Proposed Residential Development
Avon Road, Pymble

Project Application (MP 10_0219)

Stormwater Management and Riparian Aspects

Prepared for Ausbao Pty Ltd

December 2015
Job No. 2514

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Executive Summary

The Report forms part of the Land and Environment Court of NSW (L&E Court) Proceedings No.10834 of 2013. The proceedings relate to the refusal by the Planning Assessment Commission (PAC), as delegate of the Minister for Planning (Minister), of the Major Project Application (MP 10_0219) for a multi-unit residential development at 1, 1A & 5 Avon Road and 4 & 8 Beechworth Road, Pymble (Site).

On 5 December 2014, the Land and Environment Court ordered that a Concept Plan approval be issued in respect of the development of the Site, and the PAC issued the Concept Plan Approval on 19 December 2014. The proceedings No.10834 of 2013 relating to the Major Project Application were stood over following the Court's order regarding the Concept Plan and the PAC's subsequent issue of the Concept Plan Approval.

The report addresses the revisions to the Major Project Application as a consequence of the terms of the Concept Plan Approval.

The proposed residential development is located on a site fronting Avon and Beechworth Roads in Pymble and includes three apartment buildings and four freestanding residences.

NPC was engaged by Ausbao Pty Ltd to address the stormwater related issues, to prepare a Stormwater Drainage Concept Plan and a Soil and Erosion Control Plan and to address the riparian issues associated with the site. These details have been prepared in a manner to avoid any significant changes to the Stormwater Drainage Concept Plan (refer Appendix A) approved in the Concept Plan Approval (MP 10_0207). Mark Tooker has prepared this report.

The existing site encompasses part of a heavily weed infested valley bounded to the north by the North Shore rail line and with access from both Avon and Beechworth Roads (refer Figure 2). It slopes steeply down to the south over the upper third of the site with the lower two thirds of the site relatively flat. At the southern boundary, there are two rows of houses with access to Arilla Road.

The site is located near to the top of the catchment. Runoff flows onto the site from the north are controlled by the rail line embankment and a 900mm diameter pipe culvert through the embankment. At the site's southern boundary, flows enter a culvert and are directed to the culvert under Arilla Road to discharge to a stream downstream of Arilla Road.

The proposed development consists of three apartment buildings and four freestanding residences located as shown on Figure 3. Other than Building 3, the buildings are located a significant height above the drainage line through the site. A best practice Water Sensitive Urban Design (WSUD) approach has been adopted in the formulation of the water management for the development. The Stormwater Drainage Concept Plan has been derived incorporating WSUD features and formulated in concert with the Landscape Plan in order to create a natural environment along the drainage line through the site which uses water and vegetation to enhance habitats and water quality. This will form an environment which will contribute to the long term improvement in water quality and environmental quality of the

streams downstream of the site. It will also provide a significant passive recreational feature for the local residents.

The proposed Stormwater Drainage Concept Plan (refer Figure 6) would incorporate the following WSUD features and achieve the following results:

1. Roof runoff capture in rainwater tanks and reuse – this will reduce the runoff volumes, runoff pollutant load and potable water usage;
2. Inclusion of water saving appliances within the buildings;
3. Detention of runoff from impermeable surfaces to ensure peak flow rates remain at existing levels and do not impact the flooding behaviour on adjacent properties;
4. Incorporation of erosion and sediment control features during the construction stage as proposed in the Erosion and Sediment Control Plan;
5. Treatment of runoff in the post development stage to maintain pollutant loads at or below existing levels as proposed in the Stormwater Drainage Concept Plan;
6. Enhancement of the blue gum forest and habitat, stabilisation of surfaces and improvement in runoff water quality along the watercourse; and
7. Use of endemic vegetation in landscaping to reduce water demand.

Based on the NSW Office of Water policy, as the drainage line through the site is not shown as a blue line on the 1:25,000 Topographic Map for the area (refer Figure 4), it is not defined as a river under the Water Management Act 2000 and does not require a riparian corridor. A detailed site inspection has confirmed that the drainage line is not a river. Notwithstanding this, the proposed Landscape Plan demonstrates significant works will be undertaken to re establish the Blue Gum forest and understorey along with natural features to embellish the habitat quality (both terrestrial and aquatic). It will create a significant endemic bushland corridor through the site to the benefit of the environment and local residents.

As this drainage line does not have banks and is not classified as a river, the Ku ring gai Council's Category 3 classification of the drainage line in its Riparian Policy is not considered appropriate. Notwithstanding this, the Landscape Plan proposes works which meet the objectives of Council's Riparian Policy for such a Category 3 stream and would create a significant bushland corridor through the site.

