PITTWATER COUNCIL

SCOTLAND ISLAND ROAD RESERVE AND STORMWATER MANAGEMENT IMPLEMENTATION PLAN (*UI*)

Issue No. 6
JUNE 2011

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Document Amendment and Approval Record

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Note: This document is preliminary unless it is approved by a principal of Civil Certification.

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1 INTRODUCTION

Civil Certification have been engaged by Pittwater Council to develop a strategic plan for management of the roads and other items within the public road reserves on Scotland Island (*refer to separate report titled "Scotland Island Road Reserve Strategy" – 21 June 2011*).

Because of their inter-relationship, the abovementioned Road Reserve Strategy was developed in parallel with a Stormwater Management Strategy for the Island (*refer to separate report titled "Scotland Island Stormwater Management Strategy"- 21 June 2011*).

Both documents have now been finalised and incorporate several years of investigations, consultation and review.

Both strategy reports have made a number of conclusions regarding the treatment of the Islands roads and stormwater management system and put forward a range of short, medium and long term recommendations.

Because the reports are high level strategy documents it is anticipated that a number of more detailed site/issue specific investigations will need to be undertaken before implementation of some recommendations. However, it is also anticipated that many recommendations can be implemented directly.

This report is an implementation plan for Council's Urban Infrastructure (UI) group and only those recommendations which are relevant to Councils Urban Infrastructure group have been included (*ie road and drainage infrastructure related recommendations*). It is expected that separate implementation plan reports will be prepared for other divisions of Council. Recommendations that have not been included in this implementation plan include those related to traffic management, planning controls, land acquisition, fire trails, reserves and maintenance as well as any recommendations that are private lot based or policy based.

This latest report incorporates public comments received in the first quarter of 2011.

1.1 QUALIFICATIONS

This report has been prepared by Michael Shaw, a Principal of Civil Certification. Michael has over 17 years experience in civil engineering and is well versed with the standards and requirements of Pittwater Council and the unique characteristics of Scotland Island. Michael has played a significant role in development of both the road and stormwater management strategies for Scotland Island over the past 5 years. Details of Michael's qualifications and experienced are contained at **Appendix D**.

1.2 QUALIFIERS

This report has been prepared for the benefit of Pittwater Council with relation to the particular project described and no responsibility is accepted for the use of any part of this report in any other context or for any other purpose. Copyright in this report is the property of Civil Certification. In preparing this report, Civil Certification have used a degree of care, skill and diligence normally exercised by consulting engineers in similar circumstances and locality. No other warranty expressed or implied is made or intended.

2 UI IMPLEMENTATION PLAN

2.1 CONCLUSIONS AND UI RELATED RECOMMENDATIONS

A number of conclusions were drawn from both the Road Reserve (*21 June 2011*) and Stormwater Management (*21 June 2011*) Strategies. For information, a summary of these conclusions has been included at **Appendix A and B**.

These conclusions led to derivation of a number of short, medium and long term recommendations. For this implementation plan those recommendations relevant to Council's Urban Infrastructure (*UI*) Group were identified only. The short list of UI related recommendations is also included at **Appendix A and B**.

2.2 COSTING

A high level costing exercise was undertaken as part of this study to determine preliminary capital cost estimates for the UI related recommendations.

Note that these cost estimates are preliminary only to aid in the ranking exercise and are to be used with caution. It is recommended that a detailed cost estimating exercise be undertaken at some future stage.

The predicted capital costs of each road reserve and stormwater management UI related recommendation is summarised in **Appendix C**. Note these estimates do not include any ongoing maintenance, decommissioning costs, land acquisition costs and/or legal/administration/consultant costs.

2.3 RANKING SYSTEM

A high level ranking system was developed as a starting point in definition of the priority for implementation of the UI road and stormwater strategy measures.

The priority ranking system includes six simplified ranking elements, i.e. environmental improvement, cost per catchment area, measure location, safety, drainage precedence and walking track relegation . The environmental improvement element attempts to categorise the environmental effectiveness of a recommendation. The cost per catchment area element is a measure of cost effectiveness. The measure location element attempts to give measures lower on the Island (ie *near the main access points to the Island*) a higher priority. The safety related element gives priority to safety related measures as is the case with the drainage precedence element. The walking track relegation measure element attempts to place measures related to this item as the lowest priority.

The scoring range for each element is defined in **Table 1**. All ranking elements have been given equal weighting. In all cases the lower the score the higher the measure will rank.

Table 1 – Ranking Element Scores

Score	Environmental Improvement	Costs per Catchment Area ($/ha)	Safety	Walking Track	Drainage	Measures Location
1	Extreme	1-5,000	High S (2)	Non WT (0)	Drainage (0)	Coast (2)
2	Major	5,001 – 20,000				
3	Moderate	20,001 – 50,000	Medium S (4)			Middle (4)
4	Minor	50,001 – 100,000		WT (6)	Non Drainage (6)	
5	Little	100,001 – 200,000	Low S (6)			Top of Island (6)
6	Minimal	>200,001				

The results of the measure ranking exercise are contained in **Table 7** at **Appendix E**.

2.4 CONSTRUCTION SECTORS

To facilitate orderly, cost efficient and sustainable infrastructure construction, the Island has been divided into a number of "*Construction Sectors*".

The numbering of each Construction Sector represents the order in which construction is likely be implemented.

This order has been derived based on proximity to the main construction vehicle entry point to the Island (*ie Cargo Wharf*), the progressive completion of a sealed road link from Cargo Wharf to Tennis Wharf along Richard Road, Harold Street and Thompson street followed by completion of the lower road loop by sealing Robertson Road, the areas of most needed work and the practicality of completing multiple works together in zones (*ie because they are inextricably linked*).

An illustration of the Islands Construction Sectors is contained in **Figure R0**.

2.5 UI IMPLEMENTATION PLAN

An implementation plan has been developed by firstly sorting all measures by their Construction Sector then within each Sector by overall measure rank.

The resultant Scotland Island Road Reserve and Stormwater Management strategy implementation plan for Council's Urban Infrastructure (*UI*) Group is illustrated in **Table 2.**

The early stages of the implementation plan will involve establishment of a suitable construction vehicle entry point to the Island followed by a number of smaller but urgent short term drainage related works. This will be followed by the progressive construction of drainage and pavement sealing eastward from Cargo Wharf along Richard Road and ultimately completing the lower ring road loop.

All works will involve detailed design and community consultation prior to implementation.

The implementation plan included at **Table 2** will be used as a guide only and depending on budget and the conditions at the time Council may alter this list to suit. Council will liaise with SIRA and the community as a whole when finalising the list for each year. However, ultimately the decision on which works will be implemented will rest with Council.

The period in which all works will be completed is very much dependent on the available annual budget. However, based on the total estimate of works required (*ie close to $20 million*) it is anticipated that this will be a substantial period.

Because of this long period it is imperative that all permanent road drainage and sealing works are properly designed and constructed to be durable for the long term. This will enable the progressive implementation of sustainable infrastructure assets.

The measures selected for the establishment phase of the implementation plan are those that are required to facilitate construction access and/or can be constructed in a relatively short timeframe (*ie without significant investigation/design works*) but still supplement more substantial future works.

Table 2 – UI Implementation Plan

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
ESTABLISHMENT PHASE						
162	P23	**L-RSS**	Provide new access ramp and associated laydown/pickup area for large construction/maintenance vehicles	$300,000	1	152**
51	DS10-1	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 1** - Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	$36,000	1	1
52	DS10-2	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 2** - Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	$36,000	1	1
53	DS10-3	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 3** - Existing horizontal roadside stormwater grates to be progressively replaced. GENERAL MULTIPLE LOCATIONS.	$36,000	1	1
57	WR4	**S/M-RSS**	Build-up windrow on Richard Road	$4,500	2	4
83	WR61	**S/M-RSS**	Re-profile the bend on Richard Road north-west of Hilda Av	$15,000	2	4
66	WR22	**S/M-RSS**	Stabilise the drains that enter the eastern creek crossing on Richard Rd	$7,500	3	4
SECTOR 1						
107	DL2-1	**L-RSS**	**Trunk Drainage Sector 1** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	1	4
1	DS1-1	**S/M-RSS**	Table drain in Richard Road (**Sector 1**)	$51,000	1	22
8	DS4-1	**S/M-RSS**	**Waterbars/Crossbanks Sector 1** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	1	22
24	DS7-1	**S/M-RSS**	**Table Drain Crossings Sector 1** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	1	22
122	DL3-1	**L-RSS**	**5yr ARI Piped Drainage Sector 1** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	1	22
179	SWM7-14	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS8	$25,200	1	22
84	WR62	**S/M-RSS**	Fix the drainage on Richard Road opposite unnamed (40ft wide) road	$30,000	1	91
171	SWM7-6	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT6	$187,500	1	91
58	WR7	**S/M-RSS**	Install temporary timber safety bollards on the two creeks culvert crossings on Richard Road north of the unnamed (40ft wide) road reserve	$4,500	1	131
95	S11	**L-RSS**	Provide guard rail on steep down slope drop along Richard Road just north of the Unnamed Road	$18,000	1	133
102	S20	**L-RSS**	Construct road embankment retaining structures on high side of Robertson Road at Fitzpatrick Avenue (*ie above walking track/future road*)	$112,500	1	136
137	P1	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Robertson Road from intersection with Cargo Wharf Road/Fitzpatrick Ave between approx. chainages 840 and 880 (*refer to Figure R3 for road chainage details*)	$216,000	1	141
153	P15-1	**L-RSS**	**Richard Pavement Sector 1** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$409,500	1	141
91	S1	**L-RSS**	Construct retaining structures (gabion or similar) on steep road embankments along Richard Road north of the Unnamed Rd	$337,500	1	161
SECTOR 2						
54	DS12-1	**S/M-RSS**	**Outlet Stabilisation Stage 1** - Stabilise the stormwater outlets by stabilising the outlet gully	$120,000	2	4
55	DS12-2	**S/M-RSS**	**Outlet Stabilisation Stage 2** - Stabilise the stormwater outlets by stabilising the outlet gully	$120,000	2	4
56	DS12-3	**S/M-RSS**	**Outlet Stabilisation Stage 3** - Stabilise the stormwater outlets by stabilising the outlet gully	$120,000	2	4
108	DL2-2	**L-RSS**	**Trunk Drainage Sector 2** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	2	4
2	DS1-2	**S/M-RSS**	Table drain in Richard Road (**Sector 2**)	$51,000	2	22
9	DS4-2	**S/M-RSS**	**Waterbars/Crossbanks Sector 2** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	2	22
25	DS7-2	**S/M-RSS**	**Table Drain Crossings Sector 2**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	2	22

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
123	DL3-2	**L-RSS**	**5yr ARI Piped Drainage Sector 2**-Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	2	22
165	SW30	**S/M-SWMS**	Replace the stormwater grates on the Richard Road- Hilda Avenue intersection.	$15,000	2	22
178	SWM7-13	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS7	$39,600	2	22
170	SWM7-5	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT5	$187,500	2	68
177	SWM7-12	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS6	$32,400	2	68
169	SWM7-4	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT4	$187,500	2	91
164	SW7	**S/M-SWMS**	Reform drainage on Hilda Avenue.	$75,000	2	131
60	WR10	**S/M-RSS**	Adopt short-term solution to the stabilisation of the trafficable area and drainage for Hilda Ave if the road closure has not been completed	$45,000	2	140
154	P15-2	**L-RSS**	**Richard Pavement Sector 2** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$409,500	2	141
97	S17-1	**L-RSS**	**Passing Bays Stage 1** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	$90,000	2	162
88	H5, S2 and W10	**L-RSS**	Convert Hilda Ave to a walking track only (ie no vehicular access) but leave as road reserve (incl drainage and surface stabilisation)	$247,500	2	170
SECTOR 3						
109	DL2-3	**L-RSS**	**Trunk Drainage Sector 3** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	3	4
3	DS1-3	**S/M-RSS**	Table drain in Richard Road (**Sector 3**)	$51,000	3	22
10	DS4-3	**S/M-RSS**	**Waterbars/Crossbanks Sector 3**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	3	22
26	DS7-3	**S/M-RSS**	**Table Drain Crossings Sector 3** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	3	22
75	WR45	**S/M-RSS**	Re-profile Richard Road west of the eastern creek crossing. Or otherwise, remove the concrete drain and form a new rock-lined table drain	$30,000	3	22
124	DL3-3	**L-RSS**	**5yr ARI Piped Drainage Sector 3** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	3	22
176	SWM7-11	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS5	$18,000	3	22
23	DS 5,6 and 11	**S/M-RSS**	Install silt traps as shown in Plan SIR023 (includes DS5 and DS 11)	$180,000	3	63
62	WR12	**S/M-RSS**	Modify the private driveway entries of Richard Road east of the eastern creek crossing to allow flow down a newly reshaped and stabilised table drain. Then, re-profile the road as necessary to regularly direct stormwater runoff into the table drain possibly with use of cross banks	$30,000	3	68
168	SWM7-3	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT3	$187,500	3	91
65	WR21	**S/M-RSS**	Construct suitable stormwater drainage down Cecil St	$75,000	3	118
163	SW6	**S/M-SWMS**	Temporarily stabilise Cecil Street if it has not been closed to traffic.	$22,500	3	136
145	P9	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Richard Road between approx. chainages 260 and 320 (*refer to Figure R3 for road chainage details*)	$216,000	3	139
155	P15-3	**L-RSS**	**Richard Pavement Sector 3** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$409,500	3	141
143	P7	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Cecil Street	$198,000	3	157
SECTOR 4						
67	WR23	**S/M-RSS**	Replace the stormwater inlet grate on the intersection of Harold Ave and Richard Rd	$3,750	4	4
69	WR33	**S/M-RSS**	Stabilise the gully erosion downstream of the stormwater outlet on the intersection of Harold Ave and Richard Rd	$45,000	4	63
110	DL2-4	**L-RSS**	**Trunk Drainage Sector 4** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	4	68
11	DS4-4	**S/M-RSS**	**Waterbars/Crossbanks Sector 4** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	4	91
27	DS7-4	**S/M-RSS**	**Table Drain Crossings Sector 4** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	4	91
39	DS8-1	**S/M-RSS**	**Table Drains Sector 4** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	4	91
167	SWM7-2	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT2	$187,500	4	91

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
125	DL3-4	**L-RSS**	**5yr ARI Piped Drainage Sector 4** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	4	111
140	P4	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 400 and 500 (*refer to Figure R3 for road chainage details*)	$360,000	4	141
96	S14	**L-RSS**	Provide guard rail on steep down slope drop along Harold Avenue	$27,000	4	152
144	P8	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Harold Ave and round the corner into the start of Richard Road	$432,000	4	162
SECTOR 5						
111	DL2-5	**L-RSS**	**Trunk Drainage Sector 5** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	5	68
12	DS4-5	**S/M-RSS**	**Waterbars/Crossbanks Sector 5** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	5	91
28	DS7-5	**S/M-RSS**	**Table Drain Crossings Sector 5** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	5	91
40	DS8-2	**S/M-RSS**	**Table Drains Sector 5** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	5	91
166	SWM7-1	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT1	$187,500	5	91
126	DL3-5	**L-RSS**	5**yr ARI Piped Drainage Sector 5** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	5	111
138	P2 and S6	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Thompson Road from intersection with Kevin Ave between approx. chainages 0 and 35 (*refer to Figure R3 for road chainage details*)	$126,000	5	157
139	P3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 130 and 250 (*refer to Figure R3 for road chainage details*)	$432,000	5	157
98	S17-2	**L-RSS**	**Passing Bays Stage 2** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	$90,000	5	162
156	P16-1	**L-RSS**	**Thompson Pavement Sector 5** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$385,875	5	173
SECTOR 6						
112	DL2-6	**L-RSS**	**Trunk Drainage Sector 6** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	6	22
180	SWM7-15	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS9	$23,400	6	22
13	DS4-6	**S/M-RSS**	**Waterbars/Crossbanks Sector 6** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	6	68
29	DS7-6	**S/M-RSS**	**Table Drain Crossings Sector 6** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	6	68
41	DS8-3	**S/M-RSS**	**Table Drains Sector 6** - construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	$60,000	6	68
127	DL3-6	**L-RSS**	5**yr ARI Piped Drainage Sector 6** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	6	91
99	S17-3	**L-RSS**	**Passing Bays Stage 3** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	$90,000	6	162
159	P17-1	**L-RSS**	**Robertson Pavement Sector 6** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	$354,375	6	162
105	W7	**L-RSS**	Steps placed along the lower half of the Aoma Street walking track to provide all weather access	$10,500	6	175
SECTOR 7						
74	WR43	**S/M-RSS**	Re-profile the intersection of Thompson St and Robertson Rd	$22,500	7	22
113	DL2-7	**L-RSS**	**Trunk Drainage Sector 7**- Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	7	22
14	DS4-7	**S/M-RSS**	**Waterbars/Crossbanks Sector 7** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	7	68

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
30	DS7-7	**S/M-RSS**	**Table Drain Crossings Sector 7** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	7	68
42	DS8-4	**S/M-RSS**	**Table Drains Sector 7** - construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	$60,000	7	68
128	DL3-7	**L-RSS**	5**yr ARI Piped Drainage Sector 7** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	7	91
63	WR13	**S/M-RSS**	Construct cross banks and reprofile surface on the steep section of Thompson St west of Robertson Rd if not closed off to traffic	$22,500	7	126
160	P17-2	**L-RSS**	**Robertson Pavement Sector 7** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	$354,375	7	162
92	S8	**L-RSS**	Provide turning area at end of Robertson Road (*ie chainage 1540*) and convert section of Thompson Rd to the east of its intersection with Robertson Road to a stabilised walking track. Provide barriers to prevent unauthorised vehicular access along Thompson Street to the west. Site Barriers up Thompson to ensure access to existing residential properties is maintained.	$150,000	7	170
161	P21	**L-RSS**	Seal Steep section of Thompson Ch 1340-1540 (Flexible pavement). Convert upper section of Thompson Road to a walking track only (*ie close off to vehicles*). Maintain vehicular access to existing properties. Residents to construct private driveway access from end of Thompson turning head (refer to Measure S8 also)	$315,000	7	180
SECTOR 8						
64	WR20	**S/M-RSS**	Re-profile the Thompson St - Cecil St intersection	$30,000	8	87
80	WR53	**S/M-RSS**	Stabilise (rock line) the table drain in Thompson St south of Kevin Av	$15,000	8	91
31	DS7-8	**S/M-RSS**	**Table Drain Crossings Sector 8** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	8	107
114	DL2-8	**L-RSS**	**Trunk Drainage Sector 8** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	8	107
77	WR47	**S/M-RSS**	Construct and stabilise a table drain along Thompson Street between Harold Av and Cecil St. Where necessary, install cross banks.	$52,500	8	111
78	WR48	**S/M-RSS**	Construct culvert under Thompson Road at creek crossing between Harold Av and Cecil St	$37,500	8	111
15	DS4-8	**S/M-RSS**	**Waterbars/Crossbanks Sector 8** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	8	118
43	DS8-5	**S/M-RSS**	**Table Drains Sector 8** - construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	$60,000	8	118
129	DL3-8	**L-RSS**	5**yr ARI Piped Drainage Sector 8** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	8	118
141	P5 and S7	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 740 and 830 (*refer to Figure R3 for road chainage details*)	$324,000	8	157
157	P16-2	**L-RSS**	**Thompson Pavement Sector 8** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$385,875	8	175
SECTOR 9						
61	WR11	**S/M-RSS**	Re-profile Thompson St & Hilda Ave intersection and direct flow down Thompson St instead of Hilda Ave	$22,500	9	63
81	WR56	**S/M-RSS**	Direct flow off Thompson St down the unnamed (40ft wide) road reserve	$8,250	9	91
32	DS7-9	**S/M-RSS**	**Table Drain Crossings Sector 9**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	9	107
115	DL2-9	**L-RSS**	**Trunk Drainage Sector 9** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	9	107
16	DS4-9	**S/M-RSS**	**Waterbars/Crossbanks Sector 9** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	9	118
44	DS8-6	**S/M-RSS**	**Table Drains Sector 9** - construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	$60,000	9	118
130	DL3-9	**L-RSS**	5**yr ARI Piped Drainage Sector 9** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	9	118
68	WR30	**S/M-RSS**	Fix the log sediment trap on the western cutting of the Elizabeth Park track	$4,500	9	126
142	P6 and S3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 940 and 1010 (*refer to Figure R3 for road chainage details*)	$252,000	9	141
103	W1	**L-RSS**	Realignment of upper Fitzpatrick Avenue above Thompson Street because it is badly eroded and currently runs within private property	$18,000	9	152

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
104	W3	**L-RSS**	Installation of cross banks on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street to divert runoff off away from the track	$6,000	9	152
90	H7-2 and S 15	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Thompson Street (incl guard rail and retaining structures)	$191,250	9	170
106	W8	**L-RSS**	Additional steps placed on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street possible between the existing rock steps	$12,750	9	175
158	P16-3	**L-RSS**	**Thompson Pavement Sector 9** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$385,875	9	175
SECTOR 10						
17	DS4-10	**S/M-RSS**	**Waterbars/Crossbanks Sector 10**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	10	111
33	DS7-10	**S/M-RSS**	**Table Drain Crossings Sector 10** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	10	111
116	DL2-10	**L-RSS**	**Trunk Drainage Sector 10** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	10	111
45	DS8-7	**S/M-RSS**	**Table Drains Sector 10** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	10	126
131	DL3-10	**L-RSS**	5**yr ARI Piped Drainage Sector 10** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	10	126
147	P12	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Pitt View Street	$236,250	10	141
SECTOR 11						
117	DL2-11	**L-RSS**	**Trunk Drainage Sector 11** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	11	4
18	DS4-11	**S/M-RSS**	**Waterbars/Crossbanks Sector 11** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	11	22
34	DS7-11	**S/M-RSS**	**Table Drain Crossings Sector 11**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	11	22
46	DS8-8	**S/M-RSS**	**Table Drains Sector 11** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	11	22
85	WR63	**S/M-RSS**	Fix the drainage on Florence Terrace east of Pitt View St. Possible remove the concrete table drain and replace with a rock-lined drain set lower into the road profile	$67,500	11	68
132	DL3-11	**L-RSS**	5**yr ARI Piped Drainage Sector 11** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	11	68
172	SWM7-7	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS1	$36,000	11	68
173	SWM7-8	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS2	$43,200	11	68
4	DS2-1 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 11**)	$15,188	11	87
149	P14-1	**L-RSS**	**Florence Pavement Sector 11**- construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$354,375	11	141
SECTOR 12						
72	WR41	**S/M-RSS**	Form a table drain on Florence Terrace immediately south of Pathilda Reserve	$3,750	12	4
76	WR46	**S/M-RSS**	Formalise a table drain along Florence Terrace north of Pathilda Reserve	$3,750	12	4
118	DL2-12	**L-RSS**	**Trunk Drainage Sector 12** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	12	4
19	DS4-12	**S/M-RSS**	**Waterbars/Crossbanks Sector 12**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	12	22
35	DS7-12	**S/M-RSS**	**Table Drain Crossings Sector 12** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	12	22
47	DS8-9	**S/M-RSS**	**Table Drains Sector 12** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	12	22
174	SWM7-9	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS3	$32,400	12	22

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
133	DL3-12	**L-RSS**	5**yr ARI Piped Drainage Sector 12** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	12	68
5	DS2-2 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 12**)	$15,188	12	87
94	S10	**L-RSS**	Stabilise road surface (*ie flush seal*) and provide safety signs on sharp bends and steep sections of Florence Terrace	$52,500	12	133
150	P14-2	**L-RSS**	**Florence Pavement Sector 12 (incl small sect 5)** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$354,375	12	141
100	S17-4	**L-RSS**	**Passing Bays Stage 4** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	$90,000	12	162
SECTOR 13						
73	WR42	**S/M-RSS**	Re-profile Florence Terrace between Lowanna St and Elsie St to form infall drainage and form a table drain	$22,500	13	4
119	DL2-13	**L-RSS**	**Trunk Drainage Sector 13** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	13	4
20	DS4-13	**S/M-RSS**	**Waterbars/Crossbanks Sector 13** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	13	22
36	DS7-13	**S/M-RSS**	**Table Drain Crossings Sector 13** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	13	22
48	DS8-10	**S/M-RSS**	**Table Drains Sector 13** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	13	22
175	SWM7-10	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS4	$28,800	13	22
134	DL3-13	**L-RSS**	5**yr ARI Piped Drainage Sector 13** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	13	68
6	DS2-3(DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 13**)	$15,188	13	87
93	S9	**L-RSS**	Provide guard rail on Florence Tce at Pathilda Reserve and in the vicinity of Lowanna Street	$39,000	13	136
151	P14-3	**L-RSS**	**Florence Pavement Sector 13** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$354,375	13	141
SECTOR 14						
120	DL2-14	**L-RSS**	**Trunk Drainage Sector 14** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	14	4
21	DS4-14	**S/M-RSS**	**Waterbars/Crossbanks Sector 14** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$14,400	14	22
37	DS7-14	**S/M-RSS**	**Table Drain Crossings Sector 14** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	14	22
49	DS8-11	**S/M-RSS**	**Table Drains Sector 14** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	14	22
135	DL3-14	**L-RSS**	5**yr ARI Piped Drainage Sector 14** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	14	22
7	DS2-4 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 14**)	$15,188	14	63
70	WR35	**S/M-RSS**	Re-profile the intersection of Florence Terrace and Elsie St	$22,500	14	63
152	P14-4	**L-RSS**	**Florence Pavement Sector 14** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$354,375	14	141
89	H7-1	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Florence Tce (incl guard rail and retaining structures)	$191,250	14	152
101	S17-5	**L-RSS**	**Passing Bays Stage 5** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	$120,000	14	173
SECTOR 15						
121	DL2-15	**L-RSS**	**Trunk Drainage Sector 15** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$150,000	15	4
22	DS4-15	**S/M-RSS**	**Waterbars/Crossbanks Sector 15** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term	$14,400	15	22

No.	Measure No.	Type	Measure Description	Total Captial Cost Estimate (AU$ 2011)	Construction Sector (1 to 15)	Rank #
			measures)			
38	DS7-15	**S/M-RSS**	**Table Drain Crossings Sector 15 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$37,200	15	22
50	DS8-12	**S/M-RSS**	**Table Drains Sector 15 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$60,000	15	22
86	WR64	**S/M-RSS**	Duplicate the Catherine Park road culvert	$45,000	15	22
181	SWM7-16	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS10	$23,400	15	22
87	WR67	**S/M-RSS**	Enlarge the detention basin upstream of the Catherine Park culvert	$157,500	15	68
136	DL3-15	**L-RSS**	5**yr ARI Piped Drainage Sector 15-** Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$82,500	15	68
71	WR39	**S/M-RSS**	Install additional cross banks on upper Kevin St	$15,000	15	118
82	WR57	**S/M-RSS**	Form a silt trap at base of eastern cutting on the Elizabeth Park track	$3,000	15	126
79	WR51	**S/M-RSS**	Establish silt storage areas in Elizabeth Park or any other suitable location. Use these areas to store silt collected from table drain maintenance operations. Treat with gypsum and mix with organise to form a source of topsoil for the rehabilitation of road banks and table drains	$7,500	15	133
148	P13	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Kevin Ave	$315,000	15	162
146	P10 and S4	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of fire trail extending from the end of Kevin Ave between approx. chainages 190 and 300 (*refer to Figure R3 for road chainage details*)	$558,000	15	179
59	WR9	**S/M-RSS**	Construct an elevated footpath/stairway on the inside of the sharp bend on the Elizabeth park track just up-slope of Kevin St, or otherwise make this track safe for all-weather pedestrian access	$180,000	15	181

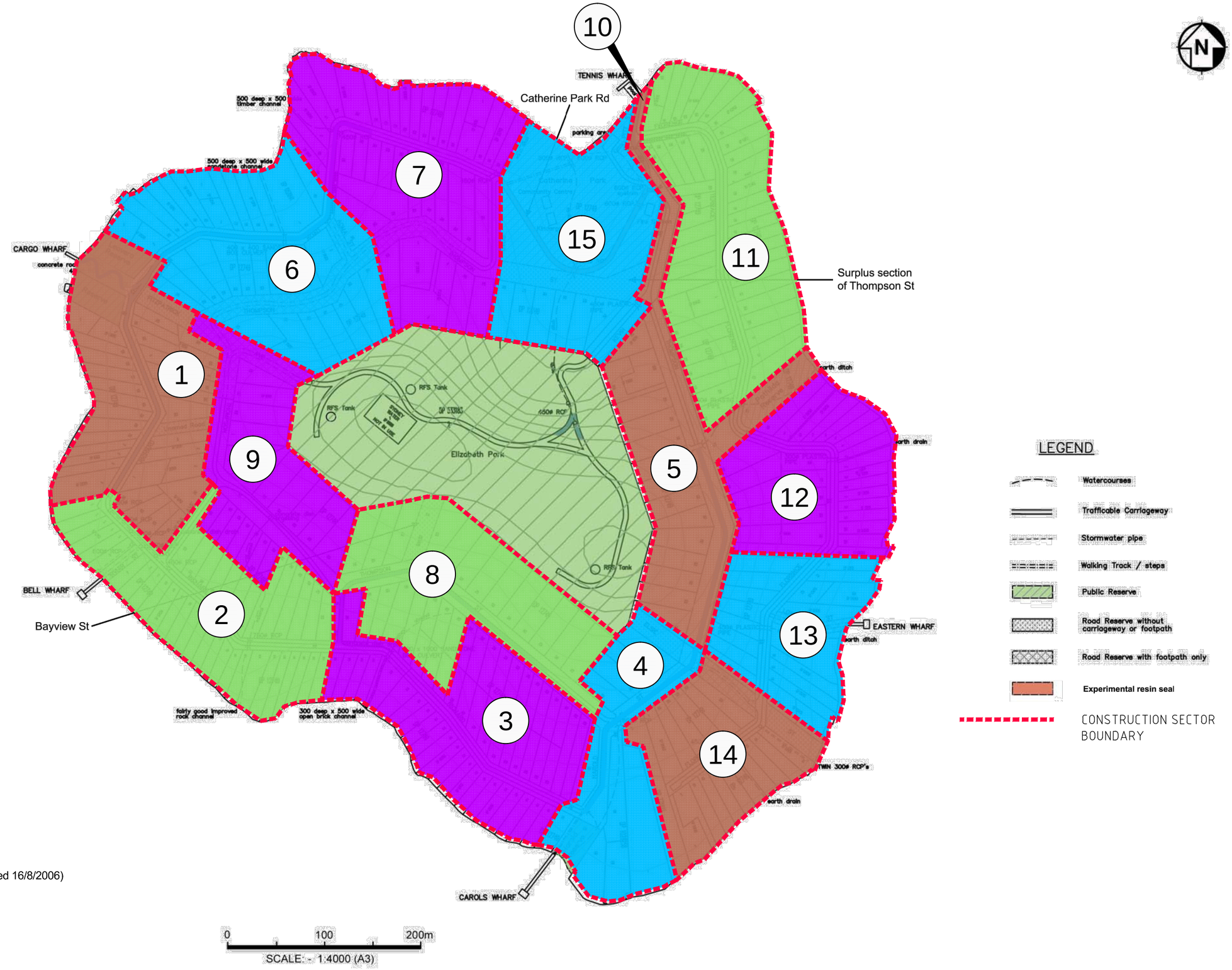
Notes:
** This measure is placed as a high priority to enable effective and cost efficient construction of all other measures on the Island.

