stephens.

“Developer” means the proprietor or properties for the time being of a Community Development Lot in the Community Plan.

“Development Act” means the Community Land Development Act 1989 and Regulations made under it.

“Development Activities” means:

(a) any form of demolition work, building work or work ancillary to or associated with building work on the Community Parcel including, without limitation, the installation of Services;

(b) any form of landscaping work or work ancillary to or associated with landscaping work on the Community Parcel;

(c) any form or work other than the forms of work referred to in paragraphs (a) and (b) of this definition which is considered necessary or desirable by the proprietors for the time being of all Community Development Lots;

(d) the use of any part of the Community Parcel in connection with the forms of work referred to in paragraphs (a) to (c) of this definition; or

(e) the subdivisions of land forming part of the Community Parcel and all associated works.

(f) road construction and associated works.

“Development Contract” means the instrument, plans and drawings which are registered with a Community Plan.

"Executive Committee" means the executive committee of the Community Association as constituted or elected from time to time under the Management Act.

"First Annual General Meeting" means the General Meeting convened and held under Section 9 of the Management Act.

"Function" includes a power, authority and duty.

"General Meeting" means:

(a) an annual general meeting; or

(b) a special general meeting;

of the Community Association.

"Landscape Modification" means any modification, addition or alteration made on or to an existing landscaped area on Community Property.

"Landscape Standards" means the landscaping standards created or adopted by the Original Proprietor as added to or altered as provided in these By-Laws

"Lot" means a Community Development Lot.

"Management Act" means the Community Land Management Act 1989 and regulations made under it.

"Management Statement" means the statement registered with the Community Plan as from time to time added to, modified or amended in accordance with the Community Titles Legislation.

"Managing Agent" means an agent appointed under Section 50 of the Management Act.

"Neighbourhood Lot" means land that is a lot in a Neighbourhood Plan but is not Neighbourhood Property, a public reserve or a drainage reserve.

"Neighbourhood Plan" has the same meaning as in the Community Titles Legislation.

"Neighbourhood Property" means the Lot shown in a Neighbourhood Plan as neighbourhood property.

"Neighbourhood Scheme" means:

(a) the subdivision of land by a Neighbourhood Plan;

(b) the proposals in any related Development Contract; and

(c) the rights conferred, and the obligations implied, by or under the Community Titles Legislation in relation to the Neighbourhood Association,

Neighbourhood Property and the proprietors and other persons having interests in, or occupying Neighbourhood Lots.

"New construction" means subdivision work, building work and associated activities that is intended to be carried out on:

(a) a Community Lot;
(b) Community Property:
(c) a Precinct Lot;
(d) Precinct Property:
(e) a Neighbourhood Lot;
(f) a Strata Lot;
(g) Neighbourhood Property; or
(h) Common property.

"Open Access Way" means an open access way set apart under Section 41 of the Development Act.

"Original Proprietor"means Winten (No 20) Pty Limited ACN 094 443 099.

"Precinct Lot" means land that is a lot in a Precinct Plan but is not Precinct Property, a public reserve or a drainage reserve.

"Precinct Plan" has the same meaning as in the Community Titles Legislation.

"Precinct Property" means the Lot shown in a Precinct Plan as precinct property.

"Precinct Scheme" means:

(a) the subdivision of land by a Precinct Plan;

(b) the proposals in any related Development Contract; and

(c) the rights conferred, and the obligations implied, by or under the Community Titles Legislation in relation to the Precinct Association, Precinct Property and the proprietors and other persons having interests in, or occupying Precinct Lots.

"Prescribed Diagram" means the diagram relating to the Service Lines with the Community Plan and prescribed in Section 36 of the Development Act.

"Private Access Way" means a private access way set apart under Section 47 of the Development Act.

"Private Services" means a service running through or servicing Lots, Association Property or Common Property which is not a Statutory Service.

"Public Place" has the meaning ascribed to it under the Local Government Act 1919 and Ordinances.

"Design Review Committee" means a committee appointed pursuant to By-law 3.7.

"Rules" means the rules made under By-Law 26.