A Sediment and Erosion Control Plan has been formulated for the construction phase of the project to control the quality of runoff from the site (refer Figure 7). This plan has been designed based on the industry best practice "Blue Book" guidelines.

The proposed stormwater management for the proposed development in the Revised Concept Plan Proposal conforms to the requirements of the Ku ring gai Council Water Management Development Control Plan – DCP 47 and the Riparian Policy.

1. Introduction

The Report forms part of the Land and Environment Court of NSW (L&E Court) Proceedings No.10834 of 2013. The proceedings relate to the refusal by the Planning Assessment Commission (PAC), as delegate of the Minister for Planning (Minister), of the Major Project Application (MP 10_0219) for a multi-unit residential development at 1, 1A & 5 Avon Road and 4 & 8 Beechworth Road, Pymble (Site).

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The report addresses the revisions to the Major Project Application as a consequence of the terms of the Concept Plan Approval.

NPC has been engaged by Ausbao Pty Ltd to address the stormwater related issues, to prepare a Stormwater Drainage Concept Plan and Erosion and Sediment Control Plan. These details have been prepared in a manner to avoid any significant changes to the Stormwater Drainage Concept Plan (refer to Appendix A) approved in the Concept Plan Approval (MP 10_0207). Mark Tooker has prepared this report.

The latest development plans are nominated as Issue U. The development plans from previous issues have been used as bases for the proposed stormwater pipe and tank plan details. I have reviewed these base plans and confirmed that the proposed development footprint and levels have not changed significantly in the Issue U plans. As such, all the stormwater and related details for the site provided in this report are relevant and accurate to the Issue U plans.

This report deals with the following issues:

1. Water sensitive urban design;
2. Riparian issues;
3. Flooding and minimum habitable floor levels;
4. Stormwater detention;
5. Stormwater water quality measures; and
6. Rainwater reuse.

2. Existing Site

The site has an area of approximately 2.4ha and is generally a T plan shape with the northern boundary adjacent to the North Shore rail line and accesses to both Avon and Beechworth Roads. The site is in the general form of a valley extending from the rail line in the north southwards to backing onto two rows of existing residential properties with frontage and access to Arilla Road (refer to the survey plan at Figure 1).

The site is sited near the top end of the catchment. The catchment which encompasses the site extends to the ridge line which is the Pacific Highway just to the north of the site. The catchment above the site has a small area of approximately 4.9 ha.

Stormwater runoff from the upstream catchment flows onto the site from a 900mm diameter pipe culvert located under the rail corridor. It appears that this pipe was not located in the original low point at the top end of the site nor aligned to the low point. As such, these flows have eroded this area at the top end of the site.

The site falls north to south with the upper third of the site being relatively steep leading to a generally lower slope over the lower two thirds of the site. There is evidence of formal gardens and a tennis court in these lower areas of the site especially on the eastern side.

The site is heavily overgrown with weeds hiding what was once a Blue Gum forest (Figure 2).

A house has been recently constructed adjacent to the southern boundary of the site which is a battleaxe lot with access to Arilla Road. At the site southern boundary, there is a drainage culvert leading along the driveway of this battleaxe block to the culvert under Arilla Road. The culvert is approximately 0.7m high and 1.2m wide. There is an overland flow route over the top of the culvert along the driveway of this property leading to Arilla Road.

3. Proposed Development

The proposed development consists of three apartment buildings and four houses as depicted on Figure 3. The existing heritage building in the north eastern corner of the site will be retained.

Building 1 is an apartment building which has a frontage to Avon Road. Runoff from this building will, after reuse, detention and treatment, discharge to the drainage line through the site.

Building 3 is located west of Building 1 and would have a minimum ground floor level of RL 125.7m AHD. This building is adjacent to the drainage line and will need to have a minimum freeboard of 500mm from the habitable floor level to the 100 year ARI flood level at this section of the site. Drainage from the building would discharge to the watercourse after reuse and detention.

Building 4 is located in the north eastern section of the property. Its proposed ground floor level is RL 135m AHD. It is located considerably above the drainage line through the centre of the site. Drainage from this building will discharge to the drainage line on the site after part of it is reused from the rainwater tanks, and all discharges would be detained prior to discharge.

Four freestanding houses would be located in the north western portion of the site with driveway access to Beechworth Road. Drainage from these houses will discharge to the drainage line on the site after part of it is reused prior to discharge. The proposed ground floor levels for these houses would be considerably above the drainage line.