3 REFERENCES

"*Scotland Island Road Reserve Strategy*" Rev 6, Civil Certification, 21 June 2011;

"*Scotland Island Stormwater Management Strategy*" Rev E, Civil certification, 21 June 2011.

FIGURES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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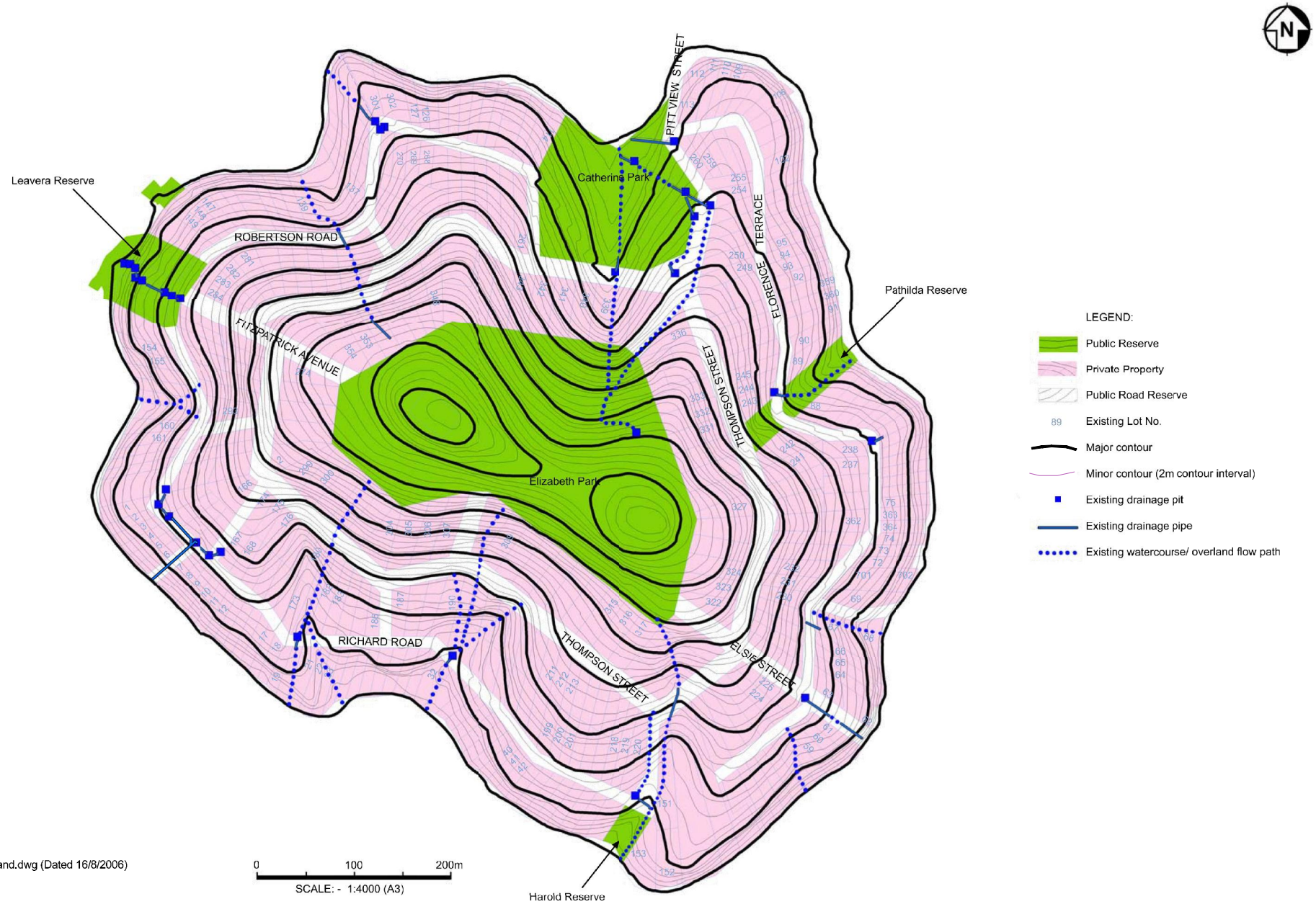
FIGURE R0
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED CONSTRUCTION SECTORS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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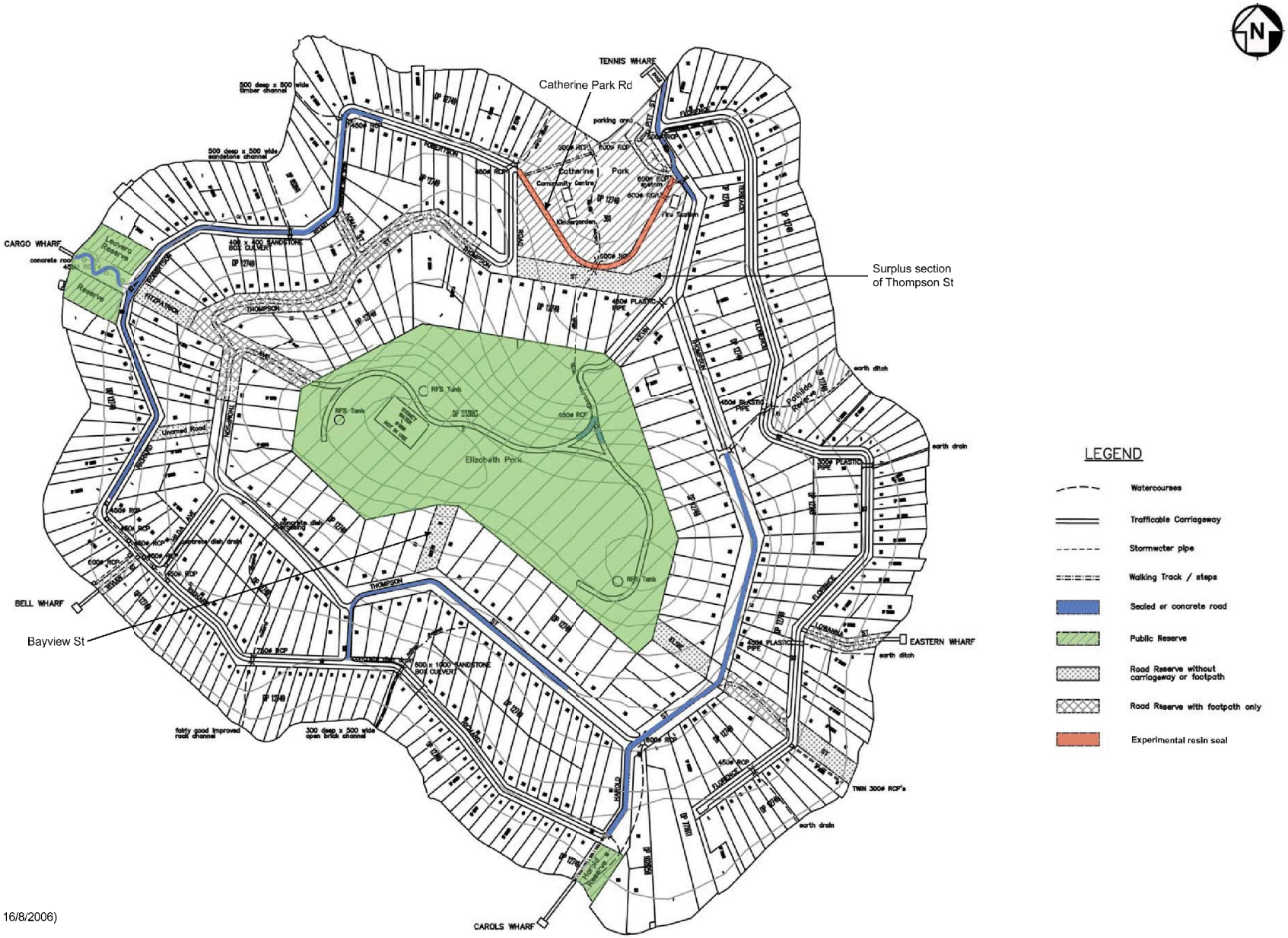
FIGURE R1
SCOTLAND ISLAND ROAD RESERVE STRATEGY
EXISTING LAND USE



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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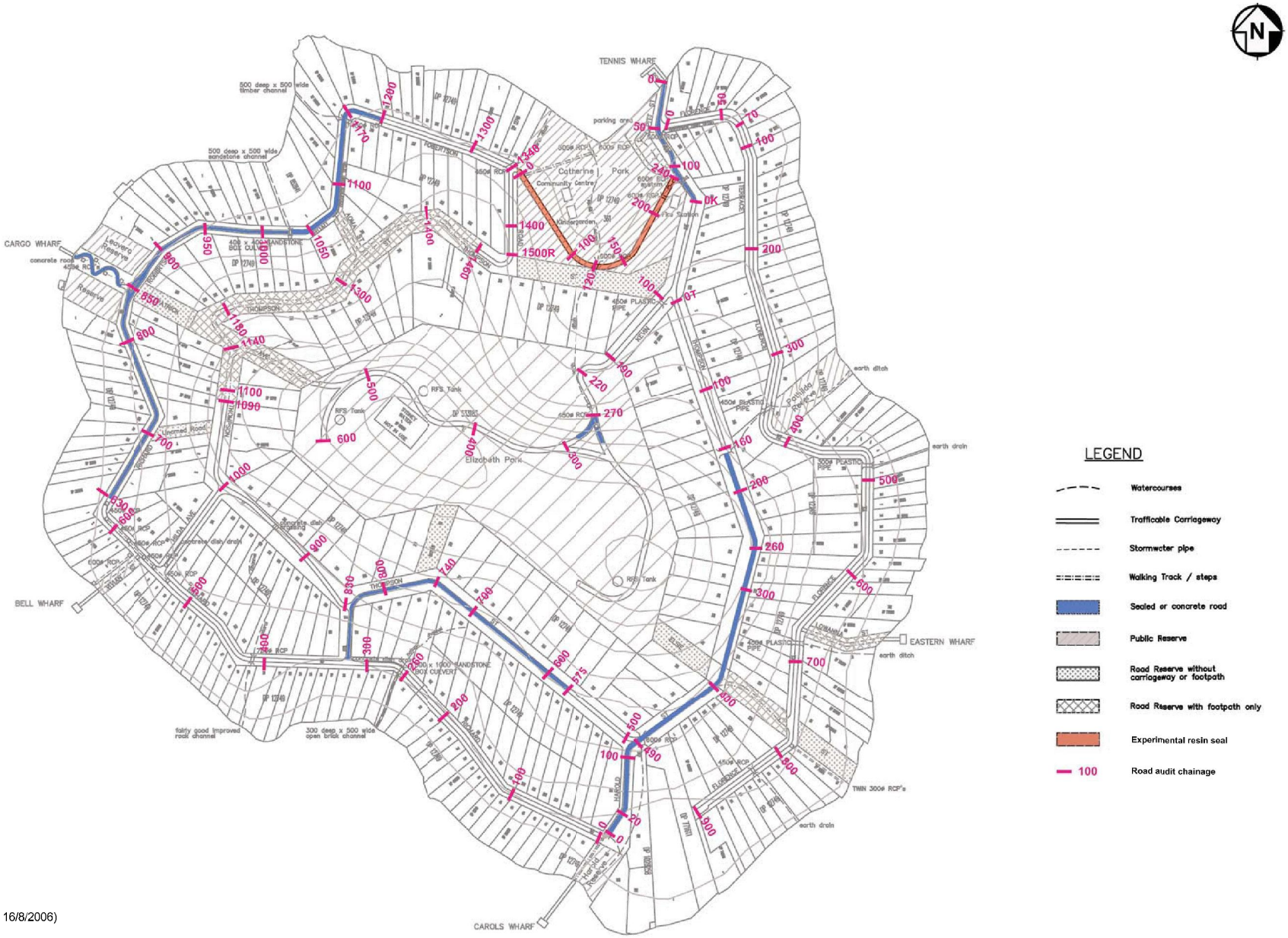
FIGURE R2
SCOTLAND ISLAND ROAD RESERVE STRATEGY
EXISTING ROAD AND DRAINAGE STRUCTURES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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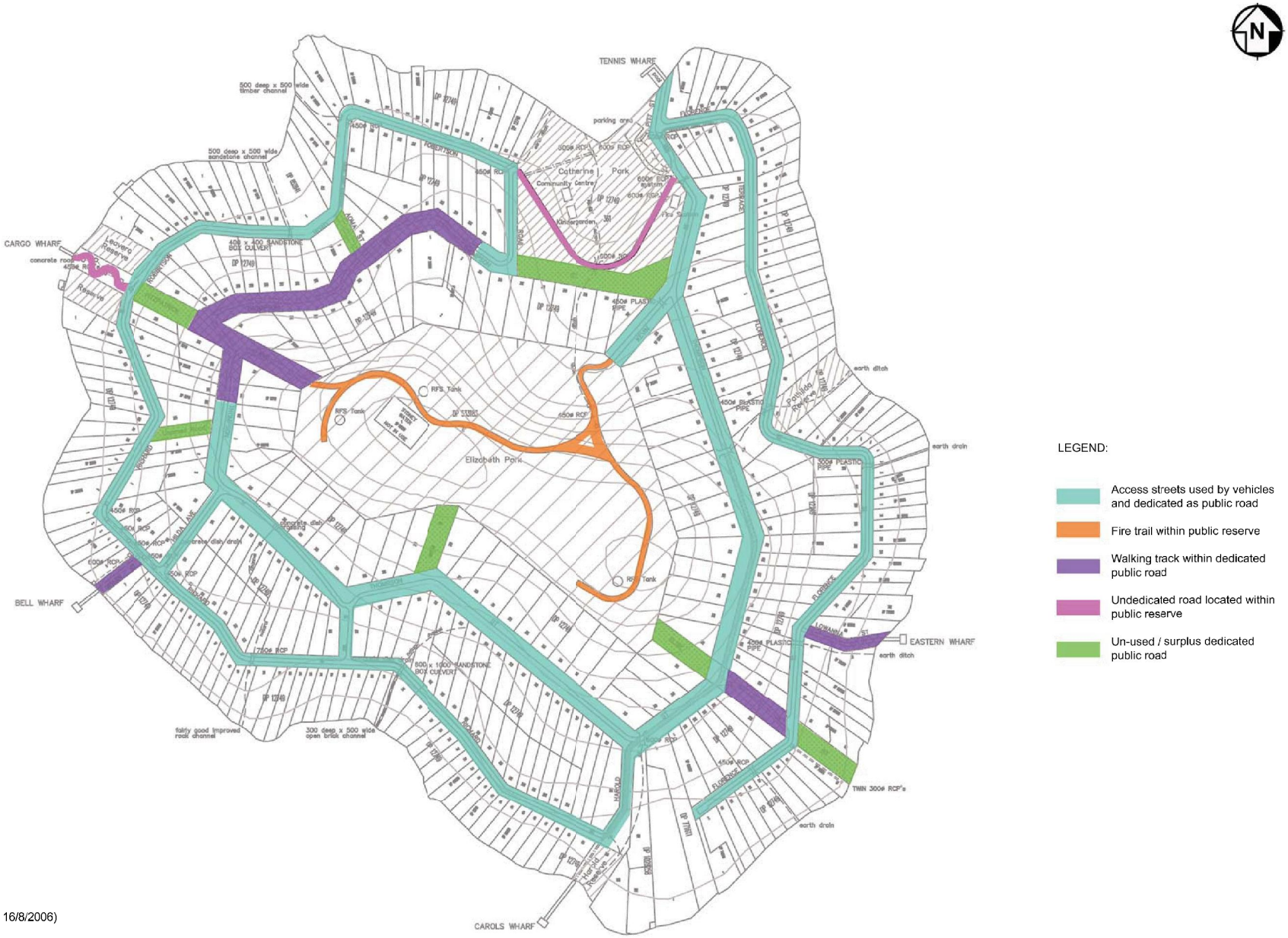
FIGURE R3
SCOTLAND ISLAND ROAD RESERVE STRATEGY
ROAD AUDIT AND CHAINAGES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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0 100 200m

SCALE: - 1:4000 (A3)

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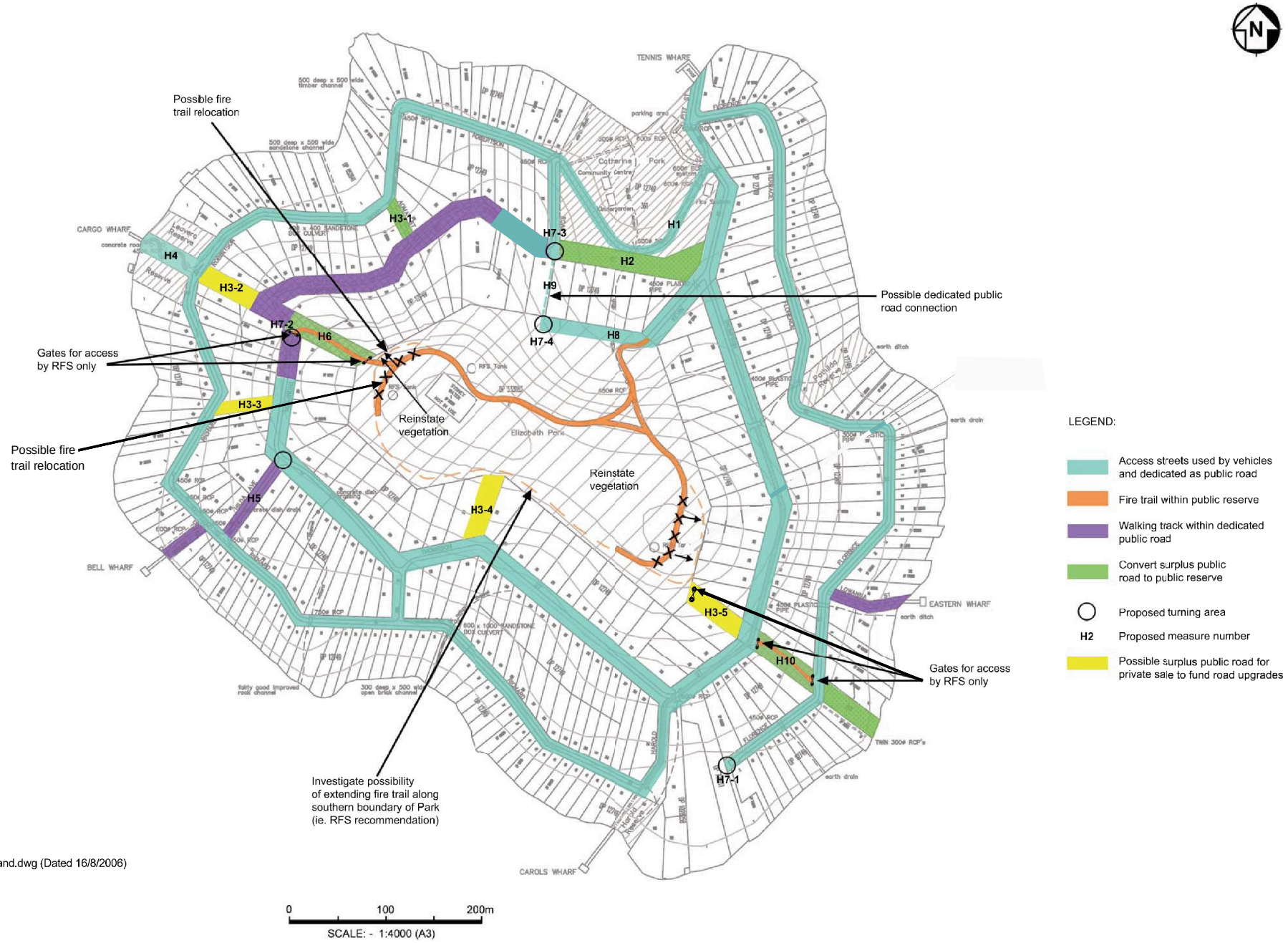
FIGURE R4
SCOTLAND ISLAND ROAD RESERVE STRATEGY
EXISTING ROAD HIERARCHY



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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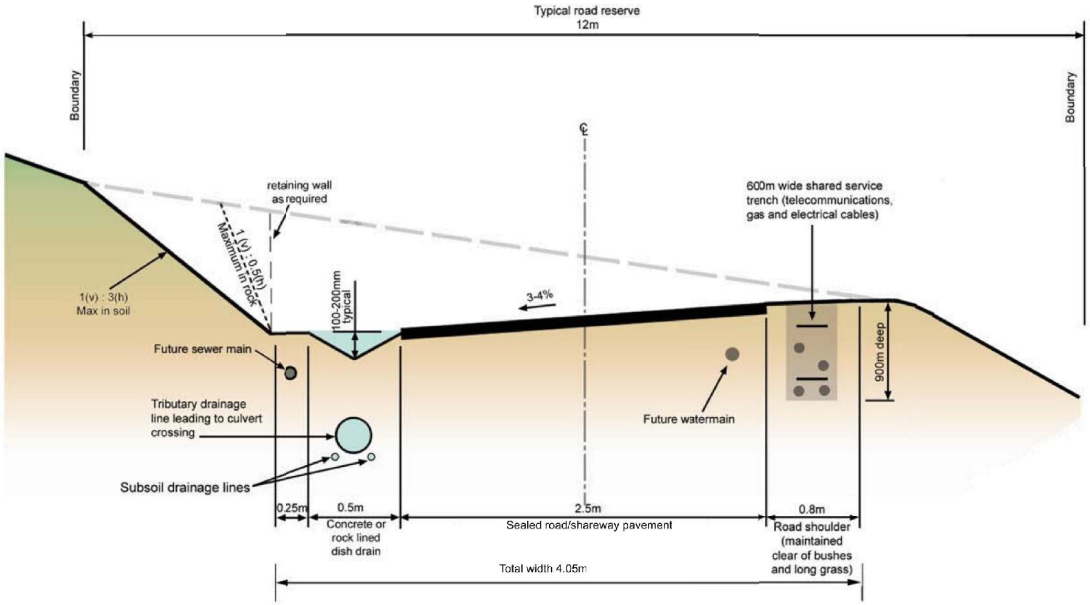
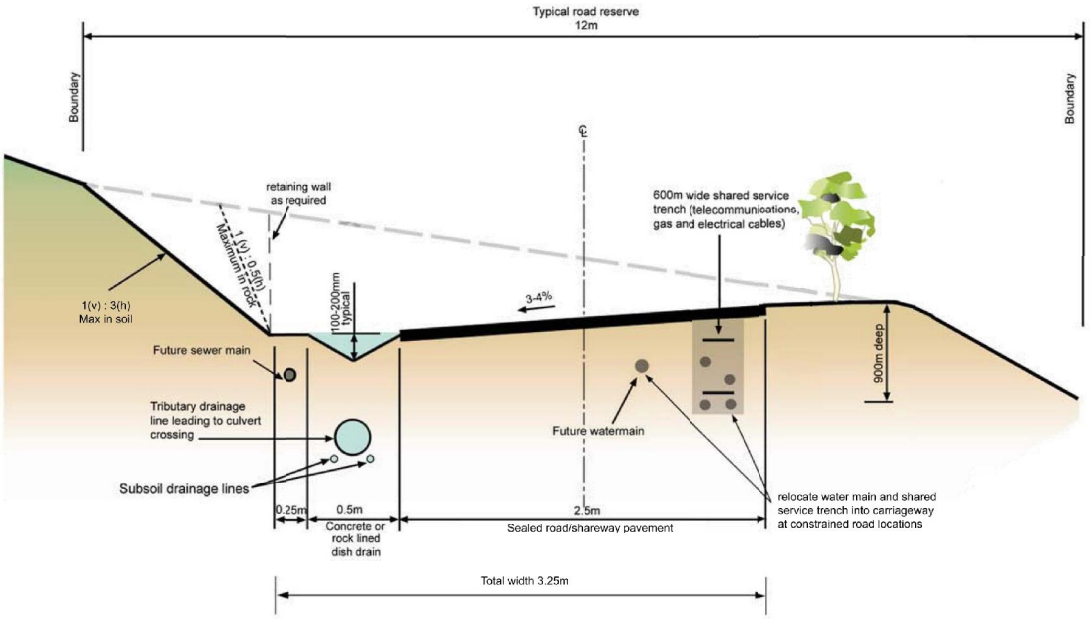
FIGURE R5
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED ROAD HIERARCHY



TYPICAL SHAREWAY CROSS SECTION

(Not to scale)



CONSTRAINED ROAD / SHAREWAY CROSS SECTION

(Not to scale)

NOTES:

1. Passing bays shall be provided generally at intervals of 200m but not exceeding 400m. The total trafficable width at passing bays shall not be less than 7m.
2. The maximum longitudinal gradient of unsealed roads shall be 16%. The maximum longitudinal gradient of all roads shall be 25%.