"Secretary" means the secretary of the Community Association.

"Security Key" means a key, magnetic card or other device used to:

(a) open and close doors, gates, buildings or locks; or
(b) operate alarms, security systems or communications systems.

"Service" means a Statutory Service or Private Service.

"Service Line" means a pipe, wire, cable, duct, conduit or pole by means of which a Service is or is to be provided the location of which is illustrated in the Prescribed Diagram.

"Service Provider" means without limitation, Energy Australia, Telecom Australia, Agility Limited, Port Stephens Council and any authorities or corporations assuming their Functions.

"Sinking Fund" means the sinking fund referred to in Section 12 of Part 4 of Schedule 1 of the Management Act.

"Statutory Service" means a service running through or servicing Lots, Association Property or Common Property provided by a Service Provider.

"Subsidiary Body" means a Precinct Association, Neighbourhood Association or Owners Corporation of the Community Scheme.

"Subsidiary Scheme" means a Precinct Plan, Neighbourhood Scheme or Strata Plan.

"Tribunal" means the Community Consumer, Trader and Tenancy Tribunal constituted under the Consumer, Trader and Tenancy Tribunal Act 2001.

"Treasurer" means the treasurer of the Community Association.

36.2 In the By-Laws unless the contrary intention appears:

(a) a reference to an instrument includes any variation or replacement of it;

(b) a reference to a statute, ordinance, code or other law includes regulations and other instruments under it and consolidations, amendments, re-enactments or replacements of any of them;

(c) the singular includes the plural and vice versa;

(d) the word "person" includes a firm, a body corporate, an association or an authority;

(e) a reference to a person includes a reference to the person's executors, administrators, successors, substitutes (including, without limitation persons taking by novation) and assigns; and

(f) a reference to a day is a reference to the period of time commencing at midnight and ending 24 hours later.

37.3 Headings are inserted for convenience and do not affect the interpretation of this Management Statement.

37.4 If the whole or any part of a provision of the By-Laws is void, unenforceable or illegal, it is severed. The remainder of the By-Laws have full force and effect. This By-Law has no effect if the severance alters the basic nature of the By-Laws or is contrary to public policy.

37.5 The Community Association may exercise a right, power or remedy at its discretion, and separately or concurrently with another right, power or remedy. A single or partial exercise of a right, power or remedy by the Community Association does not by the Community Association to exercise or delay in exercising a right, power or remedy does not prevent its exercise.

37.6 The rights, powers and remedies provided in the By-Laws are cumulative with and not exclusive of the rights, powers or remedies provided by law independently of the By-Laws.

37.7 A reference to an authority, institute, association or body or to any officer of them is in the event of that authority, institute, association, body or officer ceasing to exist or being reconstituted, renamed or replace or of their respective powers or functions being transferred to any other organisation or person deemed to be a reference to the organisation or officer established, constituted or appointed in lieu of or as replacement for or which or who serves substantially the same purposes or subject of that authority, institute, association, body or officer.

SIGNATURES, CONSENTS AND APPROVALS

Dated day of 2005

THE COMMON SEAL OF
Winten (No 20) Pty Limited ACN 094 443 099
Was affixed in accordance with its
Articles of Association in the presence of:

……	……
Signature of authorised person	Signature of authorised person
……	……
Office held	Office held
……	……

Name of authorised person
(block letters)

Name of authorised person
(block letters)

CERTIFICATE OF APPROVAL

It is Certified:

(a) that the consent authority has approved of the development described in Development Application No._____ and

(b) that the terms and conditions of this Management Statement are not inconsistent with that development as approved.

Dated _____

…….
Signature on behalf of consent authority

Annex J

Submission Report Additional Ecological Information

J.1 NATIVE VEGETATION CLEARANCE

In response to the submissions and changes to the Project Plan development, further clarification is provided on the extent of vegetation clearance. In particular it was requested that the quantum and type of vegetation be provided for:

- clearing that has occurred for the approved subdivision (Stages 1 to 3) and associated approved development modifications;
- proposed clearance for the current Project Plan application (Stages 4 to 20 Fern Bay Seaside Village) and associated infrastructure; and
- retained areas.