The Landscape Plan for the development has been formulated in workshop with the ecologist, bushfire, arborist and hydrologist specialists to create a natural and stable environment which maximises the ecological and water sensitive design outcomes as well as being an attractive area for passive recreation. The proposed drainage system including drainage lines has been located so as to avoid impact on native trees identified for retention. Small construction equipment would be used to install the drainage pipes and house sewer lines to minimise site disturbance. The anticipated drainage and house sewer line pipe diameters are shown in Figure 8.

The Landscape Plan would involve clearing all the weeds and regeneration of the Blue Gum High Forest understorey to stabilise the valley floor. The steep upper third of the site would incorporate an intermittent cascading pool system in the drainage line to slow down the runoff and create aquatic habitat features with native macrophyte planting to improve water quality. The lower two thirds of the site would incorporate a vegetated drainage line to further enhance the diversity of habitat and water quality treatment. The ephemeral wetland would be designed as a wet and dry feature to accommodate variations in rainfall patterns. The Landscape Plan would provide a valuable environmental outcome for this valley and the local residents.

4. Water Sensitive Urban Design

A water sensitive urban design (WSUD) approach has been adopted for all elements of the project. Within the area of stormwater management, the proposed WSUD features include:

1. Roof runoff capture in rainwater tanks and reuse – this will reduce the runoff volumes, runoff pollutant load and potable water usage;
2. Detention of runoff from impermeable surfaces to ensure peak flow rates remain at existing levels and do not impact flooding behaviour on adjacent properties;
3. Incorporation of erosion and sediment control features during the construction stage as proposed in the Erosion and Sediment Control Plan;
4. Treatment of runoff in the post development stage to maintain pollutant loads at or below existing levels as proposed in the Stormwater Drainage Concept Plan;
5. Enhancement of the blue gum forest and habitat, stabilisation of surfaces and improvement in runoff water quality along the drainage line; and
6. Use of endemic vegetation in landscaping to reduce water demand.

Detailed hydrologic and hydraulic modelling was undertaken by CivilCert to determine the quantitative controls required for this development to achieve the above objectives. The results are presented in Appendix B.

5. Riparian Issues

On the 1 July, 2012, the NSW Office of Water (NOW) introduced new procedures for identifying waterfront land under the Water Management Act 2000. Waterfront land identifies where controlled activities occur under this Act. This applies to riparian corridors.

The NOW specifies the need for a vegetated riparian corridor for the "rivers" shown as blue lines on the 1:25,000 topographic maps. The widths of the corridor vary according to the stream order as classified under the Strahler System.

The 1:25,000 topographic map covering the subject site (refer Figure 4) shows a blue line starting downstream of the culvert under Arilla Road south of the site. There is no blue line shown on the site. The blue line starts about 70m south of the site and heads downstream (further south). As such, no riparian corridor is required on the site. Also, no approval is required under the Water Management Act 2000 for works in the drainage line.

A detailed site inspection was undertaken of the drainage line to ascertain its classification as a "river" under the Water Management Act 2000. This inspection identified that the drainage line was heavily modified due to weed invasion and the concentration of flows from the upstream urban catchment at the pipe culvert under the railway corridor. Due to the limited upstream catchment of 5 ha, the drainage corridor does not exhibit bank features other than at the railway culvert outlet which because of its concentration of flows and its location away from the natural low point has eroded a small area around the pipe culvert outlet. This is a limited and obviously not a natural feature. In the lower two thirds of the site there is a broad area through which the flows pass. The site inspection confirmed that a riparian corridor was not required through the site.

The Landscape Plan indicates that the removal of the weeds and embellishment of the Blue Gum forest understorey with endemic species will create a broad vegetated corridor with sympathetic treatment of the drainage line which will provide significant improvements in the flora and fauna habitats of this area for the local residents to enjoy. The width of this corridor would vary from about 30m to 55m wide.

Ku ring gai Council formulated their Riparian Policy in 2003 and 2004. The policy aims to ensure the long term viability and sustainability of the creeks and riparian zones. Under this policy, the Council categorised its creeks into three categories and specifies riparian corridor widths measured from the top of bank. For the site, the Council has nominated it as the lowest importance category – Category 3. This category is primarily concerned with providing basic bank stability and protection and enhancement of water quality. The nominated riparian corridor width is 10m from top of bank on each side with no buffer width requirement.

The drainage line on the site does not have banks and as such, the policy is not relevant to the site. However, the outcomes of the proposed development as demonstrated through the Landscape Plan and the WSUD features would mean that the Council's Riparian Policy objectives for a Category 3 watercourse would be satisfied in any case.