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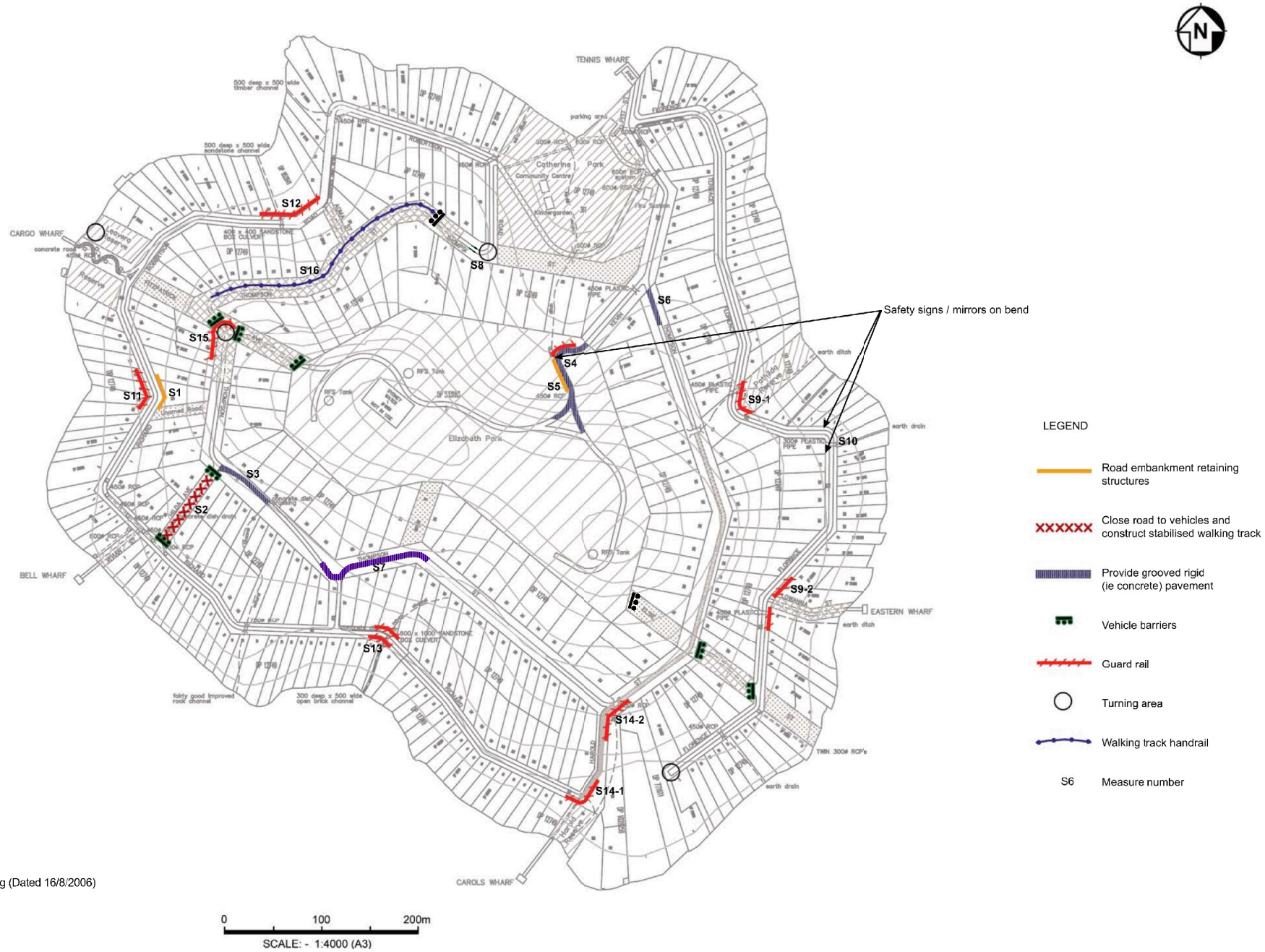
FIGURE R6
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED ROAD TYPICAL DETAILS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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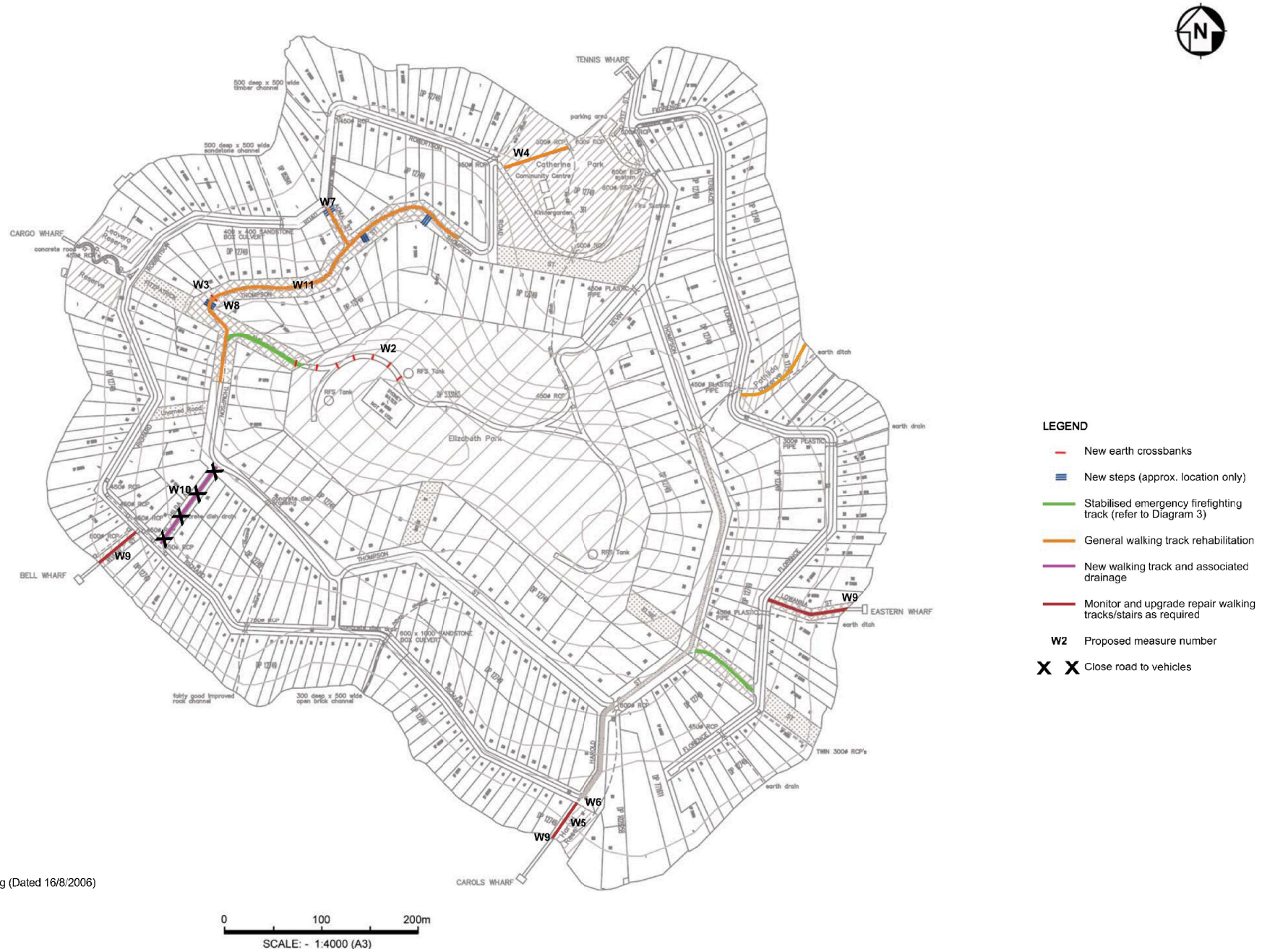
FIGURE R7
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED ROAD SAFETY IMPROVEMENT MEASURES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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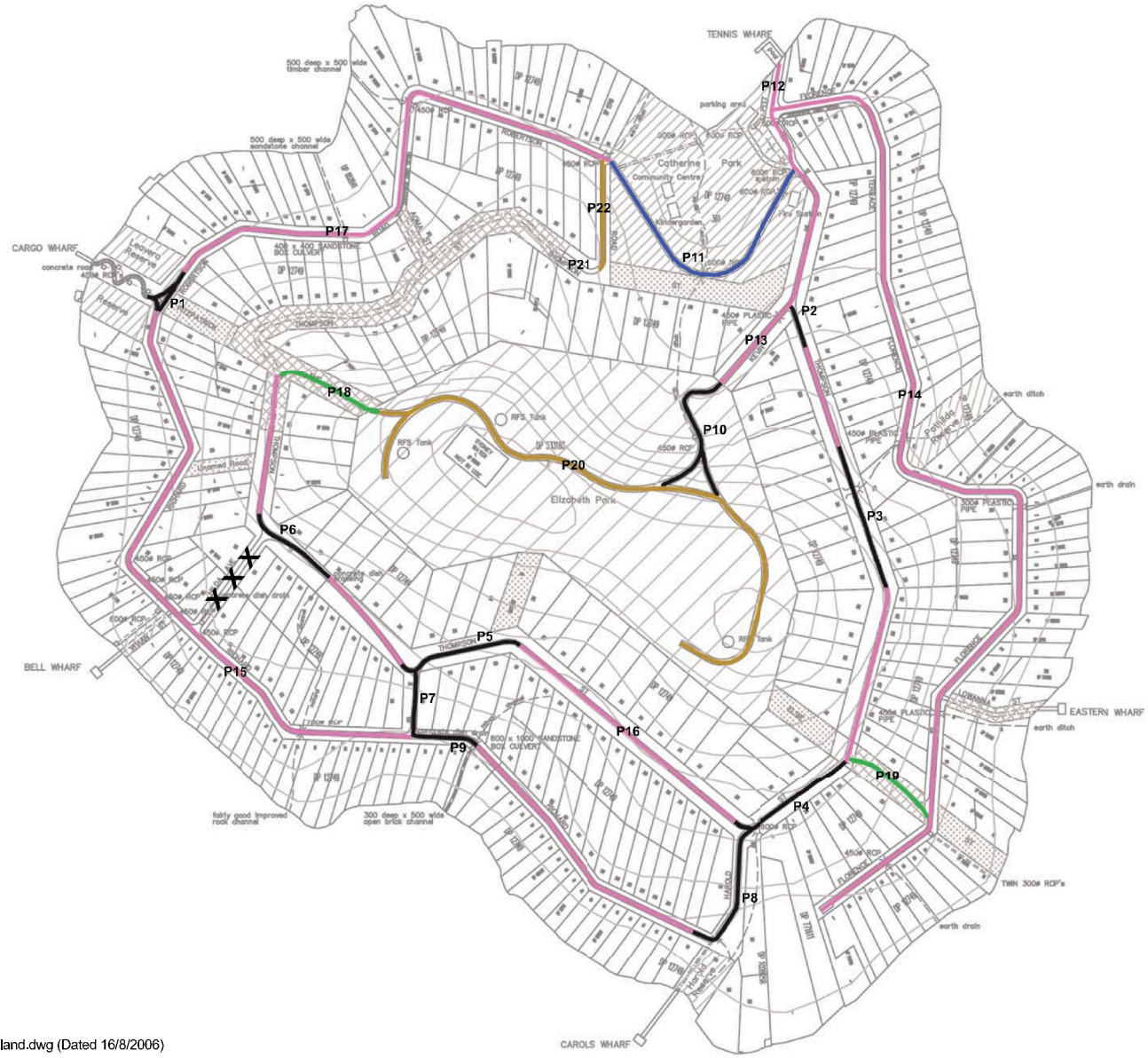
FIGURE R8
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED WALKING TRACK REHABILITATION MEASURES



LEGEND

- Resin seal / Flush seal (Flexible)
- Rigid pavement(ie. reinforced concrete) or equivalent alternative
- Flush seal (Flexible)
- Stabilised emergency firefighting track (refer to Diagram 3)
- Typical fire trail treatment (ie. unsealed carriageway incorporating regular cross banks and stabilised dish drain)
- P3 Proposed measure number
- X X Close road to vehicles

DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

0 100 200m

SCALE: - 1:4000 (A3)

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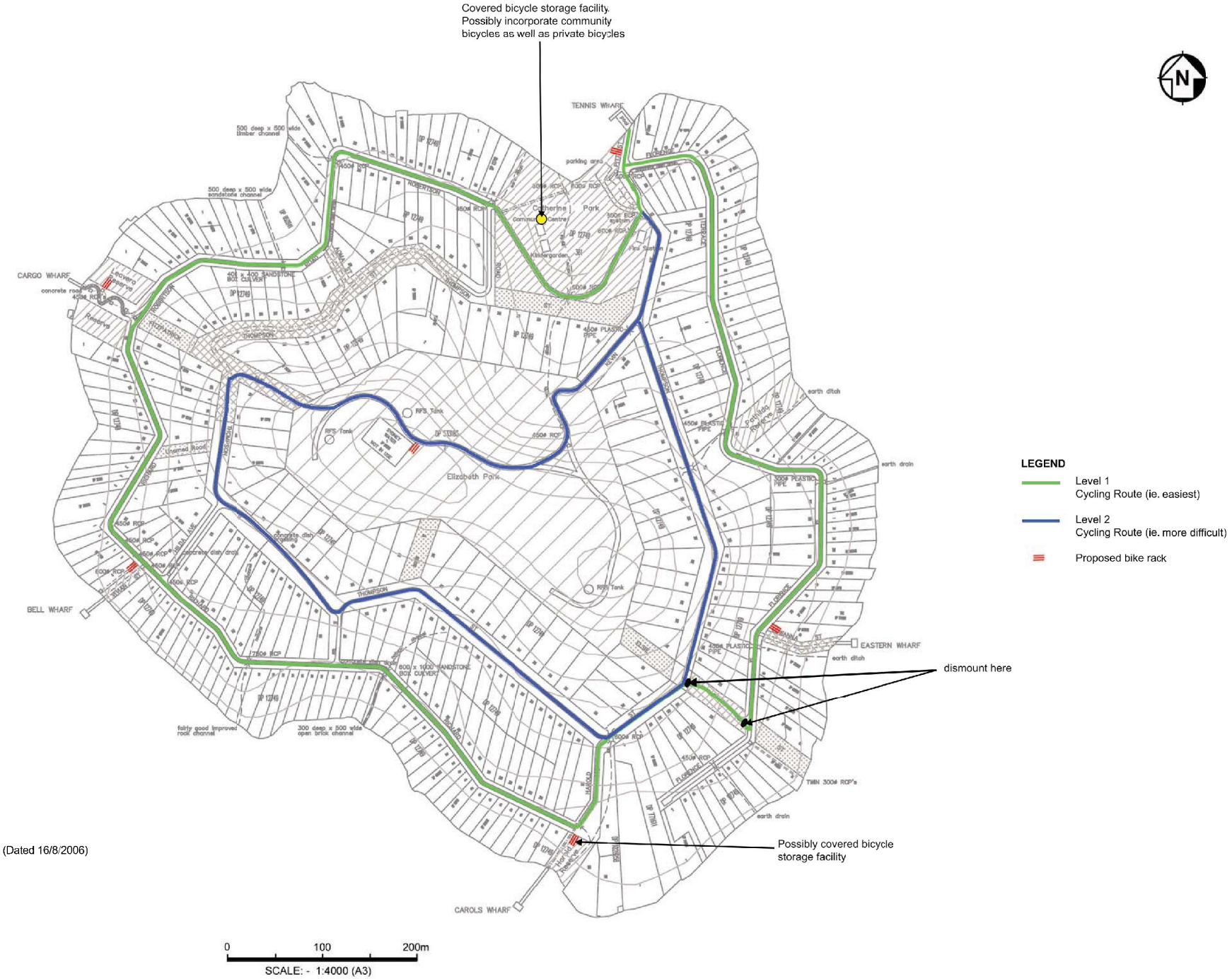
FIGURE R9
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED ROAD SURFACE TREATMENT



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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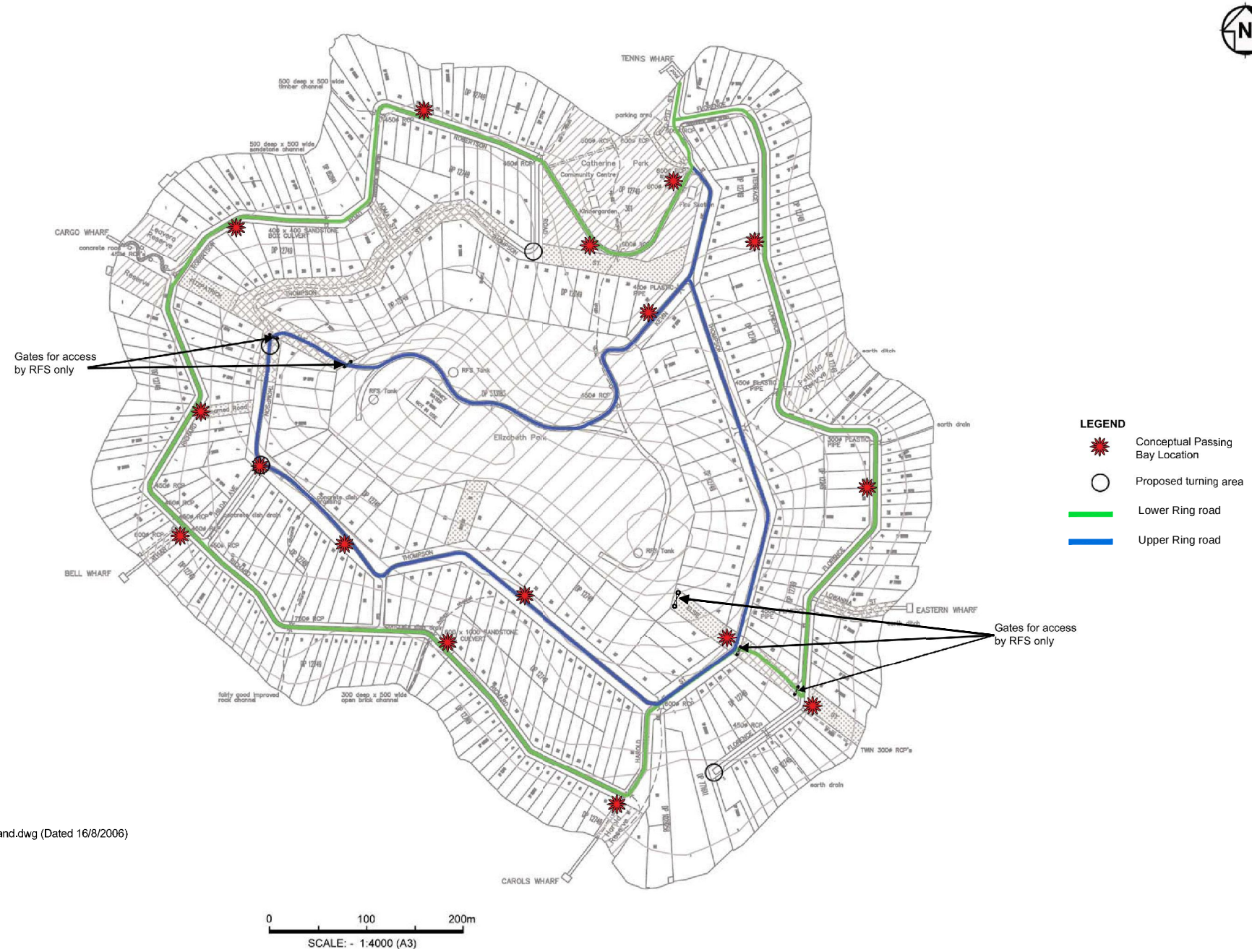
FIGURE R10
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED CYCLING FACILITIES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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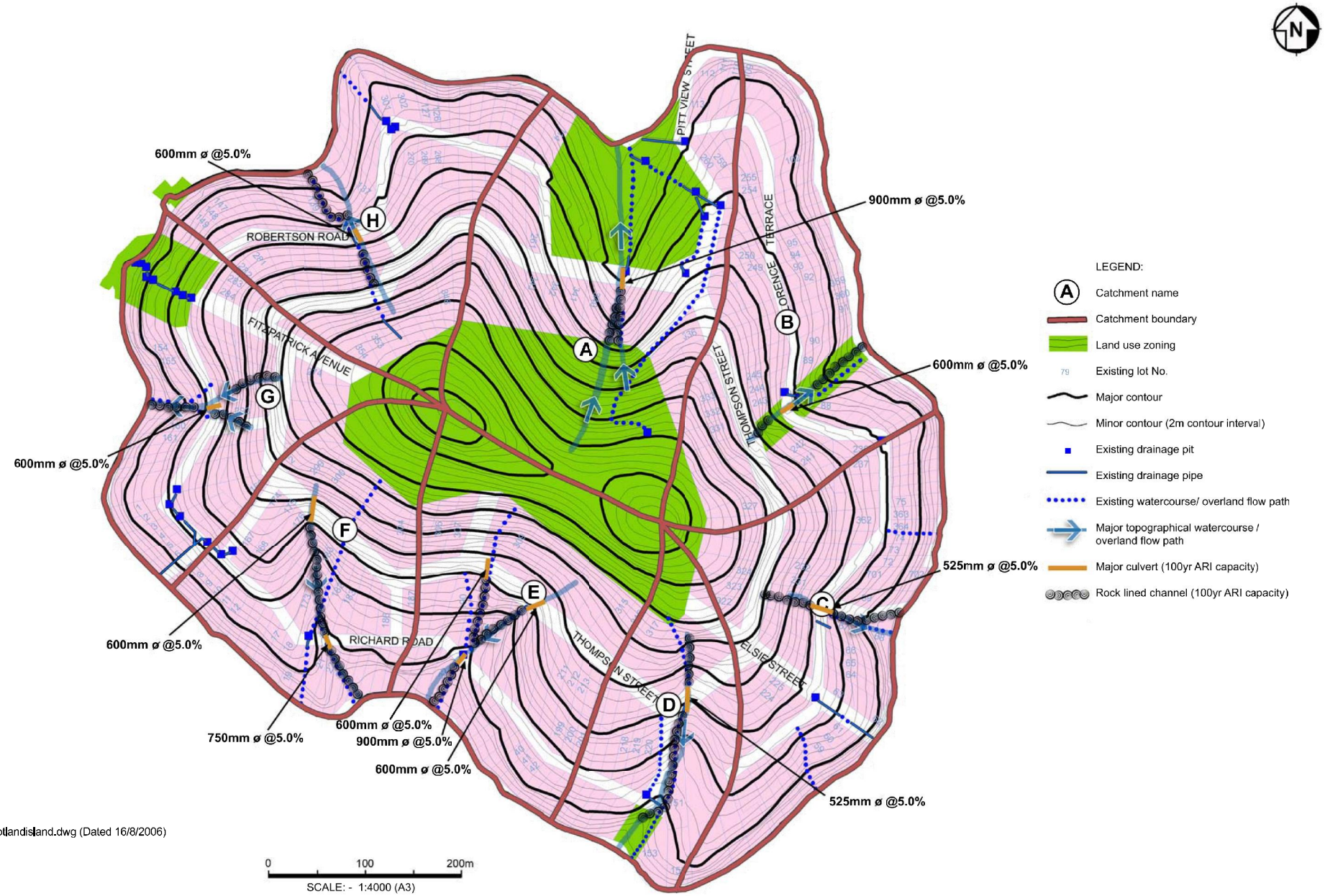
FIGURE R11
SCOTLAND ISLAND ROAD RESERVE STRATEGY
CONCEPTUAL PASSING BAY LOCATIONS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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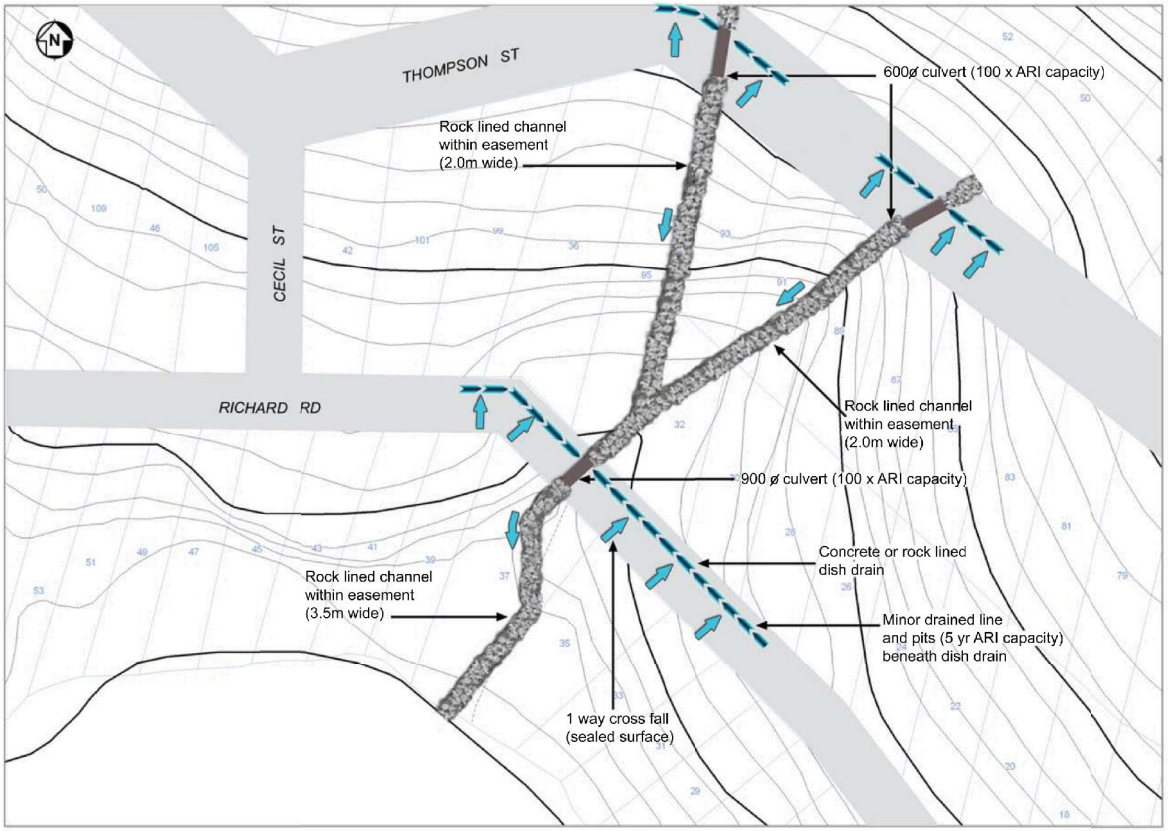
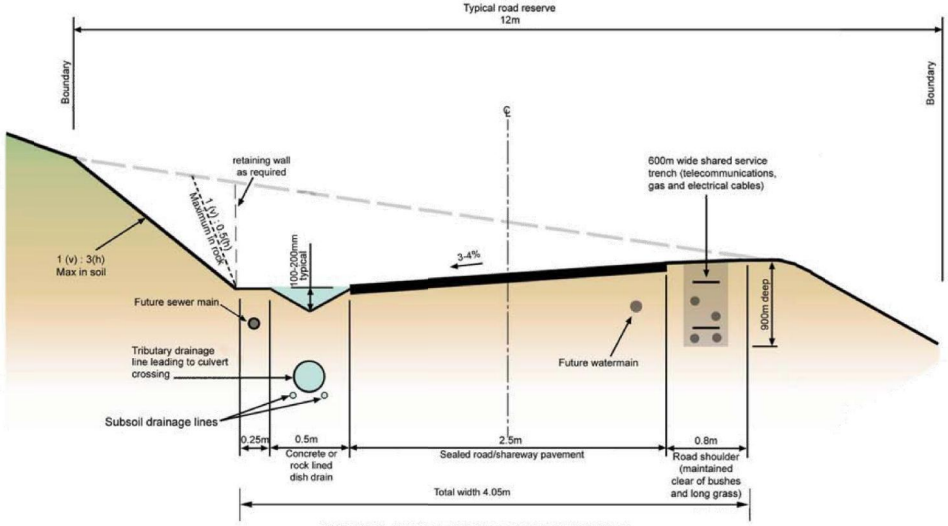
FIGURE R12
SCOTLAND ISLAND ROAD RESERVE STRATEGY
PROPOSED MAJOR DRAINAGE SYSTEM IMPROVEMENTS



PLAN OF TYPICAL INTERSECTION DRAINAGE LAYOUT



TYPICAL SHAREWAY CROSS SECTION

(Not to scale)

NOTES:

1. Passing bays shall be provided generally at intervals of 200m but not exceeding 400m. The total trafficable width at passing bays shall not be less than 7m.