Approximate areas have been calculated for all vegetation types shown in Figure A5 of Annex P of the Environmental Assessment Report. This information is provided in *Table J.1*. It should be noted that these estimates include areas shown as cleared land on Figure A5 of Annex P of the EA.

Table J.1 Estimated Vegetation Clearance for the Approved Subdivision and Current Project Plan Application

Vegetation Community	Approved Subdivision (Stages 1-3)	Proposed to be Cleared (Stages 4-20)	Vegetation to be Retained
Coastal Sand Apple Blackbutt Forest	17.2 ha	48.4 ha	71.0ha
Swamp Mahogany – Paperbark Forest	3.1 ha	6.9 ha	2.1 ha
Swamp Sclerophyll Forest	1.7 ha	0 ha	25.4 ha
Wet Heath	4.2 ha	14.6 ha	7.2 ha
Total	**26.2 ha**	**69.9ha**	**105.7ha**

Notes:

The Approved Subdivision estimates include the approved subdivision footprint, access road, and areas cleared under Section 96 modifications approved by Council.

Areas to be disturbed for the infiltration/detention basins are included in calculations for the approved and proposed subdivision.

These calculations also include areas that are identified as 'cleared land' in *Figure A.5 Annex P*.

The Amended Water Cycle Management Strategy identified six infiltration 'basins' where stormwater is temporarily detained prior to groundwater infiltration (Martens 2009). Four of these are naturally low lying areas while Basin 3 has been constructed as part of Stages 1 to 3, and Basin 6 is proposed for construction (see *Figure 3* of the Submission Report and Plan 15 of 22 in *Annex B*). The calculations in *Table J.1* includes those areas that will be cleared and re-countered to construct the conveyance swales to the natural low lying areas identified as existing basin 1, 2, 4 and 5 in Plan 15 of 22 in *Annex B* and the area to be disturbed for construction of Basin 6.

Clearance areas for each basin are detailed on Plan 15 of 22 in *Annex B*. In total approximately 12025m^2 or 1.2 ha of Coastal Sand Apple-Blackbutt Forest will be cleared for construction of the basin and conveyance swales. The conveyance swales will be lined with aggregate to prevent revegetation and promote infiltration however the batters will be rehabilitated. Of the 12025m^2 cleared for the conveyance swales approximately 6115m^2 will be rehabilitated.

A breakdown of areas of clearance and areas that will be rehabilitated in the long term for each basin follow:

- Basin 1 requires disturbance of an area of 434m^2 for construction of a conveyance swale 290m^2 and batters of approximately 72m^2 each. This swale is proposed for an existing cleared easement and will clear approximately 200m^2 of Coastal Sand Apple-Blackbutt Forest. It should be noted that the batters will be rehabilitated and in the long term will not be cleared land. The Swamp Sclerophyll Forest on Coastal Floodplain community will not be cleared;

- Basin 4 requires disturbance of an area of approximately 2785m^2 for construction of a conveyance swale (765m^2) and batters (2020m^2). This will clear approximately 2785m^2 of Coastal Sand Apple-Blackbutt Forest. It should be noted that 2020m^2 will be rehabilitated and in the long term will not be cleared land. The Swamp Sclerophyll Forest on Coastal Floodplain community will not be cleared;

- Basin 5 requires disturbance of an area of approximately 1755m^2 for construction of a conveyance swale (445m^2) and batters (1310m^2). This will clear approximately 1755m^2 of Coastal Sand Apple-Blackbutt Forest. It should be noted that 1310m^2 will be rehabilitated and in the long term will not be cleared land. The wet heath community will not be cleared; and

- Basin 6 requires disturbance of an area of approximately 7285m^2 for construction of the basin (4500m^2) and batters (2785m^2). This will clear approximately 7285m^2 of Coastal Sand Apple-Blackbutt Forest. It should be noted that 2785m^2 will be rehabilitated and in the long term will not be cleared land.