The objectives of the Category 3 watercourses in Council's policy are:

- Providing bank protection and bed stability;
- Protecting water quality;
- Protecting native vegetation; and
- Protecting in stream aquatic vegetation.

Council suggests that these objectives be achieved by:

- Emulating where possible a naturally functioning stream;
- Ensuring channel stability;
- Protecting the natural values within the channel;
- Providing lateral connectivity for in-stream function;
- Using pipes or other engineering devices as a last resort; and
- Ensuring all stormwater discharge is treated before it enters the stream.

The development proposes to reduce the runoff volume from the site as well as detain and treat runoff to control peak flow rates and pollutant load. The Landscape Plan demonstrates that the drainage line will have a natural and stable form with significant enhancement of flora and fauna habitats. The width of landscaping corridor through the site will vary from 30m to 55m which is very generous for a site at the top end of a catchment.

It is therefore considered that the proposed development readily achieves the objectives of Council's Riparian Policy even though this Policy and the Water Management Act are not relevant to the site.

6. Flooding

6.1 Flood Levels

Hydrological and hydraulic modelling was undertaken for the site to determine the 100 year ARI and Probably Maximum Flood (PMF) levels for the site. Flows through the site are unconstrained for the upper third of the site as there are no obstructions to flows. Also, the buildings in line within this section of the site are elevated a significant distance above the drainage line and would be unaffected by flood flows. The 100 year ARI flows are typically 0.5m deep along the drainage line.

At the lower end of the site, the Council culvert at the southern boundary has sufficient capacity for the 100 year ARI floods. However, when partially blocked, this restricted capacity would cause floodwaters to backup behind the culvert until flows can overtop it and flow overland down the driveway to Arilla Road.

The 100 year ARI flood extents on the site are presented in Figure 5.

In the post development conditions, an ephemeral wetland is proposed near to Building 3. This wetland would be dry most of the time but would temporarily store runoff during rainfall events. It would have stepped water levels during wet weather with the upstream weir crest level at RL 125.0m AHD and the lower weir crest at RL 123.0m AHD. The predicted post development 100yr flood levels in this area as they relate to Building 3 assuming a 50% blockage of the culvert downstream of the site would be:

Upstream basin	RL 125.2m AHD
Downstream basin	RL 123.3m AHD

The 100 year ARI flood level is the flood standard for setting minimum habitable floor levels with the addition of a minimum freeboard of 500mm. The minimum habitable floor level set for Building 3 is RL 125.7 m AHD which satisfies the flood freeboard requirements at the proposed wetlands.

The PMF flood level is used to assess the risk to personal safety in an extreme flood event (it is not used to set floor levels). The PMF flood levels for the ephemeral wetlands are predicted to be:-

Upstream wetland	RL 125.5m AHD
Downstream wetland	RL 123.7m AHD

All residents and habitable floors will be above the PMF level and as such, are not posed with significant risk to personal safety. Also, emergency vehicles could access all buildings along driveways unaffected during a PMF event.

6.2 Climate Change Impact on Flood Levels

It is predicted that climate change has the potential to cause decreases and increases in the long term rainfall intensities in Sydney. These changes could lead to decreases or increases in flood levels in Sydney. Given the uncertainty of the extent of this change, it was recommended that sensitivity testing be undertaken to assess the possible extent of increase in 100 year ARI flood levels due to an anticipated increase in rainfall intensity.

The flood modelling was undertaken with a 15% increase in rainfall intensity and the 100 year ARI flood levels at Building 3 would increase by around 20mm.

Even with this increase in rainfall intensity, the proposed minimum habitable floor level in Building 3 is still 500mm above the predicted 100 year ARI flood level. As such, the proposed minimum floor level has an appropriate freeboard to minimise the potential for flood damages even in the event climate change increases rainfall intensities. Therefore, the development conforms to the NSW Floodplain Management Manual.

7. Stormwater Peak Flows

Development without suitable controls can lead to higher peak flows and velocities leading to erosion of drainage lines and watercourses and possible increased flood levels on adjacent properties downstream. The objective in development is to ensure that runoff from the site is maintained at or below the existing peak flows. This is typically achieved by detaining flows and releasing them at or below existing peak flow rates. Hydrologic modelling is undertaken to determine the detention storage volume required to achieve this objective.

All runoff from the driveways and paved areas of the development will be directed to stormwater detention tanks (refer to the Stormwater Drainage Concept Plan at Figure 6). Runoff from the building roofs will be firstly directed to rainwater tanks and then if necessary to detention tanks. The rainwater tanks will trap some of the runoff and effectively reduce flows in the low severity storms. In larger storms, this effect is less as the rainwater tanks would fill readily and then flows would bypass the tanks. Ku ring gai Council permits 25% of the rainwater tank volume to be counted as detention storage for this reason.