2. The maximum longitudinal gradient of unsealed roads shall be 16%. The maximum longitudinal gradient of all roads shall be 25%.

DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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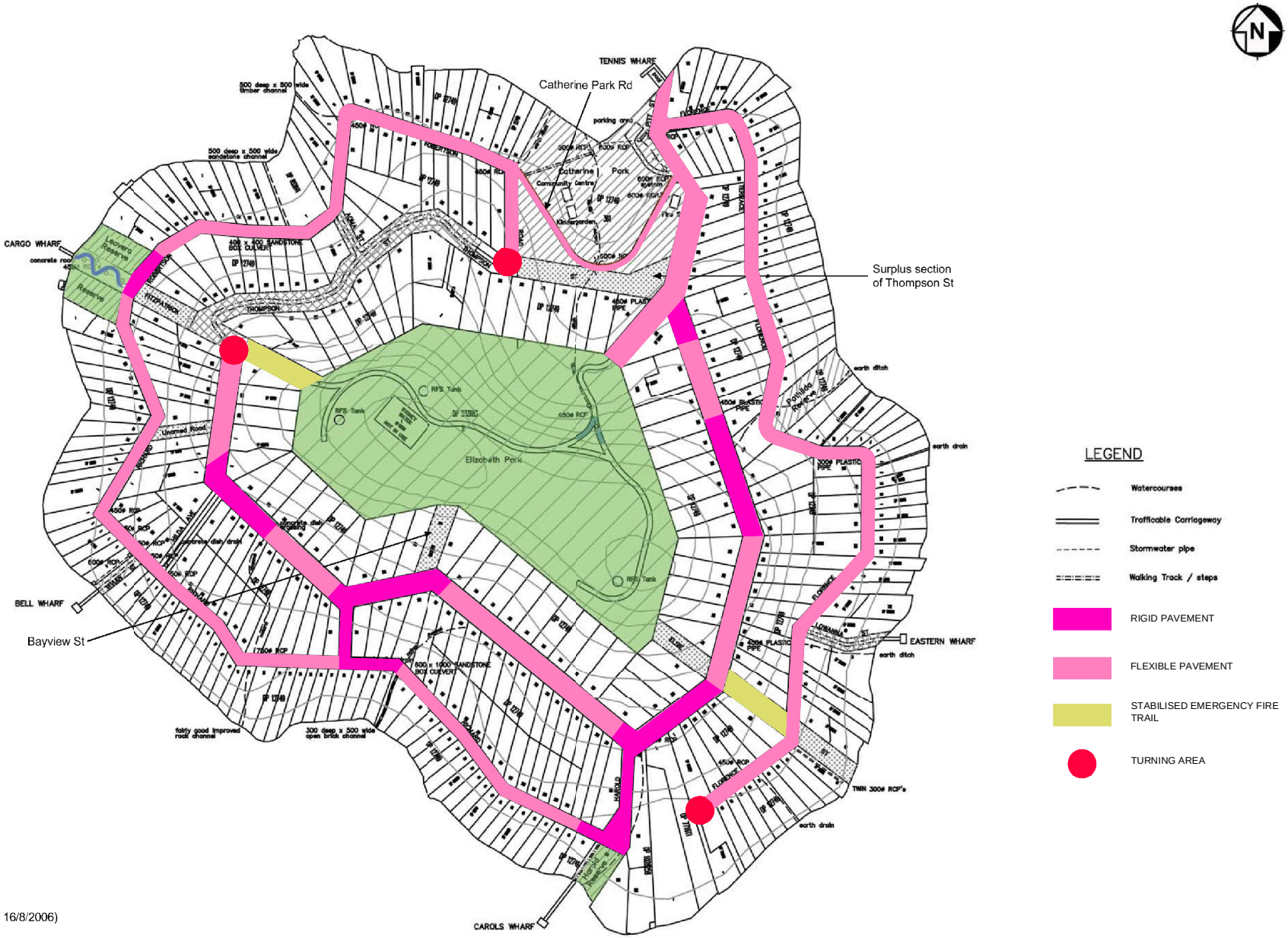
FIGURE R13
SCOTLAND ISLAND ROAD RESERVE STRATEGY
TYPICAL ROAD DRAINAGE DETAILS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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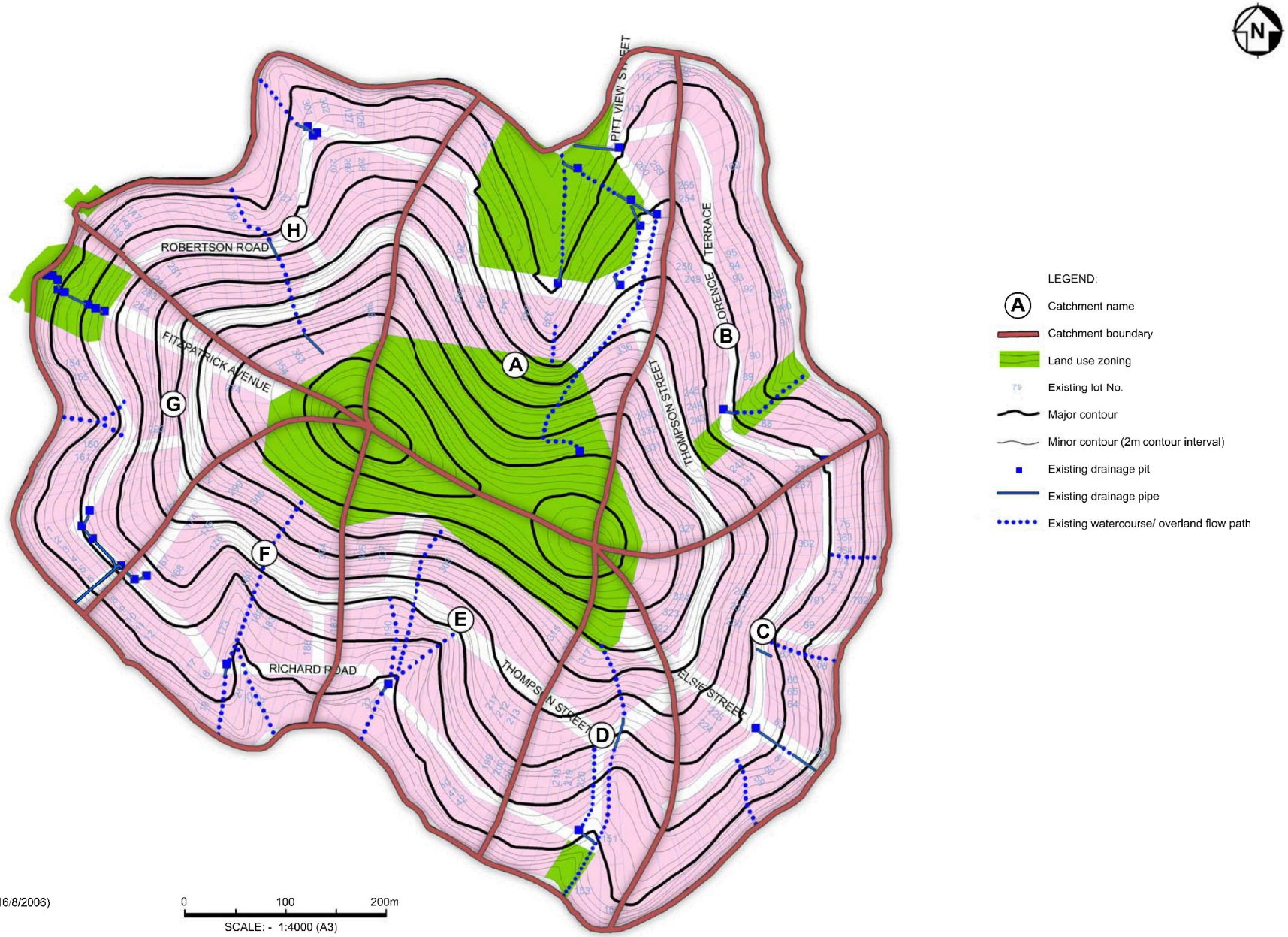
FIGURE R14
SCOTLAND ISLAND ROAD RESERVE STRATEGY
ULTIMATE SEALED ROAD LAYOUT



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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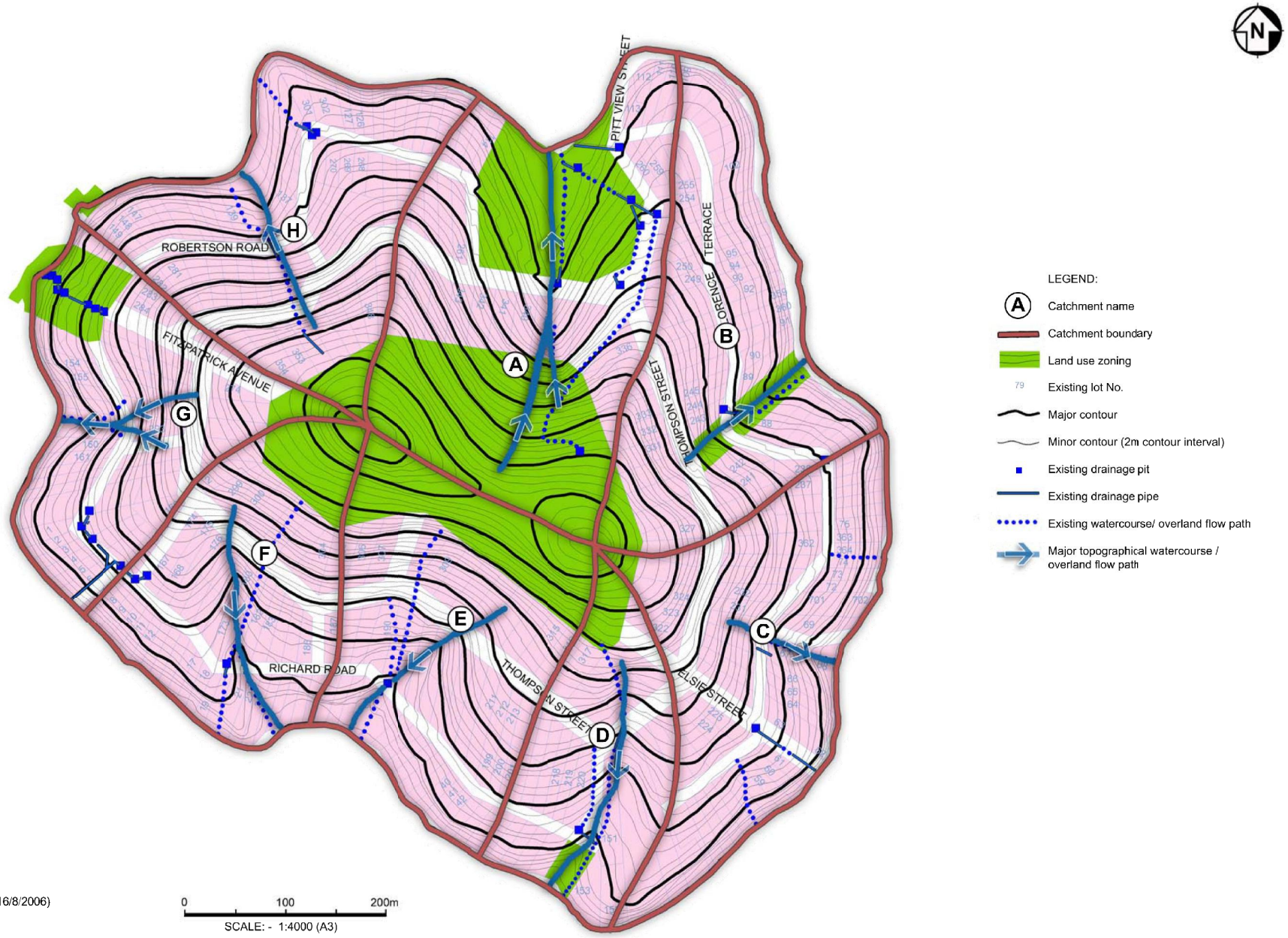
FIGURE S1
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - TOPOGRAPHICAL CATCHMENTS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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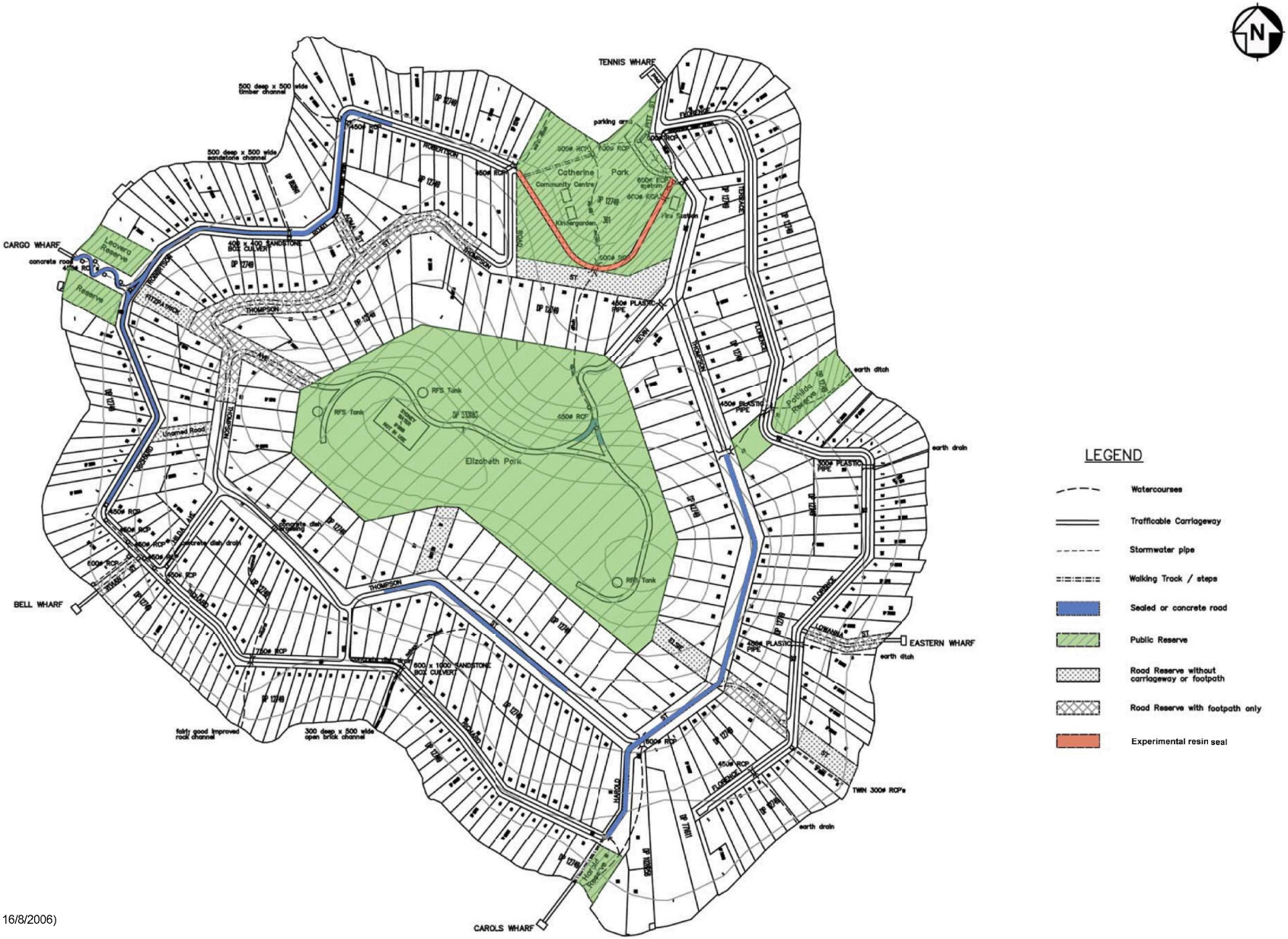
FIGURE S2
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - MAJOR TOPOGRAPHICAL WATER COURSE/OVERLAND FLOW PATHS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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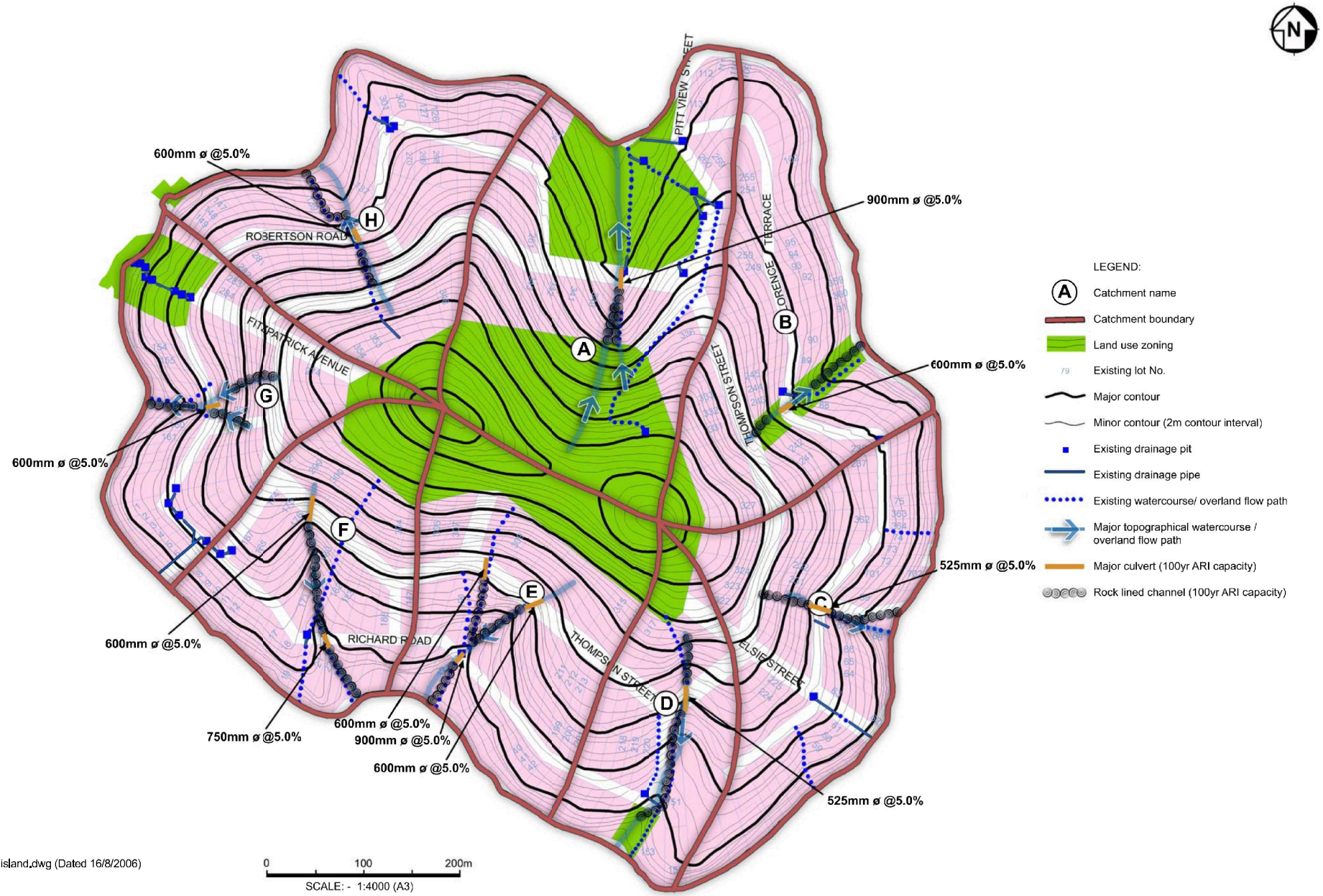
FIGURE S3
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - EXISTING DRAINAGE STRUCTURES



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

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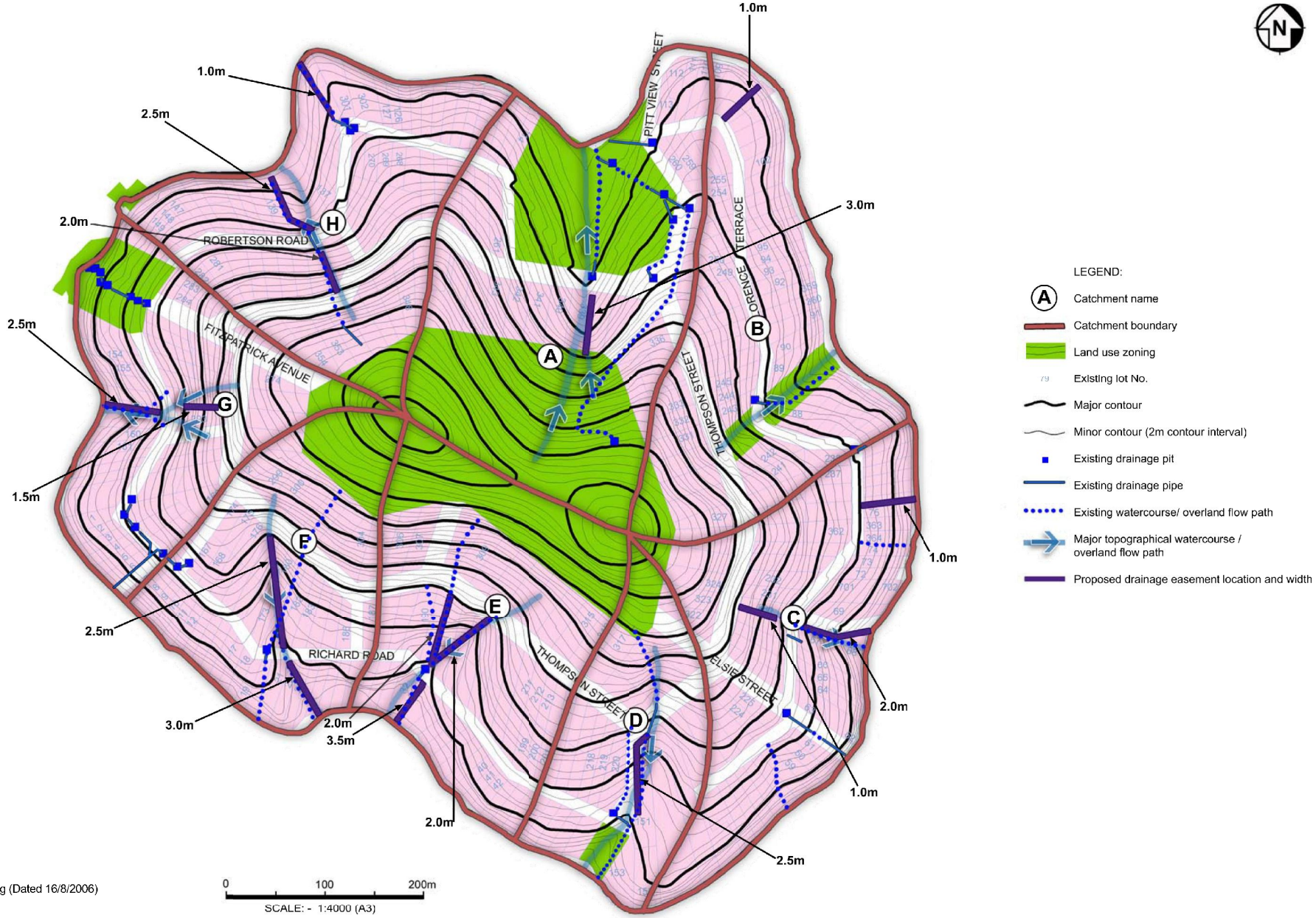
FIGURE S4
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - PROPOSED DRAINAGE SYSTEM IMPROVEMENTS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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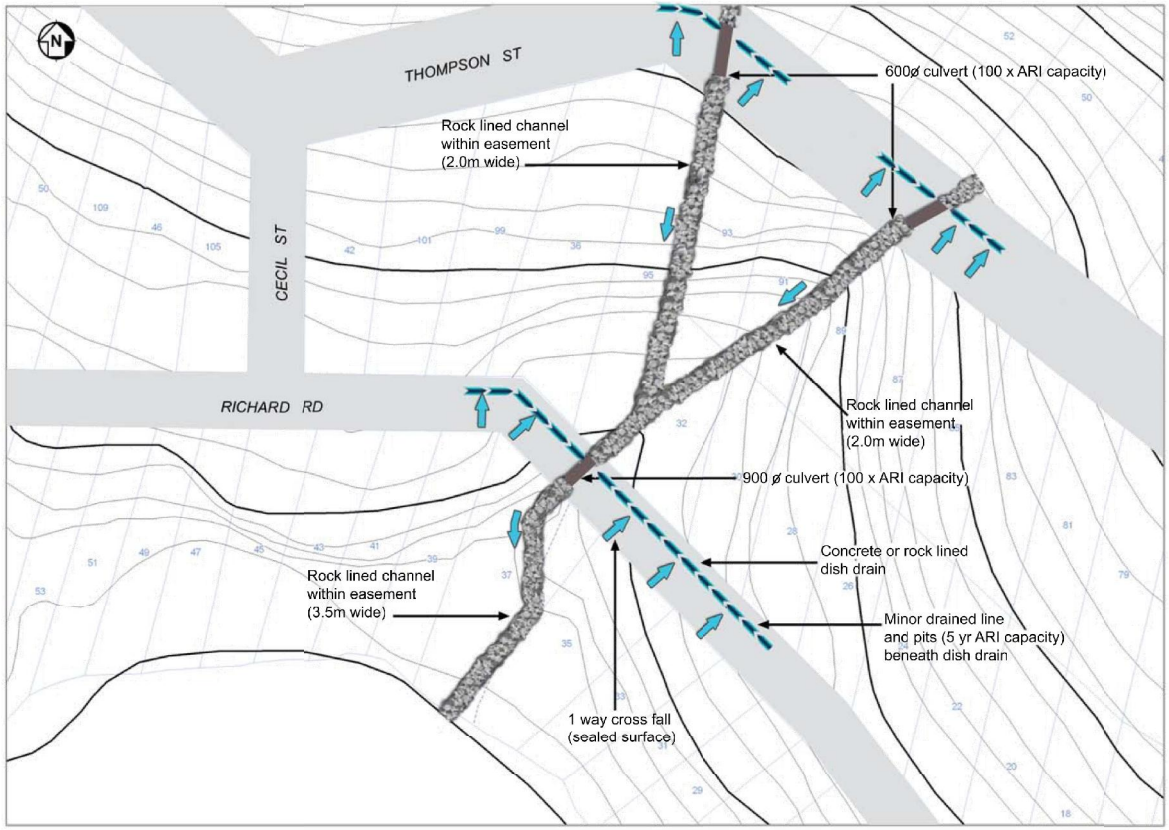
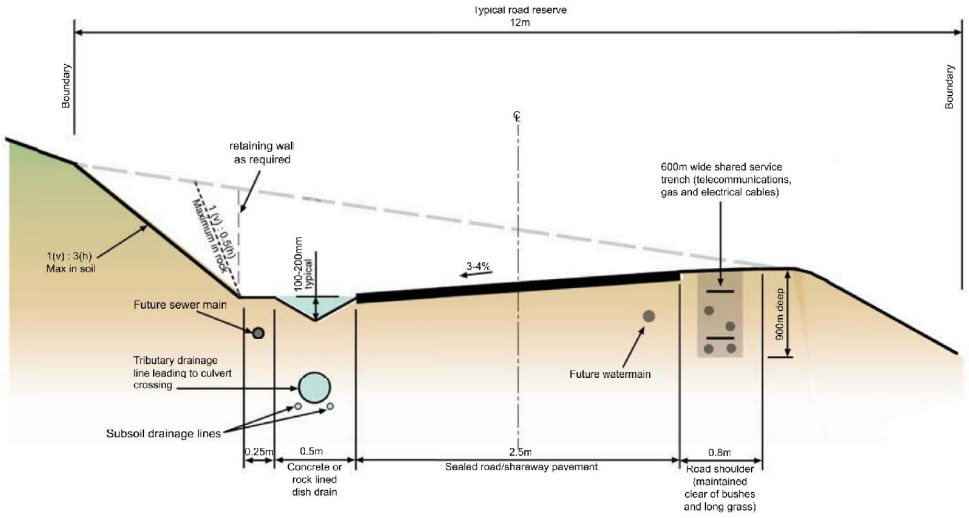
FIGURE S5
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - PROPOSED DRAINAGE EASEMENT LOCATIONS



PLAN OF TYPICAL INTERSECTION DRAINAGE LAYOUT



TYPICAL ROAD / SHAREWAY CROSS SECTION

(Not to scale)

NOTES:

1. Passing bays shall be provided generally at intervals of 200m but not exceeding 400m. The total trafficable width at passing bays shall not be less than 7m.