J.2 CONSIDERATION OF PRINCIPLES FOR THE USE OF BIODIVERSITY OFFSETS

J.2.1 Overview

In addition to the measures outlined in the Species Impact Statement (Annex R of the EA) and the Ecology Assessment Report (Annex P of the EA) to either avoid or mitigate ecological impacts and species specific impacts, measures were identified to offset the impact of the proposal.

Offset measures include:

- management of the vegetation and fauna within land dedicated as Community Conservation Lands within Fern Bay Seaside Village land holding; and

- preparation and support of a Vegetation Management Plan (VMP) for the Worimi Regional Park to the south of the subdivision for a period of 20 years (Annex D of the EA) to offset the loss of habitat trees (hollow-bearing trees) and wet heath resulting from the proposed development.

The Community Conservation Lands include land zoned 1a, 2a and 7a and are shown in Figure 5.1 (Annex V of the EA). The Community Lands Environmental Management Plan (Annex V of the EA) (CLEMP) details management strategies to protect and enhance vegetation communities and fauna habitat within the Community Conservation Lands. Management strategies outlined in the CLEMP include weed management, ongoing bush regeneration works, use of local provenance species in landscaping, pest animal control, stormwater management, fire management, traffic management and domestic pet management. Impact management is considered both prior, during and after construction as well as species specific measures to reduce the impact on threatened species. The Community Association established under Community Title will be responsible for the management and long term monitoring of the Community Conservation Lands.

Table J.2 details how the offset measures described above comply with the key principles for the use of biodiversity offsets in NSW.

Table J.2 Compliance with Key Principles for the Use of Biodiversity Offsets in NSW

Principle	Project Compliance
1. Impacts must be avoided first by using prevention and mitigation measures.	Chapter 7 of the Species Impact Statement (*Annex R* in EA) summarises measures to avoid and mitigate impacts on threatened species including retention and management of native vegetation in ecological corridors, provision of compensatory habitat and management of habitat for affected species in Community Conservation Lands. The layout of the proposed subdivision limits disturbance within the Swamp Sclerophyll Forest (Endangered Ecological Community) on the site to a small section at the entrance to the subdivision (Seaside Boulevard – already cleared) that was cleared under an existing approval. Large areas of the EEC were avoided by modification of the existing approval and inclusion within the ecological corridor. Biodiversity impacts have been reduced by the provision of a 200metre wide wildlife corridor between Nelson Bay Road and the development. The wildlife corridor has reduced the amount of clearing already approved under the existing development consent (stages 1-3) and maintains the connectivity of swamp forest in the Fern Bay area. An additional corridor of dry sclerophyll forest has been maintained between the proposed subdivision and the mobile dunes of Stockton Bight. Impacts on the Powerful Owl have been avoided through exclusion