2. The maximum longitudinal gradient of unsealed roads shall be 16%. The maximum longitudinal gradient of all roads shall be 25%.

DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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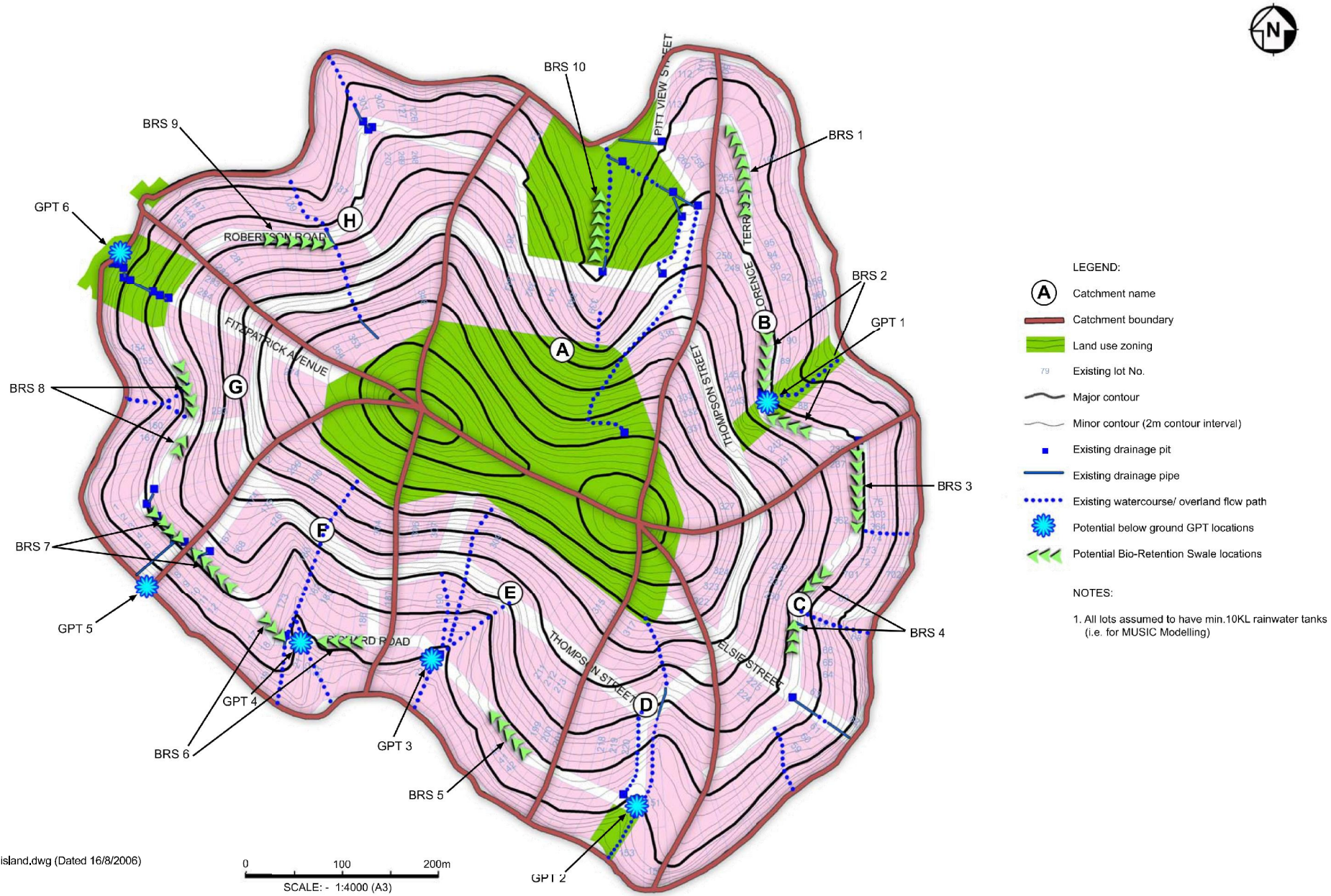
FIGURE S6
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - TYPICAL ROAD DRAINAGE DETAILS



DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

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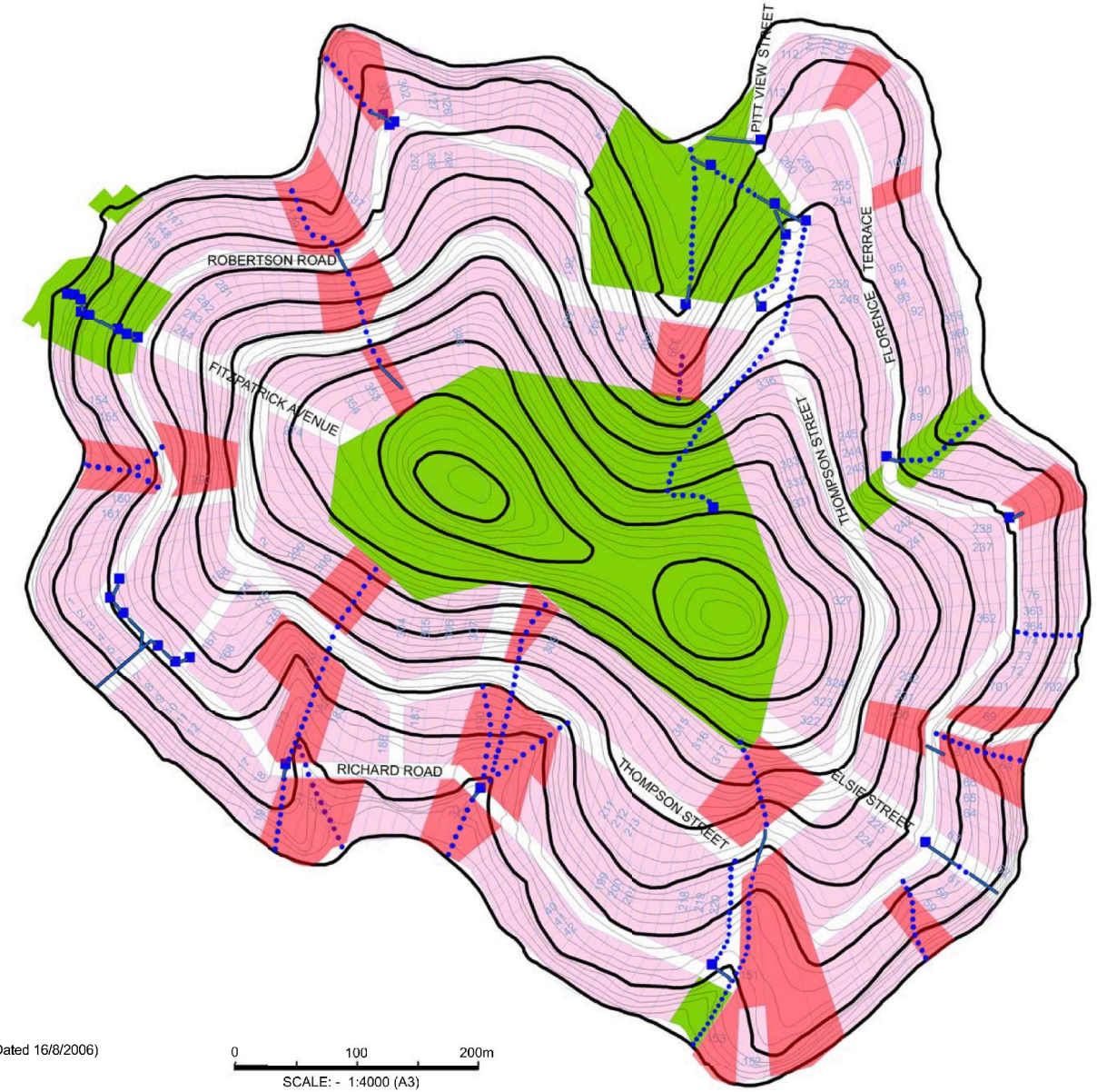
FIGURE S7
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - PROPOSED STORMWATER TREATMENT MEASURES



LEGEND:

- Land use zoning
- 79 Existing lot No.
- Major contour
- Minor contour (2m contour interval)
- Existing drainage pit
- Existing drainage pipe
- Existing watercourse/ overland flow path
- Potential flood category 3 affected properties

DATA SOURCE: Pittwater Council scotlandisland.dwg (Dated 16/8/2006)

DATE 21.06.11

0 100 200m

SCALE: - 1:4000 (A3)

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FIGURE S8
SCOTLAND ISLAND STORMWATER MANAGEMENT STRATEGY - POTENTIAL FLOOD CATEGORY AFFECTED PROPERTIES

APPENDIX A - UI RELATED ROAD RESERVE STRATEGY CONCLUSIONS AND RECOMMENDATIONS

A1. Road Reserve Strategy Conclusions and Recommendations

A1.1 Overall Conclusions

Many studies have been undertaken in that past for Scotland Island that relate in some way or another to the roads, road drainage and other components of the road reserve. In particular the recent work by Rooney (*ie the 1998 Catherine Park and 2004 South Precinct catchment studies*), Witheridge (*ie the 2004 draft road reserve Masterplan*) and Brian Barry and Associates (*ie bushfire management plan*).

The recently completed Road Reserve Strategy report (*WP, 24 September 2009*) has entailed review of all of these relevant reports as well as undertaking our own strategic investigation of all facets of the Islands road reserves.

A critical precursor to the Road Reserve Strategy was the WP Stormwater Management Strategy (*SMS*). The SMS highlights the need for improved drainage system planning and provides a framework for the way forward.

It appears that the existing level of development on the Island cannot be sustained by the road reserve infrastructure that is currently in place.

The road audit undertaken as part of the Road Reserve Strategy study revealed that many of the Island roads are akin to those that are found in rural areas. These types of roads do not seem so out of place for the rural atmosphere that is embraced by the residents. However the unique characteristics of the Island (*ie dispersive soils and very steep slopes*) combined with the level of development on the Island is placing great stress on the road infrastructure in this form and it is leading to substantial erosion and sediment export from the Island during wet weather.

It is evident from the majority of past studies and independent investigations undertaken by PBP/WP that ultimately the majority of roads on the Island will need to be sealed in some form or another for both environmental and safety reasons. Due to financial constraints it is recognised that this cannot be undertaken in the short term but it is critical that when roads are progressively sealed that they do not need to be revisited prematurely which would have the effect of slowing the overall progress or even going backwards.

Based on the above the Road Reserve Strategy report has recommended both long and short to medium term recommendations. The long term recommendations provide a bigger picture for the island that can guide the way forward. Whilst the short to medium term recommendations allow for effective progress now.

The existing road hierarchy/layout was found to be illogical in some areas with a need to rationalise. It is thought that this was primarily due to past planning decisions that did not take into account the physical constraints of the Island. As a result several recommendations have been put forward to ensure roads that are currently located within open space reserves are dedicated as public roads and vice versa. Sale of some surplus road reserves for private use (*ie further development*) to fund future upgrades is considered possible subject to vigorous assessment of any environmental impact. Converting these to public reserves (*ie open space*) is also an option which allows them to still be controlled by Council for the purposes of drainage whilst continuing to support existing vegetation. Consideration was given to converting the

existing fire trail within Elizabeth Park to a dedicated public road, however the impacts on Elizabeth Park and its environment was concluded to be too great. Due to the extent of existing damage and the resulting environmental issues it is considered that Hilda Avenue be closed to vehicular traffic and stabilised as a pedestrian walkway only. Road network changes have also been recommended that improve fire fighting operations.

Based on the road audit it was determined that the average width available for road construction on the Island was 3.7m. It was also determined that the average existing carriageway width was 3.0m. Consideration of these results along with road safety, fire fighting requirements, road drainage, future utility service requirements and future traffic management systems concluded in a typical road detail for the Island (*refer to* ***Figure R6***).

In keeping with the above and the widely held view of the Island community that public roads on the Island should primarily serve as pedestrian/cyclist pathways and secondarily as vehicular roads, it was concluded that a traffic management system that defines all Island roads as "*Shareways*", provides mechanisms to discourage increased vehicular use but allows occasional heavy vehicle use was most appropriate. As part of the proposed traffic management system parking is proposed to be banned on all Island roads, apart from two or three designated parking zones.

Road drainage is an area that warrants careful consideration in any future road reserve management decisions on the Island. The inadequacy of existing drainage systems is leading to many of the environmental and safety issues that have occurred in the past. In addition, it is slowing the progression of a positive way forward (*ie leading to premature deterioration of already stabilised surfaces*). Careful attention in design and a substantial investment in suitable drainage infrastructure is required before making any substantial improvements in road surface condition.

Finally, the Road Reserve Strategy study found that improvements to existing road safety were required at several locations. In addition recommendations relating to existing walking tracks, street furniture, utility services, cycling facilities, street lighting, retaining structures, batter stabilisation, road reserve landscaping and road maintenance have been made to guide future management of these features.

A1.2 UI Related Recommendations

This section contains our UI related recommended actions both strategically (*ie for the long term*) and in the interim (*ie short to medium term*). It is expected that the long term recommendations would have a timeframe in the order of 50 years before they are fully implemented.
These recommendations should not be seen as fixed as Island conditions and technologies may change with time. Hence, review of these recommendations should be undertaken on a regular basis.

A1.3 UI Related Long Term Recommendations

Table 3 contains a summary of the UI related long term recommendations for the road reserves of Scotland Island.

Table 3 – UI Related Long Term Road Reserve Recommendations

No.	Measure Number	Measure Description	Associated Measure
Road Hierarchy(refer to Figure R5)			
	H5	Convert Hilda Ave to a walking track only (*ie no vehicular access*) but leave as road reserve	S2
	H7	Provide turning areas (*ie hammer head or similar*) at the "dead ends" on Florence Tce and Thompson Street and investigate the viability of a turning head at the end of Robertson Road	
Typical Road Detail			
	TP1	Adopt a typical road detail for all future road construction as detailed in **Section 5.3 of RRS report and Figure R6**	
Road Safety (refer to Figure R7)			
	S1	Construct retaining structures (*gabion or similar*) on steep road embankments along Richard Road north of the Unnamed Rd	
	S2	Close Hilda Ave to vehicular traffic and construct stabilised walking track with associated drainage along full length of Hilda Ave. Provide vehicle barriers at both ends of Hilda Ave	H5
	S3	Stabilise steep section of carriageway on Thompson Street between Hilda Ave and concrete dish crossing at low point (ie *construct grooved rigid pavement similar to treatment on Cargo Wharf Rd*)	P6
	S4	Provide grooved rigid pavement (*ie concrete*) on sharp bend in fire trail at end of Kevin Ave as well as installation of warning signage, safety barriers (ie *guard rail*) and posted mirrors	P10
	S6	Stabilise steep section of carriageway at start of Thompson Street just south-east of intersection with Kevin St (ie *concrete*)	P2
	S7	Stabilise steep section of carriageway in Thompson Street just east of intersection with Cecil St (*ie concrete*) and provide signage and regular speed humps/cross banks to slow vehicles	P5
	S8	Provide turning area at end of Robertson Road (*ie chainage 1540*) and convert section of Thompson Rd to the east of its intersection with Robertson Road to a stabilised walking track. Provide barriers to prevent unauthorised vehicular access along Thompson Street to the west. Site barriers to maintain vehicular access to existing properties.	
	S9	Provide guard rail on Florence Tce at Pathilda Reserve and in the vicinity of Lowanna Street	
	S10	Stabilise road surface (*ie flush seal*) and provide safety signs on sharp bends and steep sections of Florence Terrace	
	S11	Provide guard rail on steep down slope drop along Richard Road just north of the Unnamed Road	
	S14	Provide guard rail on steep down slope drop along Harold Avenue	
	S15	Provide guard rail, turning area and vehicle barrier at end of Thompson Street with Intersection of Fitzpatrick	H6
	S17	Incorporation of passing bays at regular intervals within the road reserve	
	S20	Construct road embankment retaining structures on high side of Robertson Road at Fitzpatrick Avenue (*ie above walking track/future road*)	
Pedestrian Facilities and Walking Tracks (refer to Figure R8)			
	W1	Realignment of upper Fitzpatrick Avenue above Thompson Street because it is badly eroded and currently runs within private property	
	W3	Installation of cross banks on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street to divert runoff off away from the	

No.	Measure Number	Measure Description	Associated Measure
		track	
	W7	Steps placed along the lower half of the Aoma Street walking track to provide all weather access	
	W8	Additional steps placed on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street possible between the existing rock steps	
	W10	Close off Hilda Ave to vehicular traffic and construct new stable walkway and associate drainage	H5 & S2
Road Drainage			
	DL1	Stabilise and seal all public road/shareway surfaces (*ie bitumen, concrete or other*)	P1 toP22
	DL2	Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (*refer to **Figure R12***) in combination with culverts at all road crossings (*refer to **Figure R12***)	
	DL3	Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (*refer to **Figure R13***)	
	DL4	Provide a typical 1 way cross fall road/shareway incorporating stabilised dish drain (*rock, bitumen or concrete*) on the cut side of all roads (*refer to **Figure R13***)	
	DL5	All future road and road drainage measures should be designed by a qualified engineer backed up by construction supervision by a qualified engineer	
Street Furniture			
	RF1	Provide street furniture in accordance with **Section 5.10 of RRS report**	
Street Lighting			
	SL1	Provide street lighting in accordance with **Section 5.11 of RRS report**	
Utility Services			
	US1	Provide utility services with road reserve in accordance with **Section 5.12 of RRS report**	
Road Construction (refer to Figure R10)			
	P1	Construct rigid pavement *(or equivalent)* on steep section of Robertson Road from intersection with Cargo Wharf Road/Fitzpatrick Ave between approx. chainages 840 and 880 (*refer to **Figure R3** for road chainage details*)	
	P2	Construct rigid pavement *(or equivalent)* on steep section of Thompson Road from intersection with Kevin Ave between approx. chainages 0 and 35 (*refer to **Figure R3** for road chainage details*)	S6
	P3	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 130 and 250 (*refer to **Figure R3** for road chainage details*)	
	P4	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 400 and 500 (*refer to **Figure R3** for road chainage details*)	
	P5	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 740 and 830 (*refer to **Figure R3** for road chainage details*)	S7
	P6	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 940 and 1010 (*refer to **Figure R3** for road*	S3

No.	Measure Number	Measure Description	Associated Measure
		chainage details)	
	P7	Construct rigid pavement *(or equivalent)* for full length of Cecil Street	
	P8	Construct rigid pavement *(or equivalent)* for full length of Harold Ave and round the corner into the start of Richard Road	
	P9	Construct rigid pavement *(or equivalent)* on steep section of Richard Road between approx. chainages 260 and 320 (*refer to **Figure R3** for road chainage details*)	
	P10	Construct rigid pavement *(or equivalent)* on steep section of fire trail extending from the end of Kevin Ave between approx. chainages 190 and 300 (*refer to **Figure R3** for road chainage details*)	S4
	P12	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Pitt View Street	
	P13	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Kevin Ave	
	P14	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Florence Terrace	
	P15	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Richard Road except at locations of proposed rigid pavement (*refer to Measure P9*)	P9
	P16	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) along Thompson Street between chainages 0 and 1140 (*refer to **Figure R3** for road chainage details*) except at locations of proposed rigid pavement (*refer to Measures P2 to P6*)	P2 to P6
	P17	Construct/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) along Robertson Road between chainages 850 and 1340 (*refer to **Figure R3** for road chainage details*) except at locations of proposed rigid pavement (*refer to Measure P1*)	P1
	P21	Convert vehicular section of Thompson Road between chainages 1460 to 1500 back to a walking track only (*ie close off to vehicles*)	
	P23	Provide new access ramp at Cargo Wharf for large construction/maintenance vehicles	
Road Retaining Structures and Batter Stabilisation			
	RW1	Provide road retaining structures and batter stabilisation within the road reserve in accordance with **Section 5.14 of RRS report**	

A1.4 UI Related Short To Medium Term Recommendations

Table 4 contains a summary of the UI related short to medium term recommendations for the road reserves of Scotland Island.

Table 4 – UI Related Short to Medium Term Road Reserve Recommendations

No.	Measure Number	Measure Description	Associated Measure
Short to Medium Term Drainage Solutions			
	DS1	Prevent road runoff discharging through private property immediately south of Cecil Street. Instead, improvements should be made to the table drain in Richard Road to allow stormwater to flow down the road reserve and enter the creek	
	DS2	Prevent stormwater runoff from Florence Terrace discharging through private property approximately 8 lots north of Lowanna Street. Instead, modify the profile of Florence Terrace to allow this water to flow north to the existing grated stormwater inlet	
	DS3	Where practical all new sections of sealed road that cannot drain directly to a dish drain or other trunk drainage system should be profiled to allow sheet flow off the road (*ie do not concentrate flows*). A minimum cross fall of 3-4% should be adopted on all new sealed roads	
	DS4	Install waterbars/cross banks as shown in Plan SIR021(*refer to **Appendix B*** for all unsealed roads. The recommended 'maximum' spacing of cross banks has been determined from SCS (*1984*)	
	DS5	Install litter trap on the Cargo Hill stormwater outlet	
	DS6	Install silt traps as shown in Plan SIR023 (*refer to **Appendix B**).* The invert of all silt traps is to be set well below the elevation of the road (*ie when placed at the end of a cross bank*) or below the invert of the stormwater pipe such that neither water or sediment will pond/collect on the roadway or within the pipe	
	DS7	Pathway or driveway culvert crossing to be established at each pathway/driveway crossing of a table drain. Typical table drain vehicular and pedestrian culvert crossing is presented in **Diagram 8 of RRS report**	
	DS8	Construct table drains for all Island roads. Table drains should represent the primary drainage path within road reserves rather than the trafficable road surface (*refer to DL4 also*)	DL4
	DS10	Existing horizontal roadside stormwater grates to be progressively replaced to prevent vehicular damage to the grates and to minimise the risk of full debris blockage (*ie minimum Class C galvanised steel grate, account for 50% blockage in design of inlet and provide flexible pit marking poles*)	
	DS11	Silt traps should be constructed on the end of stormwater outlets that discharge to relatively flat areas	
	DS12	Stormwater outlets that discharge to steep gullies should principally be stabilised by stabilising the outlet gully	
Relevant UI Related Witheridge 2004 Draft Road Reserve Masterplan Short to Medium Term Action Items			
	WR4	Build-up windrow on Richard Road to prevent flow down private property opposite Cecil Street	16*
	WR7	Install temporary timber safety bollards on the two creeks culvert crossings on Richard Road north of the unnamed (40ft wide) road reserve	11, 22, & 34*
	WR9	Construct an elevated footpath/stairway on the inside of the sharp bend on the Elizabeth park track just up-slope of Kevin Street, or otherwise make this track safe for all-weather pedestrian access	113*

No.	Measure Number	Measure Description	Associated Measure
	WR10	Adopt short-term solution to the stabilisation of the trafficable area and drainage for Hilda Avenue if the road closure has not been completed	
	WR11	Re-profile Thompson St & Hilda Ave intersection and direct flow down Thompson St instead of Hilda Ave	89*
	WR12	Modify the private driveway entries of Richard Road east of the eastern creek crossing to allow flow down a newly reshaped and stabilised table drain. Then re-profile the road as necessary to regularly direct stormwater runoff into the table drain possibly with the use of cross banks	8*
	WR13	Construct cross banks and reprofile surface on the steep section of Thompson Street west of Robertson Road if not closed off to traffic yet	52*
	WR14	Re-profile Florence Terrace between north of Lowanna Street to allow drainage infall to a table drain and to prevent stormwater runoff flowing off the road into the down-slope private property	71*
	WR20	Re-profile the Thompson Street – Cecil Street intersection to control the direction of stormwater runoff	85*
	WR21	Construct suitable stormwater drainage down Cecil Street	19*
	WR22	Stabilise the drains that enter the eastern creek crossing on Richard Road	10*
	WR23	Replace the stormwater inlet grate on the intersection of Harold Avenue and Richard Road	5*
	WR30	Fix the log sediment trap on the western cutting of the Elizabeth Park track	92*
	WR31	Replace the stormwater inlet grates on Cargo Hill	38*
	WR33	Stabilise the gully erosion downstream of the stormwater outlet on the intersection of Harold Avenue and Richard Road	3*
	WR35	Re-profile the intersection of Florence Terrace and Elsie Street to prevent stormwater runoff bypassing the stormwater inlet	75*
	WR39	Install additional cross banks on upper Kevin Street	115*
	WR41	Form a table drain on Florence Terrace immediately south of Pathilda Reserve	69*
	WR42	Re-profile Florence Terrace between Lowanna Street and Elsie Street to form infall drainage and form a table drain	74*
	WR43	Re-profile the intersection of Thompson Street and Robertson Road to sheet stormwater off Robertson Road and through the upper section of Catherine Park	50*
	WR44	Construct formal culvert crossings into private properties along Robertson Road between Cargo Hill and Yamba to allow flow down the table drain. The table drain may need to be reinstated in some locations	43*
	WR45	Re-profile Richard Road west of the eastern creek crossing to allow flow to enter the existing concrete table drain. Or otherwise, remove the concrete drain and form a new rock-lined table drain	15*
	WR46	Formalise a table drain along Florence Terrace north of Pathilda Reserve	65*
	WR47	Construct and stabilise a table drain along Thompson Street between Harold Avenue and Cecil Street. Where necessary, install cross banks to direct stormwater into the table drain	82*
	WR48	Construct culvert under Thompson Road at creek crossing between Harold Avenue and Cecil Street	83*
	WR51	Establish silt storage areas in Elizabeth Park or any other suitable location. Use these areas to store silt collected from table drain maintenance operations. Treat with gypsum and mix with organise to form a source of topsoil for the rehabilitation of road banks and table drains	109*
	WR53	Stabilise (*rock line*) the table drain in Thompson Street south of Kevin	118*

No.	Measure Number	Measure Description	Associated Measure
		Avenue	
	WR56	Direct flow off Thompson Street down the unnamed (40ft wide) road reserve	91*
	WR57	Form a silt trap at base of eastern cutting on the Elizabeth Park track	100*
	WR61	Re-profile the bend on Richard Road north-west of Hilda Avenue to prevent excess runoff down through private property	31*
	WR62	Fix the drainage on Richard Road opposite unnamed (40ft wide) road	32*
	WR63	Fix the drainage on Florence Terrace east of Pitt View Street. Possible remove the concrete table drain and replace with a rock-lined drain set lower into the road profile	64*
	WR64	Duplicate the Catherine Park road culvert	53*
	WR67	Enlarge the detention basin upstream of the Catherine Park culvert	54*

Note * denotes Witheridge Action Item No

APPENDIX B - UI RELATED STORMWATER MANAGEMENT CONCLUSIONS AND RECOMMENDATIONS

B1 Stormwater Management Conclusions and Recommendations

B1.1 Conclusions

Scotland Island is unique and as such necessitates its own stormwater management procedures.

Historically, it appears that best practice drainage systems were not adopted in the planning stages of the Islands development. This has resulted in impacts such as excessive erosion, flooding and poor stormwater quality.

An assessment of the Islands hydrology revealed that the Islands development is not sustainable without some form of stormwater quantity control (*ie On Site Detention*).

An assessment of the Islands stormwater quality revealed that existing litter, sediment and nutrient loads are high. However, it was determined that minimal opportunity was available to implement traditional lot or public based treatment systems (*ie due to the topography and soil conditions*). Instead, implementation of traditional civil infrastructure improvements such as sealing roads and eliminating onsite effluent disposal systems provided the greatest improvement to stormwater quality.

An assessment of stormwater conveyance revealed that adoption of a major/minor drainage system philosophy incorporating major overland flow channels and culverts in combination with minor dish drain/pipes systems within the roadways would minimise many of the Islands current stormwater related impacts.

Finally, it is concluded that implementation of any future stormwater management measures should be cognisant of the unique characteristics of the Island, including a preference for softer engineered solutions where appropriate.

B1.2 Recommendations

Our recommendations focus on the long term but also provide some guidance on solutions in the short to medium term.

B1.3 UI Related Long Term Stormwater Management Measures

A summary of the recommended UI related long term stormwater management improvements for the Island are as follows:

1. Stabilise and seal all public road/shareway surfaces (*ie bitumen, concrete or other*);
2. Disconnect all lot based onsite effluent disposal systems and replace with a conventional reticulated mains sewer (*ie with off-Island treatment*);
3. Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (*refer to **Figure S4***) in combination with culverts at all road crossings (*refer to **Figure S4***);
4. Create drainage easements across all lots that will be affected by the above trunk drainage routes and in other locations as required (*refer to **Figure S5***);

5. Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (*refer to **Figure S6***);
6. Provide a typical 1 way cross fall road/shareway incorporating stabilised dish drain (*rock, bitumen or concrete*) on the cut side of all roads (*refer to **Figure S6***);
7. Implement and maintain public stormwater treatment measures as illustrated in **Figure S7;**

B1.4 UI Related Short to Medium Term Stormwater Management Measures

A summary of the recommended UI related short to medium term stormwater management improvements for the Island are as follows:

1. Implement the unique short to medium term UI stormwater related recommendations from the W Rooney and G Witheridge studies as shown at **Table 5.** Note that many of the short to medium term Witheridge recommendations have already been listed in the road reserve recommendations (**ie Table 3**). Hence, to prevent double up they have been excluded from **Table 5**;
2. Seal some of the steeper sections of road on the Island (*ie Hilda Ave, upper sections of Kevin Ave etc*).

Table 5 – UI Related Short to Medium Term Stormwater Management Recommendations

Measure No.	Witheridge Action Item	Witheridge Priority			Required Action
SW6	17		M		Temporarily stabilise Cecil Street if it has not been closed to traffic.
SW7	30			H	Reform drainage on Hilda Avenue.
SW30	26		M		Replace the stormwater grates on the Richard Road- Hilda Avenue intersection.

APPENDIX C - STRATEGY COST ESTIMATES

Table 6 – Strategy Cost Estimates

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
1	DS1-1	**S/M-RSS**	Table drain in Richard Road (**Sector 1**)	$34,000	$51,000	In addition to DS 8. Rock stabilised. (283mx1m wide $120/m2)
2	DS1-2	**S/M-RSS**	Table drain in Richard Road (**Sector 2**)	$34,000	$51,000	In addition to DS 8. Rock stabilised. (283mx1m wide $120/m2)
3	DS1-3	**S/M-RSS**	Table drain in Richard Road (**Sector 3**)	$34,000	$51,000	In addition to DS 8. Rock stabilised. (283mx1m wide $120/m2)
4	DS2-1 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 11**)	$10,125	$15,188	Surface works only/grading ($15/m2 x 225m x 3m)
5	DS2-2 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 12**)	$10,125	$15,188	Surface works only/grading ($15/m2 x 225m x 3m)
6	DS2-3(DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 13**)	$10,125	$15,188	Surface works only/grading ($15/m2 x 225m x 3m)
7	DS2-4 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 14**)	$10,125	$15,188	Surface works only/grading ($15/m2 x 225m x 3m)
8	DS4-1	**S/M-RSS**	**Waterbars/Crossbanks Sector 1** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
9	DS4-2	**S/M-RSS**	**Waterbars/Crossbanks Sector 2** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
10	DS4-3	**S/M-RSS**	**Waterbars/Crossbanks Sector 3**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
11	DS4-4	**S/M-RSS**	**Waterbars/Crossbanks Sector 4** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
12	DS4-5	**S/M-RSS**	**Waterbars/Crossbanks Sector 5** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
13	DS4-6	**S/M-RSS**	**Waterbars/Crossbanks Sector 6** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
14	DS4-7	**S/M-RSS**	**Waterbars/Crossbanks Sector 7** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
15	DS4-8	**S/M-RSS**	**Waterbars/Crossbanks Sector 8** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
16	DS4-9	**S/M-RSS**	**Waterbars/Crossbanks Sector 9** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
17	DS4-10	**S/M-RSS**	**Waterbars/Crossbanks Sector 10**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
18	DS4-11	**S/M-RSS**	**Waterbars/Crossbanks Sector 11** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
19	DS4-12	**S/M-RSS**	**Waterbars/Crossbanks Sector 12**- Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
20	DS4-13	**S/M-RSS**	**Waterbars/Crossbanks Sector 13** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
21	DS4-14	**S/M-RSS**	**Waterbars/Crossbanks Sector 14** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item
22	DS4-15	**S/M-RSS**	**Waterbars/Crossbanks Sector 15** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	$9,600	$14,400	8 waterbars x $1200 /item

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
23	DS 5,6 and 11	**S/M-RSS**	Install silt traps as shown in Plan SIR023 (includes DS5 and DS 11)	$120,000	$180,000	6 silt traps x $20,000/item
24	DS7-1	**S/M-RSS**	**Table Drain Crossings Sector 1** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
25	DS7-2	**S/M-RSS**	**Table Drain Crossings Sector 2**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
26	DS7-3	**S/M-RSS**	**Table Drain Crossings Sector 3** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
27	DS7-4	**S/M-RSS**	**Table Drain Crossings Sector 4** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
28	DS7-5	**S/M-RSS**	**Table Drain Crossings Sector 5** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
29	DS7-6	**S/M-RSS**	**Table Drain Crossings Sector 6** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
30	DS7-7	**S/M-RSS**	**Table Drain Crossings Sector 7** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
31	DS7-8	**S/M-RSS**	**Table Drain Crossings Sector 8** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
32	DS7-9	**S/M-RSS**	**Table Drain Crossings Sector 9**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
33	DS7-10	**S/M-RSS**	**Table Drain Crossings Sector 10** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
34	DS7-11	**S/M-RSS**	**Table Drain Crossings Sector 11**- Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
35	DS7-12	**S/M-RSS**	**Table Drain Crossings Sector 12** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
36	DS7-13	**S/M-RSS**	**Table Drain Crossings Sector 13** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
37	DS7-14	**S/M-RSS**	**Table Drain Crossings Sector 14** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
38	DS7-15	**S/M-RSS**	**Table Drain Crossings Sector 15** - Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	$24,800	$37,200	31 pathway/driveway x $800/culvert
39	DS8-1	**S/M-RSS**	**Table Drains Sector 4** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
40	DS8-2	**S/M-RSS**	**Table Drains Sector 5** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
41	DS8-3	**S/M-RSS**	**Table Drains Sector 6** - construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
42	DS8-4	**S/M-RSS**	**Table Drains Sector 7** - construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
43	DS8-5	**S/M-RSS**	**Table Drains Sector 8** - construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
44	DS8-6	**S/M-RSS**	**Table Drains Sector 9** - construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
45	DS8-7	**S/M-RSS**	**Table Drains Sector 10** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
46	DS8-8	**S/M-RSS**	**Table Drains Sector 11** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
47	DS8-9	**S/M-RSS**	**Table Drains Sector 12** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
48	DS8-10	**S/M-RSS**	**Table Drains Sector 13 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
49	DS8-11	**S/M-RSS**	**Table Drains Sector 14 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
50	DS8-12	**S/M-RSS**	**Table Drains Sector 15 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	$40,000	$60,000	$120/m2 X 334m x 1m wide. Rock Stabilised.
51	DS10-1	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 1 -** Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	$24,000	$36,000	$2000/Class C 450x450mm galvanised steel grate, assume 12 items
52	DS10-2	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 2 -** Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	$24,000	$36,000	$2000/Class C 450x450mm galvanised steel grate, assume 12 items
53	DS10-3	**S/M-RSS**	**Stormwater Grate/Pit Replacement Stage 3 -** Existing horizontal roadside stormwater grates to be progressively replaced. GENERAL MULTIPLE LOCATIONS.	$24,000	$36,000	$2000/Class C 450x450mm galvanised steel grate, assume 12 items
54	DS12-1	**S/M-RSS**	**Outlet Stabilisation Stage 1 -** Stabilise the stormwater outlets by stabilising the outlet gully	$80,000	$120,000	$20,000 per each outlet x 4
55	DS12-2	**S/M-RSS**	**Outlet Stabilisation Stage 2 -** Stabilise the stormwater outlets by stabilising the outlet gully	$80,000	$120,000	$20,000 per each outlet x 4
56	DS12-3	**S/M-RSS**	**Outlet Stabilisation Stage 3 -** Stabilise the stormwater outlets by stabilising the outlet gully	$80,000	$120,000	$20,000 per each outlet x 4
57	WR4	**S/M-RSS**	Build-up windrow on Richard Road	$3,000	$4,500	$20/sqm - assume 15sqm
58	WR7	**S/M-RSS**	Install temporary timber safety bollards on the two creeks culvert crossings on Richard Road north of the unnamed (40ft wide) road reserve	$3,000	$4,500	$500/item x 6 items
59	WR9	**S/M-RSS**	Construct an elevated footpath/stairway on the inside of the sharp bend on the Elizabeth park track just up-slope of Kevin St, or otherwise make this track safe for all-weather pedestrian access	$120,000	$180,000	Estimate
60	WR10	**S/M-RSS**	Adopt short-term solution to the stabilisation of the trafficable area and drainage for Hilda Ave if the road closure has not been completed	$30,000	$45,000	Estimate
61	WR11	**S/M-RSS**	Re-profile Thompson St & Hilda Ave intersection and direct flow down Thompson St instead of Hilda Ave	$15,000	$22,500	Assume re-profile existing surface only
62	WR12	**S/M-RSS**	Modify the private driveway entries of Richard Road east of the eastern creek crossing to allow flow down a newly reshaped and stabilised table drain. Then, re-profile the road as necessary to regularly direct stormwater runoff into the table drain possibly with use of cross banks	$20,000	$30,000	Assume re-profile existing surface only
63	WR13	**S/M-RSS**	Construct cross banks and reprofile surface on the steep section of Thompson St west of Robertson Rd if not closed off to traffic	$15,000	$22,500	In addition to DS4
64	WR20	**S/M-RSS**	Re-profile the Thompson St - Cecil St intersection	$20,000	$30,000	
65	WR21	**S/M-RSS**	Construct suitable stormwater drainage down Cecil St	$50,000	$75,000	Assume construction of stormwater pits and pipes where necessary
66	WR22	**S/M-RSS**	Stabilise the drains that enter the eastern creek crossing on Richard Rd	$5,000	$7,500	
67	WR23	**S/M-RSS**	Replace the stormwater inlet grate on the intersection of Harold Ave and Richard Rd	$2,500	$3,750	
68	WR30	**S/M-RSS**	Fix the log sediment trap on the western cutting of the Elizabeth Park track	$3,000	$4,500	
69	WR33	**S/M-RSS**	Stabilise the gully erosion downstream of the stormwater outlet on the intersection of Harold Ave and Richard Rd	$30,000	$45,000	In addition to DS12

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
70	WR35	**S/M-RSS**	Re-profile the intersection of Florence Terrace and Elsie St	$15,000	$22,500	
71	WR39	**S/M-RSS**	Install additional cross banks on upper Kevin St	$10,000	$15,000	In addition to DS4
72	WR41	**S/M-RSS**	Form a table drain on Florence Terrace immediately south of Pathilda Reserve	$2,500	$3,750	In addition to DS8
73	WR42	**S/M-RSS**	Re-profile Florence Terrace between Lowanna St and Elsie St to form infall drainage and form a table drain	$15,000	$22,500	In addition to DS2 and DS8
74	WR43	**S/M-RSS**	Re-profile the intersection of Thompson St and Robertson Rd	$15,000	$22,500	Assume re-profile existing surface only
75	WR45	**S/M-RSS**	Re-profile Richard Road west of the eastern creek crossing. Or otherwise, remove the concrete drain and form a new rock-lined table drain	$20,000	$30,000	
76	WR46	**S/M-RSS**	Formalise a table drain along Florence Terrace north of Pathilda Reserve	$2,500	$3,750	In addition to DS8
77	WR47	**S/M-RSS**	Construct and stabilise a table drain along Thompson Street between Harold Av and Cecil St. Where necessary, install cross banks.	$35,000	$52,500	In addition to DS8 and DS4
78	WR48	**S/M-RSS**	Construct culvert under Thompson Road at creek crossing between Harold Av and Cecil St	$25,000	$37,500	
79	WR51	**S/M-RSS**	Establish silt storage areas in Elizabeth Park or any other suitable location. Use these areas to store silt collected from table drain maintenance operations. Treat with gypsum and mix with organise to form a source of topsoil for the rehabilitation of road banks and table drains	$5,000	$7,500	
80	WR53	**S/M-RSS**	Stabilise (rock line) the table drain in Thompson St south of Kevin Av	$10,000	$15,000	$60/sqm
81	WR56	**S/M-RSS**	Direct flow off Thompson St down the unnamed (40ft wide) road reserve	$5,500	$8,250	Assume re-profile existing surface only and minor stabilisation works
82	WR57	**S/M-RSS**	Form a silt trap at base of eastern cutting on the Elizabeth Park track	$2,000	$3,000	In addition to DS6
83	WR61	**S/M-RSS**	Re-profile the bend on Richard Road north-west of Hilda Av	$10,000	$15,000	Assume re-profile existing surface only
84	WR62	**S/M-RSS**	Fix the drainage on Richard Road opposite unnamed (40ft wide) road	$20,000	$30,000	
85	WR63	**S/M-RSS**	Fix the drainage on Florence Terrace east of Pitt View St. Possible remove the concrete table drain and replace with a rock-lined drain set lower into the road profile	$45,000	$67,500	
86	WR64	**S/M-RSS**	Duplicate the Catherine Park road culvert	$30,000	$45,000	
87	WR67	**S/M-RSS**	Enlarge the detention basin upstream of the Catherine Park culvert	$105,000	$157,500	
88	H5, S2 and W10	**L-RSS**	Convert Hilda Ave to a walking track only (ie no vehicular access) but leave as road reserve (incl drainage and surface stabilisation)	$165,000	$247,500	Same as S2 & W10
89	H7-1	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Florence Tce (incl guard rail and retaining structures)	$127,500	$191,250	Estimate
90	H7-2 and S 15	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Thompson Street (incl guard rail and retaining structures)	$127,500	$191,250	Estimate
91	S1	**L-RSS**	Construct retaining structures (gabion or similar) on steep road embankments along Richard Road north of the Unnamed Rd	$225,000	$337,500	Estimate
92	S8	**L-RSS**	Provide turning area at end of Robertson Road (*ie chainage 1540*) and convert section of Thompson Rd to the east of its intersection with Robertson Road to a stabilised walking track. Provide barriers to prevent unauthorised vehicular access along Thompson Street to the west. Site Barriers up Thompson to ensure access to existing residential properties is maintained.	$100,000	$150,000	
93	S9	**L-RSS**	Provide guard rail on Florence Tce at Pathilda Reserve and in the vicinity of Lowanna Street	$26,000	$39,000	

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
94	S10	**L-RSS**	Stabilise road surface (*ie flush seal*) and provide safety signs on sharp bends and steep sections of Florence Terrace	$35,000	$52,500	
95	S11	**L-RSS**	Provide guard rail on steep down slope drop along Richard Road just north of the Unnamed Road	$12,000	$18,000	
96	S14	**L-RSS**	Provide guard rail on steep down slope drop along Harold Avenue	$18,000	$27,000	
97	S17-1	**L-RSS**	**Passing Bays Stage 1 -** Incorporation of passing bays at regular intervals within the road reserve (all roads)	$60,000	$90,000	Assume 3 at $20,000 each
98	S17-2	**L-RSS**	**Passing Bays Stage 2 -** Incorporation of passing bays at regular intervals within the road reserve (all roads)	$60,000	$90,000	Assume 3 at $20,000 each
99	S17-3	**L-RSS**	**Passing Bays Stage 3 -** Incorporation of passing bays at regular intervals within the road reserve (all roads)	$60,000	$90,000	Assume 3 at $20,000 each
100	S17-4	**L-RSS**	**Passing Bays Stage 4 -** Incorporation of passing bays at regular intervals within the road reserve (all roads)	$60,000	$90,000	Assume 3 at $20,000 each
101	S17-5	**L-RSS**	**Passing Bays Stage 5 -** Incorporation of passing bays at regular intervals within the road reserve (all roads)	$80,000	$120,000	Assume 4 at $20,000 each
102	S20	**L-RSS**	Construct road embankment retaining structures on high side of Robertson Road at Fitzpatrick Avenue (*ie above walking track/future road*)	$75,000	$112,500	
103	W1	**L-RSS**	Realignment of upper Fitzpatrick Avenue above Thompson Street because it is badly eroded and currently runs within private property	$12,000	$18,000	
104	W3	**L-RSS**	Installation of cross banks on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street to divert runoff off away from the track	$4,000	$6,000	In addition to DS4
105	W7	**L-RSS**	Steps placed along the lower half of the Aoma Street walking track to provide all weather access	$7,000	$10,500	
106	W8	**L-RSS**	Additional steps placed on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street possible between the existing rock steps	$8,500	$12,750	
107	DL2-1	**L-RSS**	**Trunk Drainage Sector 1 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
108	DL2-2	**L-RSS**	**Trunk Drainage Sector 2 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
109	DL2-3	**L-RSS**	**Trunk Drainage Sector 3 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
110	DL2-4	**L-RSS**	**Trunk Drainage Sector 4 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
111	DL2-5	**L-RSS**	**Trunk Drainage Sector 5 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
112	DL2-6	**L-RSS**	**Trunk Drainage Sector 6 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
113	DL2-7	**L-RSS**	**Trunk Drainage Sector 7-** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
114	DL2-8	**L-RSS**	**Trunk Drainage Sector 8 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
115	DL2-9	**L-RSS**	**Trunk Drainage Sector 9 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
116	DL2-10	**L-RSS**	**Trunk Drainage Sector 10 -** Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
117	DL2-11	**L-RSS**	**Trunk Drainage Sector 11** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
118	DL2-12	**L-RSS**	**Trunk Drainage Sector 12** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
119	DL2-13	**L-RSS**	**Trunk Drainage Sector 13** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
120	DL2-14	**L-RSS**	**Trunk Drainage Sector 14** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
121	DL2-15	**L-RSS**	**Trunk Drainage Sector 15** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	$100,000	$150,000	
122	DL3-1	**L-RSS**	**5yr ARI Piped Drainage Sector 1** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
123	DL3-2	**L-RSS**	**5yr ARI Piped Drainage Sector 2**-Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
124	DL3-3	**L-RSS**	**5yr ARI Piped Drainage Sector 3** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
125	DL3-4	**L-RSS**	**5yr ARI Piped Drainage Sector 4** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
126	DL3-5	**L-RSS**	5**yr ARI Piped Drainage Sector 5** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
127	DL3-6	**L-RSS**	5**yr ARI Piped Drainage Sector 6** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
128	DL3-7	**L-RSS**	5**yr ARI Piped Drainage Sector 7** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
129	DL3-8	**L-RSS**	5**yr ARI Piped Drainage Sector 8** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
130	DL3-9	**L-RSS**	5**yr ARI Piped Drainage Sector 9** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
131	DL3-10	**L-RSS**	5**yr ARI Piped Drainage Sector 10** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
132	DL3-11	**L-RSS**	5**yr ARI Piped Drainage Sector 11** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
133	DL3-12	**L-RSS**	5**yr ARI Piped Drainage Sector 12** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
134	DL3-13	**L-RSS**	5**yr ARI Piped Drainage Sector 13** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
135	DL3-14	**L-RSS**	5**yr ARI Piped Drainage Sector 14** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
136	DL3-15	**L-RSS**	5**yr ARI Piped Drainage Sector 15**- Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	$55,000	$82,500	
137	P1	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Robertson Road from intersection with Cargo Wharf Road/Fitzpatrick Ave between approx. chainages 840 and 880 (*refer to Figure R3 for road chainage details*)	$144,000	$216,000	rigid $800/m2. Also includes loop. Total length approx. 60m. Av width 3m.

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
138	P2 and S6	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Thompson Road from intersection with Kevin Ave between approx. chainages 0 and 35 (*refer to Figure R3 for road chainage details*)	$84,000	$126,000	rigid $800/m2. Total length approx. 35m. Av width 3m. Incl shoulder. Table drain separate.
139	P3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 130 and 250 (*refer to Figure R3 for road chainage details*)	$288,000	$432,000	rigid $800/m2. Total length approx. 120m. Av width 3m.Incl shoulder. Table drain separate.
140	P4	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 400 and 500 (*refer to Figure R3 for road chainage details*)	$240,000	$360,000	rigid $800/m2. Total length approx. 100m. Av width 3m.Incl shoulder. Table drain separate.
141	P5 and S7	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 740 and 830 (*refer to Figure R3 for road chainage details*)	$216,000	$324,000	rigid $800/m2. Total length approx. 90m. Av width 3m.Incl shoulder. Table drain separate.
142	P6 and S3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 940 and 1010 (*refer to Figure R3 for road chainage details*)	$168,000	$252,000	rigid $800/m2. Total length approx. 70m. Av width 3m.Incl shoulder. Table drain separate.
143	P7	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Cecil Street	$132,000	$198,000	rigid $800/m2. Total length approx. 55m. Av width 3m.Incl shoulder. Table drain separate.
144	P8	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Harold Ave and round the corner into the start of Richard Road	$288,000	$432,000	rigid $800/m2. Total length approx. 120m. Av width 3m.Incl shoulder. Table drain separate.
145	P9	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Richard Road between approx. chainages 260 and 320 (*refer to Figure R3 for road chainage details*)	$144,000	$216,000	rigid $800/m2. Total length approx.60m. Av width 3m.Incl shoulder. Table drain separate.
146	P10 and S4	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of fire trail extending from the end of Kevin Ave between approx. chainages 190 and 300 (*refer to Figure R3 for road chainage details*)	$372,000	$558,000	rigid $800/m2. Total length approx.155m. Av width 3m. Includes branch.Incl shoulder. Table drain separate.
147	P12	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Pitt View Street	$157,500	$236,250	Flex $350/m2/ Total Length 150m. Av width 3m.Incl shoulder. Table drain separate.
148	P13	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Kevin Ave	$210,000	$315,000	Flex $350/m2/ Total Length 200m. Av width 3m.Incl shoulder. Table drain separate.
149	P14-1	**L-RSS**	**Florence Pavement Sector 11-** construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.
150	P14-2	**L-RSS**	**Florence Pavement Sector 12 (incl small sect 5) -** construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.
151	P14-3	**L-RSS**	**Florence Pavement Sector 13 -** construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.
152	P14-4	**L-RSS**	**Florence Pavement Sector 14 -** construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.
153	P15-1	**L-RSS**	**Richard Pavement Sector 1 -** Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$273,000	$409,500	Flex $350/m2/ Total Length 780m. Av width 3m.Incl shoulder. Table drain separate.
154	P15-2	**L-RSS**	**Richard Pavement Sector 2 -** Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$273,000	$409,500	Flex $350/m2/ Total Length 260m. Av width 3m.Incl shoulder. Table drain separate.

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
155	P15-3	**L-RSS**	**Richard Pavement Sector 3** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	$273,000	$409,500	Flex $350/m2/ Total Length 260m. Av width 3m.Incl shoulder. Table drain separate.
156	P16-1	**L-RSS**	**Thompson Pavement Sector 5** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$257,250	$385,875	Flex $350/m2/ Total Length 86.7m. Av width 3m.Incl shoulder. Table drain separate.
157	P16-2	**L-RSS**	**Thompson Pavement Sector 8** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$257,250	$385,875	Flex $350/m2/ Total Length 86.7m. Av width 3m.Incl shoulder. Table drain separate.
158	P16-3	**L-RSS**	**Thompson Pavement Sector 9** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	$257,250	$385,875	Flex $350/m2/ Total Length 86.7m. Av width 3m.Incl shoulder. Table drain separate.
159	P17-1	**L-RSS**	**Robertson Pavement Sector 6** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.Incl shoulder. Table drain separate.
160	P17-2	**L-RSS**	**Robertson Pavement Sector 7** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	$236,250	$354,375	Flex $350/m2/ Total Length 225m. Av width 3m.Incl shoulder. Table drain separate.
161	P21	**L-RSS**	Seal Steep section of Thompson Ch 1340-1540 (Flexible pavement). Convert upper section of Thompson Road to a walking track only (*ie close off to vehicles*). Maintain vehicular access to existing properties. Residents to construct private driveway access from end of Thompson turning head (refer to Measure S8 also)	$210,000	$315,000	Flex $350/m2/ Total Length 200m. Av width 3m.Incl shoulder. Table drain separate.
162	P23	**L-RSS**	Provide new access ramp and associated laydown/pickup area for large construction/maintenance vehicles	$200,000	$300,000	Estimate
163	SW6	**S/M-SWMS**	Temporarily stabilise Cecil Street if it has not been closed to traffic.	$15,000	$22,500	
164	SW7	**S/M-SWMS**	Reform drainage on Hilda Avenue.	$50,000	$75,000	Assume general purpose mat adopted
165	SW30	**S/M-SWMS**	Replace the stormwater grates on the Richard Road- Hilda Avenue intersection.	$10,000	$15,000	Assume re-construct stormwater pits and pipes where necessary
166	SWM7-1	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT1	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
167	SWM7-2	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT2	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
168	SWM7-3	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT3	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
169	SWM7-4	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT4	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
170	SWM7-5	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT5	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
171	SWM7-6	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT6	$125,000	$187,500	S&I Med.GPT (CDS or equiv)
172	SWM7-7	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS1	$24,000	$36,000	100m x 1m wide. $240/m2
173	SWM7-8	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS2	$28,800	$43,200	120m x 1m wide. $240/m2

No.	Measure No.	Type	Measure Description	Captial Cost Estimate not incl contingencies (AU$ 2011)	Total Captial Cost Estimate incl contingencies (AU$ 2011)	Notes (cost pre contingency)
174	SWM7-9	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS3	$21,600	$32,400	90m x 1m wide. $240/m2
175	SWM7-10	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS4	$19,200	$28,800	80m x 1m wide. $240/m2
176	SWM7-11	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS5	$12,000	$18,000	50m x 1m wide. $240/m2
177	SWM7-12	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS6	$21,600	$32,400	90m x 1m wide. $240/m2
178	SWM7-13	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS7	$26,400	$39,600	110m x 1m wide. $240/m2
179	SWM7-14	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS8	$16,800	$25,200	70m x 1m wide. $240/m2
180	SWM7-15	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS9	$15,600	$23,400	65m x 1m wide. $240/m2
181	SWM7-16	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS10	$15,600	$23,400	65m x 1m wide. $240/m2
			Subtotal	**$12,735,350**	**$19,103,025**	
			Additional 1: Engineering & design fee - assume 15% of subtotal	**$1,910,303**		
			Additional 2: Project & construction management fee - assume 10% of subtotal	**$1,273,535**		
			Subtotal + Additional 1 & 2	**$15,919,188**		
			Contingency (30%)	**$3,183,838**		
			Total	**$19,103,025**		

Notes:

1. This cost estimate is based on limited design information and as such is preliminary only.

2. This cost estimate is based on Civil certifications's experience and judgement as a firm of practicing professional engineers familiar with the construction industry. However, it can NOT be guaranteed to contain all required construction activities. If a reliable estimate of quantities is required, then an appropriately qualified Quantity Surveyor would need to be engaged.