Principle	Project Compliance
	of development from within a 100 metre radius of the identified roost tree. Other species specific impact mitigation measures include pre-clearance inspections and modified tree clearing operations to minimise mortality of species such as Squirrel Gliders.
2. All regulatory requirements must be met.	Offsets have not been used to satisfy approvals or assessments under other legislation.
3. Offsets must never reward ongoing poor performance.	There will be no incentive for the Community Association to deliberately degrade or mismanage offset areas. The community of the Fern Bay Seaside Village will be encouraged to establish a local environment group to undertake ongoing maintenance works within conservation areas and reserves on site. In addition, residents will be involved in the management and protection of the conservation reserves which will be managed under Community Title (*Community Lands Management Act 1989*). Signage, pamphlets and/or information sessions will inform residents of relevant issues such as responsible pet ownership and appropriate use of pesticides and fertilisers. Degradation of Worimi Regional Park will be reduced by the rationalisation of tracks, and the use of fences and gates to restrict access from the subdivision to the park. Bollard and wire fencing will be erected along the eastern boundary of the Fern Bay Seaside Village subdivision and Worimi State Recreation Area and along the eastern interface of the active dune and vegetated area in Worimi Regional Park, south to the Commonwealth land boundary. The fencing will limit vehicular access thereby facilitating rehabilitation of existing tracks and reducing opportunities for waste dumping and weed spread.
4. Offsets will complement other government programs.	The proposed offsets preserve vegetation and habitat areas through the dedication of lands as Community Conservation Lands as well as the management of a dedicated Regional Park (Since the gazettal of the Worimi Conservation Lands in February 2007, the land proposed for offset has been known as Worimi Regional Park). The conservation lands are currently unmanaged and have compromised biodiversity values due to threats such as weed and waste. The dedication of offsets will assist in reducing the threats to biodiversity in currently unmanaged areas.
5. Offsets must be underpinned by sound ecological principles.	The management of Community Conservation Lands is detailed in the CLEMP (Annex V of EA). This Plan assesses the conservation status of lands within the Community Conservation Lands and sets out management actions to mitigate development impacts on vegetation communities, threatened flora and fauna species and habitat. The Plan also considers the long term functionality of biodiversity. Management actions focus on enhancing biodiversity values of existing vegetation through measures such as weed management and pest control as well as specific habitat enhancement measures. The VMP for Worimi Regional Park considers the structure and functionality of the different vegetation communities within the Park and also considers the conservation significance of species (eg *Eucalyptus parramattensis subsp decadens* x *E. robusta*) within the area. The VMP focuses on increasing the habitat value of existing vegetation via reducing impacts such as illegal access, weeds and rubbish dumping. Natural regeneration of disturbed areas is favoured over planting. Planting (with local provenance seed) will occur only if natural regeneration is not occurring.
6. Offsets should aim to result in a net	Table J.1 identifies area of habitat to be cleared for the proposed Fern Bay Seaside Village and retained within the Community

Principle	Project Compliance
improvement in biodiversity over time.	Conservation Lands. Generally the area of habitats to be retained and managed to improve habitat values is greater than the area proposed to be cleared except for the wet heath habitat. The offset negotiated with DECC as part of the Master Plan approval identified offset measures for this habitat type. Both the Community Conservation Lands and Worimi Regional Park will be actively managed to enhance biodiversity over time. Management of threats and specific management actions for endangered species (eg *Diurus praecox*) and communities, as well as a reportable monitoring program, will allow for ongoing improvement in biodiversity values over time. In Worimi Regional Park management will include exotic species removal, waste removal, rationalisation of tracks, rehabilitation of unused tracks, annual monitoring of waste removal sites, and rehabilitation of areas with local provenance seed (if necessary). The offset package also involves the rehabilitation of approximately 31.7 hectares of wet heath habitat within Worimi Regional Park through track rationalisation, weed management and rubbish removal. The Fern Bay Seaside Village subdivision will involve clearing approximately 14.6 ha of wet heath habitat. Retention of *Eucalyptus parramattensis subsp decadens* x *E. robusta* in Worimi Regional Park (considered to have high conservation value) and management of key threatening processes (such as weed invasion, rubbish dumping and high frequency fire) will minimise threatening processes for this species and enhance the habitat value of the area.
7. Offsets must be enduring - they must offset the impact of the development for the period that the impact occurs.	THE CLEMP (Annex V of EA) sets out a monitoring and maintenance program for the Community Conservation Lands for a period of up to 20 years from the date of the development consent. The lands will be managed as community title under the *Community Lands Management Act 1989*. Altering the zoning of the lands to a consistent 7(a) Environmental Protection zoning (Port Stephens Council) should help to reinforce the conservation status of the lands. The VMP for Worimi Regional Park is for a period of 20 years. The report has been prepared in consultation with DECC (now DECCW). A Voluntary Planning Agreement will be entered into between Aspen and DECCW relating to the management of the Park. The Vegetation Management Plan (VMP) for the offset area will be implemented via the Voluntary Planning Agreement. Aspen will have primary responsibility for implementation of the VMP up to and including year five, in consultation with DECCW to ensure that the contracts and works meet DECCW standards. Responsibility for implementing the VMP in years six to 20 will transfer to DECCW with funding provided by Aspen Group.
8. Offsets should be agreed prior to the impact occurring.	The dedication of community lands as Community Conservation Lands has been proposed as part of the current Project Plan application. The establishment of an offset area in Worimi Regional Park was negotiated as part of the approval process for the Master Plan (MP 20-4-2005) for Fern Bay Seaside Village which was signed by the Minister on 8 August 2006.
9. Offsets must be quantifiable - the impacts and benefits must be reliably estimated.	The development of Fern Bay Seaside Village has been the subject of a comprehensive environmental assessment which details all the likely impacts of the development. The environmental assessment quantifies the area of impact, the species and communities to be impacted, the existing condition of habitat and management actions to reduce impacts. The VMP for Worimi Regional Park and the CLEMP for the