3. This cost estimate does not include tendering costs.

4. This cost estimate does not include GST.

5. RSS = Road Reserve Strategy. SWM = Stormwater Management Strategies. L = long term measure. S/M = short to medium term measure.

APPENDIX D - CV

Civil Certification
Accredited Certifiers
Civil Engineering

ABN 87 532 718 229
0412 264 237

Michael J Shaw
BE MIEAust CPEng NPER

Principal
Civil Certification

Resume

1. SUMMARY

Michael is a senior civil engineer with over 17 years experience in the fields of civil engineering, road design, drainage, hydrology, stormwater management and urban infrastructure design. He operates his own business specialising in private certification and stormwater management. Michael has worked on many civil design projects ranging from development of large scale strategic masterplans to detailed design of stormwater management facilities and urban infrastructure for residential subdivisions. His expertise lies in solving complicated drainage problems, water sensitive urban design (*WSUD*), flooding, detailed civil design, understanding the local government approvals process and managing multidisciplinary teams. Michael's experience covers all facets of civil engineering for urban development from due diligence through to approvals, detailed design, superintendency and certification. He has also provided expert advice to the Land and Environment Court with relation to drainage and stormwater quality issues.

2. EXPERIENCE

Positions held -& Location

Oct 2010 – Present	▶ Principal, Civil Certification, Sydney, NSW, Australia
April 2008-Sept 2010	▶ Manager, Urban Infrastructure, Environment Group - Worley Parsons, Sydney, NSW, Australia.
Aug. 2007-March 2008	▶ Principal Engineer – Urban Infrastructure - Worley Parsons incorporating Patterson Britton & Partners, Sydney, NSW, Australia;
Nov. 1997-Jul. 2007	▶ Senior Associate – Urban Infrastructure - Patterson Britton & Partners, Sydney, NSW, Australia;
Aug. 1996-Oct 1997	▶ Water Resources Engineer – Willing & Partners, Sydney, NSW, Australia;
Feb. 1991-Aug. 1994	▶ Design Engineer, Development Engineer, Investigation Engineer & Survey Assistant – Ryde City Council, Sydney, NSW, Australia.

Standout Projects

▶ ***Stormwater Management Strategies(SMS)***

-Port Jackson South Stormwater Management Plan *(2,870ha catchment)*;

-Drummoyne Council Stormwater Quality Strategy *(830ha catchment)*;

-Lake Illawarra South Stormwater Quality Strategy *(1,548ha catchment)*;

-Elliot Lake Stormwater Quality Strategy *(1,220ha catchment)*;

-Scotland Island SMS *(53ha catchment)*;

-Corks Lane Milton, DA Stage SMS (*150 lot residential subdivision*);

-Pasadena, Church Point, DA Stage Stormwater Management and Reuse Strategy (*mixed use dev.*);

-Yallambee Ave West Gosford, DA Stage SMS *(100 lot residential subdivision*)

-CSIRO Greystanes, Employment Lands SMS *(60ha industrial site*);

-Warriewood Valley, Sector 3, Rezoning Stage SMS *(130 lot residential subdivision*);

-Warriewood Valley, Sector 8, Rezoning to Subdivision Certificate Stage SMS *(140 lot residential subdivision*);

-Warriewood Valley, Buffer Areas 1 and 2, Rezoning and DA Stage SMS (*300 lot residential subdivision*

-Warriewood Valley, Buffer Area 3, Rezoning and DA Stage SMS (*250 townhouse subdivision*);

-Macarthur Square Regional Centre Masterplan DA Stage WSUD Strategy (*61ha residential subdivision*);

-Department of Defence Site, Ermington ("*Ermington Riverfront*") DA Stage SMS (*20ha residential subdivision*

-West Kembla Grange, Wollongong, Aquatic Issues Assessment (*858ha catchment*);

-Eastwood Quarry, Masterplan/Rezoning Stage SMS (*20ha residential subdivision*);

-Perentie and Dawes Road Masterplan, Belrose, Stormwater Quality Strategy (*30ha residential subdivision*);

-Walter Road, Ingleside DA Stage SMS (*15ha rural residential subdivision*);

-Domayne, Austlink Park Belrose SMS (large *commercial use development*);

-Grassmere LES, Camden SMS (*50ha rural residential subdivision*);

-Warriewood Valley (*Sectors C, D, & 12*) Rezoning Stage SMS *(100 lot residential subdivision*); and

-Summer Hill Flour Mill Concept Plan Application Stormwater Management Plan and Flood Study (*250 dwelling high density residential subdivision*).

- ***Water Sensitive Urban Design (WSUD)***

-Sand Filtration Unit, Drummoyne Park (*ie Stormwater Treatment*);

-Barnwell Park Golf Course Stormwater Treatment and Reuse;

-Powell Creek Reserve Eco Carpark

-Warriewood Valley, Sector 10, Detailed Design of WSUD elements (*bio-retention systems and wetland for 170 lot residential subdivision*);

-Warriewood Valley, Sector 12, Detailed Design of WSUD elements (*bio-retention systems and wetland for 180 lot residential subdivision*);

-Rouse Hill Regional Centre – Detailed design and performance analysis of bio retention systems, raingardens and constructed wetland;

-Hezlett Road, North Kellyville – Generic lot based raingarden design, road bio-retention swale design and detention offset analysis.

- ***Riparian/Creek Design/Investigation***

-Wollondilly Shire Riparian Corridor Definition Study;

-Parsley Bay, Woollahra, Creekline Rehabilitation;

-Embankment Stabilisation Design, Koloona Ave, Byarong Creek ,Wollongong;

-Embankment Stabilisation Design, 5 sites along Cabbage Tree Creek, Towradgi Creek and Byarong Creek, Wollongong;

-Prospect Creek, Fairfield – Design of confluence stabilisation and creek rehabilitation measures; and

-Narrabeen Creek, Pittwater – Detailed design of creek rehabilitation and embankment stabilisation measures from Graf Ave to Ponderosa Parade.

- ***Civil Subdivision Design***

-Potts Hill, Eastern Precinct – Lead design team for 13ha Industrial development of Sydney Water Surplus Lands. Engaged by Landcom to provide approval documentation for Part 3 Major Project and to deliver detailed design of all subdivision infrastructure (*ie civil, roads, RE walls, stormwater, power, sewer, water, recycled water and utility services*).

-Tweed Road, Lithgow, Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 38 lot residential subdivision;

-Sector 20, Warriewood, Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 63 lot residential subdivision;

-7 Orchard Road, Warriewood, Detailed Design of Lot Based Stormwater Management Facilities and Access Road for a 10 lot residential subdivision;

-Heritage Estates, Shoalhaven, Conceptual Design of Civil Infrastructure. (*water, sewage, utility services, roads and drainage*) for 20ha residential subdivision;

-Randwick Defence Site (*Stage 1A*), Detailed Design of Civil Infrastructure (*roads, drainage, water, sewer and all other utility services*) for a 80 lot residential subdivision; and

-Cooks Cove Development, Upgrade to Scarborough and Bicentennial Parks – Lead design team for approvals and detailed design of upgrade to park facilities, including carparks, creekline, stormwater drainage, bulk earthworks, access roads, services etc to accommodate future relocation of facilities from Cooks Cove development site (*Part 3A Major Project*).

- ***Drainage Analysis/Design***

-Canada Bay Council city wide DRAINS modelling project *(970ha catchment*);

-Canada Bay Council Detention modelling and OSD policy development;

-City of Canada Bay Council MAPINFO drainage database update;

-Old Bathurst Road, Emu Plains, Detailed Design of Stormwater Management Facilities *(24ha industrial subdivision*)

-Andrew Road, Penrith, Detailed Design of Stormwater Management Facilities *(8ha industrial subdivision*)

-St Mervyns Ave, Woollahra, Stormwater Outlet Extension;

-Grosvenor Street Stormwater Drainage Study;

-Perentie and Dawes Road Masterplan, Belrose, Stormwater Drainage Concept Plan;

-Yulong Concept Drainage Study, Dept Defence Moorebank *(25ha industrial subdivision);*

-Headland Road, Curl Curl OSD Design;

-Cooper Park Amphitheatre , Woollahra, Detailed Stormwater Drainage Design;
-Paradise Avenue, Paradise Beach, Detailed Stormwater Drainage Design;
-Georges River Sailing Club, Seawall and Beach Nourishment Design;
-St Andrew Church, Wahroonga OSD and Stormwater Drainage Design;
-North Sydney Catchment Management Studies (*in total 86ha catchment*);
-Greystanes Estate, Northern Residential Lands, Detailed Design of Water Management Facilities (*70ha residential development*); and
-Barina Downs Road, Detention Basin Design (*large regional detention facility*).
-Robertson Road, Scotland Island – Detailed Stormwater Drainage Design

- ***Flood Studies (FS)***

-Prospect Creek Channel Enhancement FS;
-Oats Ave, Gladesville FS;
-Casa Paloma Caravan Park FS;
-Kiaora Place Development, Double Bay FS;
-Darling Park/Cross City Tunnel - Flood impact assessment;
-Mowbray Road, Nursing Home, Assessment of overland flow impacts;
-Macquarie Links Golf Course FS (*Bunburry Curran Creek, Campbelltown*);
-Wigan Road, Dee Why FS;
-Green Road FS;
-Anzac Creek, Moorebank FS;
-Eastwood Hotel Drainage/Flooding Study;
-Mona Street, Mona Vale FS;
-Frenchs Creek FS;
-Darling Walk Flood Assessment, Darling Harbour; and
-Lynwood Ave, Dee Why Flood Assessment.

- ***Dam Hazard Assessment***

-Kellyville Ridge Dam, Second Ponds Creek, Dam Hazard Assessment;
-UWS Campbelltown Dam Hazard Assessment;
-Hume Golf Course, Albury Dam Hazard Assessment; and
-CSIRO, Greystanes Dam Hazard Assessment.

- ***Water Quality Monitoring***

-Sectors 2, 8 and 11 Warriewood, Post construction (*ie residential subdivision*) stormwater quality monitoring;
-Warriewood Valley (*Various Sectors*) Approval Stage Water Quality Monitoring over an 8 year period

-Shellharbour Council Stormwater Monitoring Strategy (*entire Shellharbour LGA - 14,000ha*);

-St Marys Eastern Precinct Water Quality Monitoring Strategy *(160ha residential subdivision*);

-Rouse Hill Regional Centre – Post development water quality monitoring of treatment measures and receiving waters (*Auto sampling and grab sampling*);

-Water Quality Sampling for Metal Recycling development, Ingleburn.

- ***Major Culvert Amplification Design***

-Careel Creek/Barrenjoey Road Culvert Amplification Works (*Pittwater Council and RTA*);

- Nareen Creek /Narrabeen RSL Culvert Entry Upgrade (*Pittwater Council)*;

-Howell Reserve Culvert Entry Upgrade and Drainage Diversion Line (*Pittwater Council);*

-Fern Creek/Garden Street Culvert Amplification (*Pittwater Council*);

-Narrabeen Creek/Ponderosa Pde Culvert Amplification (*Pittwater Council*); and

-Garie Beach Culvert Amplification (*RTA and NPWS*).

- ***Road/Carpark Design***

-Transport Infrastructure Development Corporation (*TIDC*) Commuter Car Park Program, Detailed Design of At Grade Carparks at Emu Plains Station, Woonona Station and Waterfall Station (over $1 million in fees)

- Rookwood Road Potts Hill, Detailed Design of RTA signalised intersection upgrade (*Landcom)*

-Brunker Road Potts Hill, Detailed Design of RTA signalised intersection upgrade (*Landcom)*

-Scotland Island Road Reserve Masterplan (*53ha area*);

-P&O Port Botany, Detailed Design of Staff Carparking Facilities *(50 spaces*);

-McKeown Street, Maroubra Beach, Detailed Road Design for streetscape improvement works;

-Department of Defence Site, Randwick (*Stages 1A, 1B and Community Centre*), Detailed Road Design for large residential subdivision(*5.6ha residential subdivision*);

-Greystanes Estate Northern Residential Land, Detailed Road Design for large residential subdivision *(50ha residential subdivision*);

-Sector 20 Warriewood, Detailed Road Design for large residential subdivision *(50ha residential subdivision*);

-Lidcombe Botanica, Detailed Road Design for heritage precinct of large residential subdivision; and

-Heffron Park Randwick, Detailed Design of 100 space carpark and associated road improvement works.

- ***Infrastructure/Servicing Strategies***

-Ermington Naval Stores *(700 lot residential development*);

-Greystanes Estate, Prospect (*250ha residential & employment development*);

-UWS Werrington *(48ha residential development*) ;

-Airds Town Centre Masterplan;

-Sector 7 (*2 Daydream Avenue*), Warriewood *(3ha mixed use commercial/light industrial development*);

-St Mary's (*ADI Site-Eastern Precinct-160ha residential development*);

-Green Square Master Plan, South Sydney (*Zetland*); and

-Mt Penang, Gosford Business Park development.

- ***Gross Pollutant Traps (GPT's)***

-Dee Why Beach GPT design (*special non proprietary*);

-Birkenhead Point and Brent Street GPTs (*special non proprietary*);

-St Georges Crescent Catchment Oil/Grit Separators (*multiple proprietary*);

-Stormwater Trust Application Assistance, Waterways Authority - Blackwattle Bay GPT;

-Brookvale Creek Rehabilitation – detailed design of large offline GPT/trash rack; and

-Drummoyne Council - Three Ways to Improve The Bays GPT Design Project (*special non proprietary*).

- ***General Civil Engineering***

BER Sydney South, provision of general civil engineering design for Abigroup for a number of Schools in Sydney South.; and

McCarr's Creek Road/Pittwater Road Inventory and Condition Assessment.

- ***Expert Advice / Certification***

-DA Stormwater management, West Ryde Urban Village Redevelopment for Ryde City Council (*ie acting on behalf of Council*);

-DA Stormwater management, Top Ryde Shopping Centre Redevelopment for Ryde City Council(*ie acting on behalf of Council*);

-Yulong Moorebank , review of road design for Department of Defence;

-Rushcutters Bay Flood Study Peer Review for Lindsay Bennelong Developments;

-Review of Managing Urban Stormwater Manual April 2004 on behalf of Landcom;

-Clontarf Street, Seaforth – Civil inspections for Landcom res. dev. on behalf of Manly Council;

-Sector 20, Warriewood – Superintendency for $6 million Civil Works Contract;

-Expert advice (*water quality on industrial site*) for L&E Court Case - Phiney Place, Ingleburn;

-Expert advice (*drainage*) for L&E Court Case – Park Street, Mona Vale;

-Expert advice (*drainage*) for L&E Court Case – 120 Hopetoun Avenue, Vaucluse;

-Expert advice (*drainage/riparian corridor*) for L&E Court Case – 23B Macpherson Street, Warriewood.

-Expert advice (riparian matters/controlled activity application/culvert creek crossing) for Supreme Court Case – Wambo Coal Mine, Warkworth

3. EDUCATION & PROFESSIONAL AFFILIATIONS

- Bachelor of Engineering (*Civil*), University of Technology, Sydney, 1996;
- Member, Institution of Engineers, Australia (*MIEAust*);
- Charted Professional Engineer (*CPEng*);
- National Professional Engineers Register (*NPER - Civil*);
- NSW Accredited Certifier (BPAct 2005) – Categories B1, C1, C2, C3, C4, C6, C15 (*BPB 0816)*

APPENDIX E – MEASURE RANKING

Table 7 – Measure Ranking List

No.	Measure No.	Type	Measure Description	Priority Ranking Elements											
				Enviro Imprv Rank	Loc. Rank	Catch. #	Catch. Area (ha)	Cost per Catchment Area ($/ha)	Cost Eff. Rank	Safe Rank	WT Rank	Drain Rank	Sub Total	Const Sector	Rank #
1	DS1-1	**S/M-RSS**	Table drain in Richard Road (**Sector 1**)	2.0	2.0	G	5.0	10,200	2.0	4.0	0.0	0.0	10.0	1	22
2	DS1-2	**S/M-RSS**	Table drain in Richard Road (**Sector 2**)	2.0	2.0	F	5.0	10,200	2.0	4.0	0.0	0.0	10.0	2	22
3	DS1-3	**S/M-RSS**	Table drain in Richard Road (**Sector 3**)	2.0	2.0	E	5.0	10,200	2.0	4.0	0.0	0.0	10.0	3	22
4	DS2-1 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 11**)	2.5	3.0	B	3.0	5,063	2.0	4.0	0.0	0.0	11.5	11	87
5	DS2-2 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 12**)	2.5	3.0	B,C	3.0	5,063	2.0	4.0	0.0	0.0	11.5	12	87
6	DS2-3(DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 13**)	2.5	3.0	C	3.0	5,063	2.0	4.0	0.0	0.0	11.5	13	87
7	DS2-4 (DS2 and WR14)	**S/M-RSS**	Modify the profile of Florence Terrace (**Sector 14**)	2.5	3.0	C	6.0	2,531	1.0	4.0	0.0	0.0	10.5	14	63
8	DS4-1	**S/M-RSS**	**Waterbars/Crossbanks Sector 1** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	G	5.0	2,880	1.0	4.0	0.0	0.0	10.0	1	22
9	DS4-2	**S/M-RSS**	**Waterbars/Crossbanks Sector 2** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	F	5.0	2,880	1.0	4.0	0.0	0.0	10.0	2	22
10	DS4-3	**S/M-RSS**	**Waterbars/Crossbanks Sector 3-** Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	E	5.0	2,880	1.0	4.0	0.0	0.0	10.0	3	22
11	DS4-4	**S/M-RSS**	**Waterbars/Crossbanks Sector 4** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	4.0	D	3.5	4,114	1.0	4.0	0.0	0.0	12.0	4	91
12	DS4-5	**S/M-RSS**	**Waterbars/Crossbanks Sector 5** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	4.0	B,C	3.0	4,800	1.0	4.0	0.0	0.0	12.0	5	91
13	DS4-6	**S/M-RSS**	**Waterbars/Crossbanks Sector 6** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	3.0	H	3.5	4,114	1.0	4.0	0.0	0.0	11.0	6	68
14	DS4-7	**S/M-RSS**	**Waterbars/Crossbanks Sector 7** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	3.0	H	3.5	4,114	1.0	4.0	0.0	0.0	11.0	7	68
15	DS4-8	**S/M-RSS**	**Waterbars/Crossbanks Sector 8** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	4.5	E	2.5	5,760	2.0	4.0	0.0	0.0	13.5	8	118
16	DS4-9	**S/M-RSS**	**Waterbars/Crossbanks Sector 9** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	4.5	F	2.5	5,760	2.0	4.0	0.0	0.0	13.5	9	118
17	DS4-10	**S/M-RSS**	**Waterbars/Crossbanks Sector 10-** Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	3.0	A	0.5	28,800	3.0	4.0	0.0	0.0	13.0	10	111
18	DS4-11	**S/M-RSS**	**Waterbars/Crossbanks Sector 11** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	B	3.0	4,800	1.0	4.0	0.0	0.0	10.0	11	22
19	DS4-12	**S/M-RSS**	**Waterbars/Crossbanks Sector 12-** Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	B,C	3.0	4,800	1.0	4.0	0.0	0.0	10.0	12	22
20	DS4-13	**S/M-RSS**	**Waterbars/Crossbanks Sector 13** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	C	3.0	4,800	1.0	4.0	0.0	0.0	10.0	13	22
21	DS4-14	**S/M-RSS**	**Waterbars/Crossbanks Sector 14** - Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	C	6.0	2,400	1.0	4.0	0.0	0.0	10.0	14	22

No.	Measure No.	Type	Measure Description	Priority Ranking Elements											
				Enviro Imprv Rank	Loc. Rank	Catch. #	Catch. Area (ha)	Cost per Catchment Area ($/ha)	Cost Eff. Rank	Safe Rank	WT Rank	Drain Rank	Sub Total	Const Sector	Rank #
22	DS4-15	S/M-RSS	**Waterbars/Crossbanks Sector 15 -** Install waterbars/cross banks for all unsealed roads (not including specific sites mentioned in other short/medium term measures)	3.0	2.0	A	3.0	4,800	1.0	4.0	0.0	0.0	10.0	15	22
23	DS 5,6 and 11	S/M-RSS	Install silt traps as shown in Plan SIR023 (includes DS5 and DS 11)	1.0	1.5	G,A, B	22.4	8,036	2.0	6.0	0.0	0.0	10.5	3	63
24	DS7-1	S/M-RSS	**Table Drain Crossings Sector 1 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	G	5.0	7,440	2.0	3.0	0.0	0.0	10.0	1	22
25	DS7-2	S/M-RSS	**Table Drain Crossings Sector 2-** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	F	5.0	7,440	2.0	3.0	0.0	0.0	10.0	2	22
26	DS7-3	S/M-RSS	**Table Drain Crossings Sector 3 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	E	5.0	7,440	2.0	3.0	0.0	0.0	10.0	3	22
27	DS7-4	S/M-RSS	**Table Drain Crossings Sector 4 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	4.0	D	3.5	10,629	2.0	3.0	0.0	0.0	12.0	4	91
28	DS7-5	S/M-RSS	**Table Drain Crossings Sector 5 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	4.0	B,C	3.0	12,400	2.0	3.0	0.0	0.0	12.0	5	91
29	DS7-6	S/M-RSS	**Table Drain Crossings Sector 6 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	3.0	H	3.5	10,629	2.0	3.0	0.0	0.0	11.0	6	68
30	DS7-7	S/M-RSS	**Table Drain Crossings Sector 7 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	3.0	H	3.5	10,629	2.0	3.0	0.0	0.0	11.0	7	68
31	DS7-8	S/M-RSS	**Table Drain Crossings Sector 8 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	4.5	E	2.5	14,880	2.0	3.0	0.0	0.0	12.5	8	107
32	DS7-9	S/M-RSS	**Table Drain Crossings Sector 9-** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	4.5	F	2.5	14,880	2.0	3.0	0.0	0.0	12.5	9	107
33	DS7-10	S/M-RSS	**Table Drain Crossings Sector 10 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	3.0	A	0.5	74,400	4.0	3.0	0.0	0.0	13.0	10	111
34	DS7-11	S/M-RSS	**Table Drain Crossings Sector 11-** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	B	3.0	12,400	2.0	3.0	0.0	0.0	10.0	11	22
35	DS7-12	S/M-RSS	**Table Drain Crossings Sector 12 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	B,C	3.0	12,400	2.0	3.0	0.0	0.0	10.0	12	22
36	DS7-13	S/M-RSS	**Table Drain Crossings Sector 13 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	C	3.0	12,400	2.0	3.0	0.0	0.0	10.0	13	22
37	DS7-14	S/M-RSS	**Table Drain Crossings Sector 14 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	C	6.0	6,200	2.0	3.0	0.0	0.0	10.0	14	22
38	DS7-15	S/M-RSS	**Table Drain Crossings Sector 15 -** Pathway/driveway culvert crossing to be established at each pathway/driveway crossing of a table drain	3.0	2.0	A	3.0	12,400	2.0	3.0	0.0	0.0	10.0	15	22
39	DS8-1	S/M-RSS	**Table Drains Sector 4 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	4.0	D	3.5	17,143	2.0	4.0	0.0	0.0	12.0	4	91
40	DS8-2	S/M-RSS	**Table Drains Sector 5 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	4.0	B,C	3.0	20,000	2.0	4.0	0.0	0.0	12.0	5	91
41	DS8-3	S/M-RSS	**Table Drains Sector 6 -** construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	2.0	3.0	H	3.5	17,143	2.0	4.0	0.0	0.0	11.0	6	68
42	DS8-4	S/M-RSS	**Table Drains Sector 7 -** construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	2.0	3.0	H	3.5	17,143	2.0	4.0	0.0	0.0	11.0	7	68
43	DS8-5	S/M-RSS	**Table Drains Sector 8 -** construct stabilised table drains f(not including specific sites mentioned in other short/medium term measures).	2.0	4.5	E	2.5	24,000	3.0	4.0	0.0	0.0	13.5	8	118
44	DS8-6	S/M-RSS	**Table Drains Sector 9 -** construct stabilised table drains f (not including specific sites mentioned in other short/medium term measures).	2.0	4.5	F	2.5	24,000	3.0	4.0	0.0	0.0	13.5	9	118
45	DS8-7	S/M-RSS	**Table Drains Sector 10 -** construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	3.0	A	0.5	120,000	5.0	4.0	0.0	0.0	14.0	10	126