Principle	Project Compliance
	Community Conservation Lands include details of the connectivity of vegetation with surrounding areas, the existing condition of vegetation communities, management to increase biodiversity values, and conservation significance of identified species. A monitoring program to assess improvements over time is included in both Plans.
10. Offsets must be targeted.	The proposed offset of Community Conservation Lands and the agreed conservation offset package for Worimi Regional Park are targeted at providing 'like for like' vegetation types and habitat, and enhancing habitat values of these areas through implementation of management measures via implementation of targeted management plans. Both areas are known to support or are likely to support a similar assemblage of threatened species as identified within the development footprint. For some species the offset The Community Conservation Lands conserve a number of different communities (see *Table J.1*) including Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast which is considered an Endangered Ecological Community. Relative to the area that will be conserved the greatest loss of habitat resulting from the development of Fern Bay Seaside Village will be wet heath habitat (see *Table J.1*). The VMP for Worimi Regional Park focuses on improving the condition of wet heath habitat similar to that which would be removed as part of the Fern Bay Seaside Village subdivision. The VMP also focuses on protecting individual specimens of *Eucalyptus parramattensis subsp. decadens* x *E. robusta*. This species is considered to have a high conservation value. Rehabilitation works concentrating on removal of Bitou Bush and other weeds would also be undertaken in an area of Coastal Sand Apple-Blackbutt Forest - similar habitat to that proposed to be cleared as part of the Fern Bay Seaside Village subdivision.
11. Offsets must be located appropriately.	The Community Conservation Lands are located on the same parcel of land as the proposed development and the vegetation and habitats are representative of the same broad vegetation communities. Worimi Regional Park is located directly to the south of the proposed Fern Bay Seaside village. The VMP for the Park assesses the ecological similarities between the vegetation communities and habitats to be conserved within the Park and those to be cleared as a result of the development of Fern Bay Seaside Village. All of the offsets are located in the vegetated dunes of Stockton/Newcastle Bight and are characterised by the same land form, vegetation type and soil type.
12. Offsets must be supplementary. Must be beyond existing requirements and not already funded under another scheme.	Both the Community Conservation Lands and Worimi Regional Park are not subject to funding under any other scheme. The Community Conservation Lands are currently not managed by the government. Worimi Regional Park is a recently established national park that is managed by DECCW in conjunction with the Worimi Conservation Lands Board of Management. DECCW leases the Worimi Regional Park by way of a lease agreement with the Worimi Local Aboriginal Land Council, on behalf of the Worimi Registered Owners. The lease agreement acknowledges that the Master Plan approval for this development includes ecological offset measures to be undertaken in Worimi Regional Park.
13. Offsets and their actions must be enforceable through development	The Developer, Aspen Group, will be responsible for implementing, auditing and monitoring all management actions within the CLEMP during construction and establishment stages of the development. The Community Association, established under Community Title,

Principle	Project Compliance
consent conditions, licence conditions, conservation agreements or a contract.	will be responsible for the management and monitoring of the Conservation Lands following the establishment of these areas. The Community Association will be responsible for ensuring that regular reviews of the CLEMP occur in consultation with both Port Stephens Council and DECCW. Monitoring reports measured against given performance indicators will be prepared annually by Aspen in regards to the management of Worimi Regional Park. The monitoring report will be provided to DECCW for review. A Voluntary Planning Agreement will be entered into between Aspen and DECCW relating to the management of the Park. The Vegetation Management Plan (VMP) for the offset area will be implemented via the Voluntary Planning Agreement.

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