No.	Measure No.	Type	Measure Description	Priority Ranking Elements											
				Enviro Imprv Rank	Loc. Rank	Catch. #	Catch. Area (ha)	Cost per Catchment Area ($/ha)	Cost Eff. Rank	Safe Rank	WT Rank	Drain Rank	Sub Total	Const Sector	Rank #
46	DS8-8	S/M-RSS	**Table Drains Sector 11** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	2.0	B	3.0	20,000	2.0	4.0	0.0	0.0	10.0	11	22
47	DS8-9	S/M-RSS	**Table Drains Sector 12** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	2.0	B,C	3.0	20,000	2.0	4.0	0.0	0.0	10.0	12	22
48	DS8-10	S/M-RSS	**Table Drains Sector 13** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	2.0	C	3.0	20,000	2.0	4.0	0.0	0.0	10.0	13	22
49	DS8-11	S/M-RSS	**Table Drains Sector 14** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	2.0	C	6.0	10,000	2.0	4.0	0.0	0.0	10.0	14	22
50	DS8-12	S/M-RSS	**Table Drains Sector 15** - construct stabilised table drains (not including specific sites mentioned in other short/medium term measures).	2.0	2.0	A	3.0	20,000	2.0	4.0	0.0	0.0	10.0	15	22
51	DS10-1	S/M-RSS	**Stormwater Grate/Pit Replacement Stage 1** - Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	3.0	2.0	All	8.0	4,500	1.0	2.0	0.0	0.0	8.0	1	1
52	DS10-2	S/M-RSS	**Stormwater Grate/Pit Replacement Stage 2** - Existing horizontal roadside stormwater grates to be progressively replaced. General MULTIPLE LOCATIONS.	3.0	2.0	All	8.0	4,500	1.0	2.0	0.0	0.0	8.0	1	1
53	DS10-3	S/M-RSS	**Stormwater Grate/Pit Replacement Stage 3** - Existing horizontal roadside stormwater grates to be progressively replaced. GENERAL MULTIPLE LOCATIONS.	3.0	2.0	All	8.0	4,500	1.0	2.0	0.0	0.0	8.0	1	1
54	DS12-1	S/M-RSS	**Outlet Stabilisation Stage 1** - Stabilise the stormwater outlets by stabilising the outlet gully	1.5	1.5	All	17.6	6,818	2.0	4.0	0.0	0.0	9.0	2	4
55	DS12-2	S/M-RSS	**Outlet Stabilisation Stage 2** - Stabilise the stormwater outlets by stabilising the outlet gully	1.5	1.5	All	17.6	6,818	2.0	4.0	0.0	0.0	9.0	2	4
56	DS12-3	S/M-RSS	**Outlet Stabilisation Stage 3** - Stabilise the stormwater outlets by stabilising the outlet gully	1.5	1.5	All	17.6	6,818	2.0	4.0	0.0	0.0	9.0	2	4
57	WR4	S/M-RSS	Build-up windrow on Richard Road	2.0	2.0	D,E,F,G	4.0	1,125	1.0	4.0	0.0	0.0	9.0	2	4
58	WR7	S/M-RSS	Install temporary timber safety bollards on the two creeks culvert crossings on Richard Road north of the unnamed (40ft wide) road reserve	5.0	2.0	G	2.0	2,250	1.0	1.0	0.0	6.0	15.0	1	131
59	WR9	S/M-RSS	Construct an elevated footpath/stairway on the inside of the sharp bend on the Elizabeth park track just up-slope of Kevin St, or otherwise make this track safe for all-weather pedestrian access	5.0	6.0	A	2.0	90,000	4.0	1.0	6.0	6.0	28.0	15	181
60	WR10	S/M-RSS	Adopt short-term solution to the stabilisation of the trafficable area and drainage for Hilda Ave if the road closure has not been completed	3.0	4.0	F	2.0	22,500	3.0	2.0	0.0	6.0	18.0	2	140
61	WR11	S/M-RSS	Re-profile Thompson St & Hilda Ave intersection and direct flow down Thompson St instead of Hilda Ave	2.5	4.0	F	2.0	11,250	2.0	2.0	0.0	0.0	10.5	9	63
62	WR12	S/M-RSS	Modify the private driveway entries of Richard Road east of the eastern creek crossing to allow flow down a newly reshaped and stabilised table drain. Then, re-profile the road as necessary to regularly direct stormwater runoff into the table drain possibly with use of cross banks	3.0	2.0	F	2.0	15,000	2.0	4.0	0.0	0.0	11.0	3	68
63	WR13	S/M-RSS	Construct cross banks and reprofile surface on the steep section of Thompson St west of Robertson Rd if not closed off to traffic	3.0	4.0	A	1.0	22,500	3.0	4.0	0.0	0.0	14.0	7	126
64	WR20	S/M-RSS	Re-profile the Thompson St - Cecil St intersection	2.5	4.0	F	1.0	30,000	3.0	2.0	0.0	0.0	11.5	8	87
65	WR21	S/M-RSS	Construct suitable stormwater drainage down Cecil St	3.0	2.5	F	1.0	75,000	4.0	4.0	0.0	0.0	13.5	3	118
66	WR22	S/M-RSS	Stabilise the drains that enter the eastern creek crossing on Richard Rd	2.0	2.0	E	7.1	1,056	1.0	4.0	0.0	0.0	9.0	3	4
67	WR23	S/M-	Replace the stormwater inlet grate on the intersection of Harold Ave and Richard Rd	4.0	2.0	D	2.0	1,875	1.0	2.0	0.0	0.0	9.0	4	4

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		RSS													
68	WR30	**S/M-RSS**	Fix the log sediment trap on the western cutting of the Elizabeth Park track	1.0	6.0	H	1.0	4,500	1.0	6.0	0.0	0.0	14.0	9	126
69	WR33	**S/M-RSS**	Stabilise the gully erosion downstream of the stormwater outlet on the intersection of Harold Ave and Richard Rd	1.5	2.0	D	2.0	22,500	3.0	4.0	0.0	0.0	10.5	4	63
70	WR35	**S/M-RSS**	Re-profile the intersection of Florence Terrace and Elsie St	3.0	2.5	C	1.0	22,500	3.0	2.0	0.0	0.0	10.5	14	63
71	WR39	**S/M-RSS**	Install additional cross banks on upper Kevin St	3.0	4.5	E	1.0	15,000	2.0	4.0	0.0	0.0	13.5	15	118
72	WR41	**S/M-RSS**	Form a table drain on Florence Terrace immediately south of Pathilda Reserve	2.0	2.0	B	3.0	1,250	1.0	4.0	0.0	0.0	9.0	12	4
73	WR42	**S/M-RSS**	Re-profile Florence Terrace between Lowanna St and Elsie St to form infall drainage and form a table drain	3.0	2.0	C	3.0	7,500	2.0	2.0	0.0	0.0	9.0	13	4
74	WR43	**S/M-RSS**	Re-profile the intersection of Thompson St and Robertson Rd	3.0	2.0	A	1.0	22,500	3.0	2.0	0.0	0.0	10.0	7	22
75	WR45	**S/M-RSS**	Re-profile Richard Road west of the eastern creek crossing. Or otherwise, remove the concrete drain and form a new rock-lined table drain	3.0	2.0	E	1.0	30,000	3.0	2.0	0.0	0.0	10.0	3	22
76	WR46	**S/M-RSS**	Formalise a table drain along Florence Terrace north of Pathilda Reserve	2.0	2.0	B	1.0	3,750	1.0	4.0	0.0	0.0	9.0	12	4
77	WR47	**S/M-RSS**	Construct and stabilise a table drain along Thompson Street between Harold Av and Cecil St. Where necessary, install cross banks.	2.0	4.0	E	2.0	2,6250	3.0	4.0	0.0	0.0	13.0	8	111
78	WR48	**S/M-RSS**	Construct culvert under Thompson Road at creek crossing between Harold Av and Cecil St	3.0	4.0	E	6.0	6,250	2.0	4.0	0.0	0.0	13.0	8	111
79	WR51	**S/M-RSS**	Establish silt storage areas in Elizabeth Park or any other suitable location. Use these areas to store silt collected from table drain maintenance operations. Treat with gypsum and mix with organise to form a source of topsoil for the rehabilitation of road banks and table drains	2.0	6.0	B	1.0	7,500	2.0	6.0	0.0	0.0	16.0	15	133
80	WR53	**S/M-RSS**	Stabilise (rock line) the table drain in Thompson St south of Kevin Av	2.0	4.0	E	1.0	15,000	2.0	4.0	0.0	0.0	12.0	8	91
81	WR56	**S/M-RSS**	Direct flow off Thompson St down the unnamed (40ft wide) road reserve	3.0	4.0	G	3.0	2,750	1.0	4.0	0.0	0.0	12.0	9	91
82	WR57	**S/M-RSS**	Form a silt trap at base of eastern cutting on the Elizabeth Park track	1.0	6.0	A/E	9.9	303	1.0	6.0	0.0	0.0	14.0	15	126
83	WR61	**S/M-RSS**	Re-profile the bend on Richard Road north-west of Hilda Av	3.0	2.0	G	1.0	15,000	2.0	2.0	0.0	0.0	9.0	2	4
84	WR62	**S/M-RSS**	Fix the drainage on Richard Road opposite unnamed (40ft wide) road	3.0	2.0	G	1.0	30,000	3.0	4.0	0.0	0.0	12.0	1	91
85	WR63	**S/M-RSS**	Fix the drainage on Florence Terrace east of Pitt View St. Possible remove the concrete table drain and replace with a rock-lined drain set lower into the road profile	3.0	2.0	A	9.9	6,818	2.0	4.0	0.0	0.0	11.0	11	68
86	WR64	**S/M-RSS**	Duplicate the Catherine Park road culvert	3.0	2.0	A	9.9	4,545	1.0	4.0	0.0	0.0	10.0	15	22
87	WR67	**S/M-RSS**	Enlarge the detention basin upstream of the Catherine Park culvert	1.0	2.0	A	9.9	15,909	2.0	6.0	0.0	0.0	11.0	15	68
88	H5, S2 and W10	**L-RSS**	Convert Hilda Ave to a walking track only (ie no vehicular access) but leave as road reserve (incl drainage and surface stabilisation)	3.0	4.0	G	1.0	247,500	6.0	2.0	0.0	6.0	21.0	2	170
89	H7-1	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Florence Tce (incl guard rail and retaining structures)	4.0	2.0	B	1.0	191,250	5.0	2.0	0.0	6.0	19.0	14	152
90	H7-2 and S 15	**L-RSS**	Provide turning areas(ie hammer head or similar) at the "dead end" on Thompson Street (incl guard rail and retaining structures)	4.0	4.0	B	1.0	191,250	5.0	2.0	0.0	6.0	21.0	9	170

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91	S1	**L-RSS**	Construct retaining structures (gabion or similar) on steep road embankments along Richard Road north of the Unnamed Rd	4.0	2.0	G	1.0	337,500	6.0	2.0	0.0	6.0	20.0	1	161
92	S8	**L-RSS**	Provide turning area at end of Robertson Road (*ie chainage 1540*) and convert section of Thompson Rd to the east of its intersection with Robertson Road to a stabilised walking track. Provide barriers to prevent unauthorised vehicular access along Thompson Street to the west. Site Barriers up Thompson to ensure access to existing residential properties is maintained.	4.0	4.0	A	1.0	150,000	5.0	2.0	0.0	6.0	21.0	7	170
93	S9	**L-RSS**	Provide guard rail on Florence Tce at Pathilda Reserve and in the vicinity of Lowanna Street	5.0	2.0	BC	1.0	39,000	3.0	1.0	0.0	6.0	17.0	13	136
94	S10	**L-RSS**	Stabilise road surface (*ie flush seal*) and provide safety signs on sharp bends and steep sections of Florence Terrace	3.0	2.0	C	1.0	52,500	4.0	1.0	0.0	6.0	16.0	12	133
95	S11	**L-RSS**	Provide guard rail on steep down slope drop along Richard Road just north of the Unnamed Road	5.0	2.0	G	1.0	18,000	2.0	1.0	0.0	6.0	16.0	1	133
96	S14	**L-RSS**	Provide guard rail on steep down slope drop along Harold Avenue	5.0	4.0	D	1.0	27,000	3.0	1.0	0.0	6.0	19.0	4	152
97	S17-1	**L-RSS**	**Passing Bays Stage 1** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	5.0	4.0	All	1.0	90,000	4.0	1.5	0.0	6.0	20.5	2	162
98	S17-2	**L-RSS**	**Passing Bays Stage 2** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	5.0	4.0	All	1.0	90,000	4.0	1.5	0.0	6.0	20.5	5	162
99	S17-3	**L-RSS**	**Passing Bays Stage 3** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	5.0	4.0	All	1.0	90,000	4.0	1.5	0.0	6.0	20.5	6	162
100	S17-4	**L-RSS**	**Passing Bays Stage 4** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	5.0	4.0	All	1.0	90,000	4.0	1.5	0.0	6.0	20.5	12	162
101	S17-5	**L-RSS**	**Passing Bays Stage 5** - Incorporation of passing bays at regular intervals within the road reserve (all roads)	5.0	4.0	All	1.0	120,000	5.0	1.5	0.0	6.0	21.5	14	173
102	S20	**L-RSS**	Construct road embankment retaining structures on high side of Robertson Road at Fitzpatrick Avenue (*ie above walking track/future road*)	4.0	3.0	A	3.0	37,500	3.0	1.0	0.0	6.0	17.0	1	136
103	W1	**L-RSS**	Realignment of upper Fitzpatrick Avenue above Thompson Street because it is badly eroded and currently runs within private property	3.0	4.0	A	2.0	9,000	2.0	4.0	6.0	0.0	19.0	9	152
104	W3	**L-RSS**	Installation of cross banks on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street to divert runoff off away from the track	3.0	4.0	A	1.0	6,000	2.0	4.0	6.0	0.0	19.0	9	152
105	W7	**L-RSS**	Steps placed along the lower half of the Aoma Street walking track to provide all weather access	4.0	2.0	H	1.0	10,500	2.0	2.0	6.0	6.0	22.0	6	175
106	W8	**L-RSS**	Additional steps placed on the Fitzpatrick Avenue walking track between Robertson Road and Thompson Street possible between the existing rock steps	4.0	2.0	A	1.0	12,750	2.0	2.0	6.0	6.0	22.0	9	175
107	DL2-1	**L-RSS**	**Trunk Drainage Sector 1** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	G	5.0	30,000	3.0	2.0	0.0	0.0	9.0	1	4
108	DL2-2	**L-RSS**	**Trunk Drainage Sector 2** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	F	5.0	30,000	3.0	2.0	0.0	0.0	9.0	2	4
109	DL2-3	**L-RSS**	**Trunk Drainage Sector 3** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	E	5.0	30,000	3.0	2.0	0.0	0.0	9.0	3	4
110	DL2-4	**L-RSS**	**Trunk Drainage Sector 4** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	4.0	D	3.5	42,857	3.0	2.0	0.0	0.0	11.0	4	68
111	DL2-5	**L-RSS**	**Trunk Drainage Sector 5** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	4.0	B,C	3.0	50,000	3.0	2.0	0.0	0.0	11.0	5	68

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112	DL2-6	**L-RSS**	**Trunk Drainage Sector 6** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	3.0	H	3.5	42,857	3.0	2.0	0.0	0.0	10.0	6	22
113	DL2-7	**L-RSS**	**Trunk Drainage Sector 7**- Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	3.0	H	3.5	42,857	3.0	2.0	0.0	0.0	10.0	7	22
114	DL2-8	**L-RSS**	**Trunk Drainage Sector 8** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	4.5	E	2.5	60,000	4.0	2.0	0.0	0.0	12.5	8	107
115	DL2-9	**L-RSS**	**Trunk Drainage Sector 9** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	4.5	F	2.5	60,000	4.0	2.0	0.0	0.0	12.5	9	107
116	DL2-10	**L-RSS**	**Trunk Drainage Sector 10** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	3.0	A	0.5	300,000	6.0	2.0	0.0	0.0	13.0	10	111
117	DL2-11	**L-RSS**	**Trunk Drainage Sector 11** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	B	3.0	50,000	3.0	2.0	0.0	0.0	9.0	11	4
118	DL2-12	**L-RSS**	**Trunk Drainage Sector 12** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	B,C	3.0	50,000	3.0	2.0	0.0	0.0	9.0	12	4
119	DL2-13	**L-RSS**	**Trunk Drainage Sector 13** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	C	3.0	50,000	3.0	2.0	0.0	0.0	9.0	13	4
120	DL2-14	**L-RSS**	**Trunk Drainage Sector 14** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	C	6.0	25,000	3.0	2.0	0.0	0.0	9.0	14	4
121	DL2-15	**L-RSS**	**Trunk Drainage Sector 15** - Define and construct 100yr ARI capacity major trunk drainage routes for all major catchments. These are envisaged to consist of naturalistic rock lined creeks/overland flow channels (refer to Figure R12) in combination with culverts at all road crossings (refer to Figure R12)	2.0	2.0	A	3.0	50,000	3.0	2.0	0.0	0.0	9.0	15	4
122	DL3-1	**L-RSS**	**5yr ARI Piped Drainage Sector 1** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	G	5.0	16,500	2.0	3.0	0.0	0.0	10.0	1	22
123	DL3-2	**L-RSS**	**5yr ARI Piped Drainage Sector 2**-Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	F	5.0	16,500	2.0	3.0	0.0	0.0	10.0	2	22
124	DL3-3	**L-RSS**	**5yr ARI Piped Drainage Sector 3** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	E	5.0	16,500	2.0	3.0	0.0	0.0	10.0	3	22
125	DL3-4	**L-RSS**	**5yr ARI Piped Drainage Sector 4** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	4.0	D	3.5	23,571	3.0	3.0	0.0	0.0	13.0	4	111
126	DL3-5	**L-RSS**	5**yr ARI Piped Drainage Sector 5** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	4.0	B,C	3.0	27,500	3.0	3.0	0.0	0.0	13.0	5	111
127	DL3-6	**L-RSS**	5**yr ARI Piped Drainage Sector 6** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	3.0	H	3.5	23,571	3.0	3.0	0.0	0.0	12.0	6	91

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128	DL3-7	**L-RSS**	**5yr ARI Piped Drainage Sector 7** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	3.0	H	3.5	23,571	3.0	3.0	0.0	0.0	12.0	7	91
129	DL3-8	**L-RSS**	**5yr ARI Piped Drainage Sector 8** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	4.5	E	2.5	33,000	3.0	3.0	0.0	0.0	13.5	8	118
130	DL3-9	**L-RSS**	**5yr ARI Piped Drainage Sector 9** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	4.5	F	2.5	33,000	3.0	3.0	0.0	0.0	13.5	9	118
131	DL3-10	**L-RSS**	**5yr ARI Piped Drainage Sector 10** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	3.0	A	0.5	165,000	5.0	3.0	0.0	0.0	14.0	10	126
132	DL3-11	**L-RSS**	**5yr ARI Piped Drainage Sector 11** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	B	3.0	27,500	3.0	3.0	0.0	0.0	11.0	11	68
133	DL3-12	**L-RSS**	**5yr ARI Piped Drainage Sector 12** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	B,C	3.0	27,500	3.0	3.0	0.0	0.0	11.0	12	68
134	DL3-13	**L-RSS**	**5yr ARI Piped Drainage Sector 13** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	C	3.0	27,500	3.0	3.0	0.0	0.0	11.0	13	68
135	DL3-14	**L-RSS**	**5yr ARI Piped Drainage Sector 14** -Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	C	6.0	13,750	2.0	3.0	0.0	0.0	10.0	14	22
136	DL3-15	**L-RSS**	**5yr ARI Piped Drainage Sector 15-** Install 5yr ARI capacity minor piped drainage lines within the public roads/shareways feeding into all trunk drainage culverts (refer to Figure R13)	3.0	2.0	A	3.0	27,500	3.0	3.0	0.0	0.0	11.0	15	68
137	P1	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Robertson Road from intersection with Cargo Wharf Road/Fitzpatrick Ave between approx. chainages 840 and 880 (*refer to Figure R3 for road chainage details*)	2.5	2.0	G	1.0	216,000	6.0	2.0	0.0	6.0	18.5	1	141
138	P2 and S6	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Thompson Road from intersection with Kevin Ave between approx. chainages 0 and 35 (*refer to Figure R3 for road chainage details*)	2.5	4.0	A	1.0	126,000	5.0	2.0	0.0	6.0	19.5	5	157
139	P3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 130 and 250 (*refer to Figure R3 for road chainage details*)	2.5	4.0	B	4.0	108,000	5.0	2.0	0.0	6.0	19.5	5	157
140	P4	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 400 and 500 (*refer to Figure R3 for road chainage details*)	2.5	4.0	CD	4.0	90,000	4.0	2.0	0.0	6.0	18.5	4	141
141	P5 and S7	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 740 and 830 (*refer to Figure R3 for road chainage details*)	2.5	4.0	EF	3.0	108,000	5.0	2.0	0.0	6.0	19.5	8	157
142	P6 and S3	**L-RSS**	Construct rigid pavement *(or equivalent)*on steep section of Thompson Road between approx. chainages 940 and 1010 (*refer to Figure R3 for road chainage details*)	2.5	4.0	FG	3.0	84,000	4.0	2.0	0.0	6.0	18.5	9	141
143	P7	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Cecil Street	2.5	4.0	F	1.0	198,000	5.0	2.0	0.0	6.0	19.5	3	157
144	P8	**L-RSS**	Construct rigid pavement *(or equivalent)* for full length of Harold Ave and round the corner into the start of Richard Road	2.5	4.0	D	1.0	432,000	6.0	2.0	0.0	6.0	20.5	4	162
145	P9	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of Richard Road between approx. chainages 260 and 320 (*refer to Figure R3 for road chainage details*)	2.5	2.0	EF	2.0	108,000	5.0	2.0	0.0	6.0	17.5	3	139
146	P10 and S4	**L-RSS**	Construct rigid pavement *(or equivalent)* on steep section of fire trail extending from the end of Kevin Ave between approx. chainages 190 and 300 (*refer to Figure R3 for road chainage details*)	2.5	6.0	A	2.0	279,000	6.0	2.0	0.0	6.0	22.5	15	179

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				Enviro Imprv Rank	Loc. Rank	Catch. #	Catch. Area (ha)	Cost per Catchment Area ($/ha)	Cost Eff. Rank	Safe Rank	WT Rank	Drain Rank	Sub Total	Const Sector	Rank #
147	P12	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Pitt View Street	2.5	2.0	A	4.0	59,063	4.0	4.0	0.0	6.0	18.5	10	141
148	P13	**L-RSS**	Construct new/rehabilitate existing flexible pavement (*ie insitu profiled and stabilised basecourse over two coat flush seal*) for full length of Kevin Ave	2.5	4.0	A	4.0	78,750	4.0	4.0	0.0	6.0	20.5	15	162
149	P14-1	**L-RSS**	**Florence Pavement Sector 11**- construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	2.5	2.0	B	3.0	118,125	4.0	4.0	0.0	6.0	18.5	11	141
150	P14-2	**L-RSS**	**Florence Pavement Sector 12 (incl small sect 5)** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	2.5	2.0	B	3.0	118,125	4.0	4.0	0.0	6.0	18.5	12	141
151	P14-3	**L-RSS**	**Florence Pavement Sector 13** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	2.5	2.0	C	3.0	118,125	4.0	4.0	0.0	6.0	18.5	13	141
152	P14-4	**L-RSS**	**Florence Pavement Sector 14** - construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Florence Terrace (4 stages)	2.5	2.0	C	6.0	59,063	4.0	4.0	0.0	6.0	18.5	14	141
153	P15-1	**L-RSS**	**Richard Pavement Sector 1** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	2.5	2.0	G	5.0	81,900	4.0	4.0	0.0	6.0	18.5	1	141
154	P15-2	**L-RSS**	**Richard Pavement Sector 2** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	2.5	2.0	F	5.0	81,900	4.0	4.0	0.0	6.0	18.5	2	141
155	P15-3	**L-RSS**	**Richard Pavement Sector 3** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) for full length of Richard Road except at locations of proposed rigid pavement (refer to Measure P9) (3 stages)	2.5	2.0	E	5.0	81,900	4.0	4.0	0.0	6.0	18.5	3	141
156	P16-1	**L-RSS**	**Thompson Pavement Sector 5** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	2.5	4.0	B	3.0	128,625	5.0	4.0	0.0	6.0	21.5	5	173
157	P16-2	**L-RSS**	**Thompson Pavement Sector 8** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	2.5	4.5	E	2.5	154,350	5.0	4.0	0.0	6.0	22.0	8	175
158	P16-3	**L-RSS**	**Thompson Pavement Sector 9** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Thompson Street between chainages 0 and 1140 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measures P2 to P6) (3 stages)	2.5	4.5	F	2.5	154,350	5.0	4.0	0.0	6.0	22.0	9	175
159	P17-1	**L-RSS**	**Robertson Pavement Sector 6** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	2.5	3.0	G	3.5	101,250	5.0	4.0	0.0	6.0	20.5	6	162
160	P17-2	**L-RSS**	**Robertson Pavement Sector 7** - Construct new/rehabilitate existing flexible pavement (ie insitu profiled and stabilised basecourse over two coat flush seal) along Robertson Road between chainages 850 and 1340 (refer to Figure R3 for road chainage details) except at locations of proposed rigid pavement (refer to Measure P1) (3 stages)	2.5	3.0	H	3.5	101,250	5.0	4.0	0.0	6.0	20.5	7	162

No.	Measure No.	Type	Measure Description	Priority Ranking Elements											
				Enviro Imprv Rank	Loc. Rank	Catch. #	Catch. Area (ha)	Cost per Catchment Area ($/ha)	Cost Eff. Rank	Safe Rank	WT Rank	Drain Rank	Sub Total	Const Sector	Rank #
161	P21	**L-RSS**	Seal Steep section of Thompson Ch 1340-1540 (Flexible pavement). Convert upper section of Thompson Road to a walking track only (*ie close off to vehicles*). Maintain vehicular access to existing properties. Residents to construct private driveway access from end of Thompson turning head (refer to Measure S8 also)	2.5	4.0	A	2.0	157,500	5.0	2.0	6.0	6.0	25.5	7	180
162	P23	**L-RSS**	Provide new access ramp and associated laydown/pickup area for large construction/maintenance vehicles	4.0	2.0	G	5.7	52,632	4.0	3.0	0.0	6.0	19.0	1	152
163	SW6	**S/M-SWMS**	Temporarily stabilise Cecil Street if it has not been closed to traffic.	2.0	4.0	F	1.0	22,500	3.0	2.0	0.0	6.0	17.0	3	136
164	SW7	**S/M-SWMS**	Reform drainage on Hilda Avenue.	3.0	4.0	F	1.0	75,000	4.0	4.0	0.0	0.0	15.0	2	131
165	SW30	**S/M-SWMS**	Replace the stormwater grates on the Richard Road- Hilda Avenue intersection.	4.0	2.0	F	1.0	15,000	2.0	2.0	0.0	0.0	10.0	2	22
166	SWM7-1	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT1	1.0	2.0	B	6.8	27,574	3.0	6.0	0.0	0.0	12.0	5	91
167	SWM7-2	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT2	1.0	2.0	D	4.0	46,875	3.0	6.0	0.0	0.0	12.0	4	91
168	SWM7-3	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT3	1.0	2.0	E	7.0	26,786	3.0	6.0	0.0	0.0	12.0	3	91
169	SWM7-4	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT4	1.0	2.0	F	5.6	33,482	3.0	6.0	0.0	0.0	12.0	2	91
170	SWM7-5	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT5	1.0	2.0	FG	11.2	16,741	2.0	6.0	0.0	0.0	11.0	2	68
171	SWM7-6	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7 - GPT6	1.0	2.0	G	5.7	32,895	3.0	6.0	0.0	0.0	12.0	1	91
172	SWM7-7	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS1	1.0	2.0	B	6.8	5,294	2.0	6.0	0.0	0.0	11.0	11	68
173	SWM7-8	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS2	1.0	2.0	B	6.8	6,353	2.0	6.0	0.0	0.0	11.0	11	68
174	SWM7-9	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS3	1.0	2.0	C	6.7	4,836	1.0	6.0	0.0	0.0	10.0	12	22
175	SWM7-10	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS4	1.0	2.0	C	6.7	4,299	1.0	6.0	0.0	0.0	10.0	13	22
176	SWM7-11	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS5	1.0	2.0	E	7.0	2,571	1.0	6.0	0.0	0.0	10.0	3	22
177	SWM7-12	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS6	1.0	2.0	F	5.6	5,786	2.0	6.0	0.0	0.0	11.0	2	68
178	SWM7-13	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS7	1.0	2.0	FG	11.1	3,568	1.0	6.0	0.0	0.0	10.0	2	22
179	SWM7-14	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS8	1.0	2.0	G	5.7	4,421	1.0	6.0	0.0	0.0	10.0	1	22
180	SWM7-15	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS9	1.0	2.0	H	6.9	3,391	1.0	6.0	0.0	0.0	10.0	6	22
181	SWM7-16	**L-SWMS**	Implement public stormwater treatment measures as illustrated in Figure S7- BRS10	1.0	2.0	A	9.8	2,388	1.0	6.0	0.0	0.0	10.0	15	22