Council's DCP 47 stipulates a detention requirement for approximately 557m³ of storage. Each apartment building would have detention storage of 170.3m³ and a rainwater tank volume of 20m³ (20 kL). The four residences and heritage building would each have a rainwater tank volume of 5m³ (5kL) and a detention storage of $5m^3$ (5kL). An allowance for 25% of the rainwater tank volume (85m³) would provide 21m³ of detention storage. The combination of rainwater and detention storage would provide the required detention storage of 557m³. This conforms to the Ku ring gai Council's requirements in the Water Management Development Control Plan – DCP 47. Details of the tanks are provided in Figures 9-16. The tanks for the heritage building would be located underneath the elevated walkway on the eastern side of the building and would be screened with vegetation.

The detailed hydrologic and hydraulic modelling is detailed in Appendix B. The invert levels and top water levels in the OSD tanks are:

- House 1 invert level RL 153.2 TWL RL 154.2
- House 2 RL 144.5 RL 145.5
- House 3 RL 144.5 RL 145.5
- House 4 RL 144.5 RL 145.5
- Building 1 RL 124.1 RL 125.4
- Building 3 RL 124.3 RL 125.4
- Building 4 RL 129.9 RL 131.6
- Heritage House RL143.9 RL 144.9

The runoff from the buildings up to the 50 year ARI storm would be piped from the detention basin to the drainage line through the site to a scour protected outlet designed to complement the flora and habitat goals of the Landscape Plan. The alignment and sizes of the pipe drainage and house sewer lines are depicted on Figure 8. The alignments have been selected to minimise the impact on existing valuable trees. The area between the proposed buildings and the stormwater drainage line outlet would be

stabilised with vegetation as detailed in the Landscape Plan such that overland flows from the development would not cause erosion and deposition in the rehabilitated drainage line.

Ku ring gai Council adopted in April 2005 the Water Management Development Control Plan – DCP 47. Under this plan the proposed development is categorised as a Type 5 development in a Location B which discharges directly to a natural waterbody. The proposed management of peak runoff flows for the subject development conform to the requirements of DCP 47.

8. Stormwater Water Quality

The management of stormwater runoff water quality covers two phases:

- During construction; and
- Post development.

8.1 During Construction

The objectives during construction are to minimise the erosion caused by runoff over the site and maximise the sediment and pollutant control on the site, thereby minimising the sediment load and any pollutant load in runoff which discharges off the site. The controls proposed on the subject site conform to the industry best practice guidelines in the "Blue Book".

The main principles of erosion and sediment control are to:

- Minimise the extent of site disturbance;
- Rapidly stabilise disturbed areas;
- Divert clean runoff around work areas; and
- Trap eroded sediment prior to discharging to a drainage line or natural waterbody.

The proposed Erosion and Sediment Control Plan for the site is detailed in Figure 7. The detailed calculations for this plan are presented in Appendix B.

The Plan conforms to the requirements of the Ku ring gai Council Water Management DCP 47.

8.2 Post Development

Stormwater runoff from development sites typically contain elevated levels of suspended solids, nutrients and debris/trash and can contribute to the pollution of receiving waters. Industry best practice in urban development is to introduce WSUD features in the development which reduce the runoff annual pollutant load by the following percentages:

- Gross pollutants 90%
- Total suspended solids 80%
- Total phosphorus 60%
- Total nitrogen 45%

The WSUD features proposed for the subject development to achieve these reductions in runoff pollutant loads are:

- Litter baskets in all drainage inlet pits;
- 20 kL rainwater tank in each apartment building and 5kL for each house for reuse of roof runoff;
- 170.3 m3 detention tank in each apartment building;
- 5m3 detention tank in each house;
- Water efficient fittings in the buildings to minimise potable water use;
- 550 m2 surface area of an ephemeral wetland;
- Use of vegetation to stabilise the site; and
- Vegetation along the drainage line through the site to provide habitat and remove pollutants.

The location of these proposed controls are presented on Figure 6. The locations of the OSD and rainwater tanks are depicted on Figures 9 - 14. Tank cross sections are provided in Figures 15 and 16. Typical cross sections of the ephemeral wetlands and pool and riffles features are presented on Figure 17.

The proposed runoff water quality control system was modelled using the industry best practice program MUSIC and the pollutant reductions achieved would be:

- Gross pollutants 99%
- Total suspended solids 95%
- Total phosphorus 61%
- Total nitrogen 82%

This exceeds the industry best practice requirements for runoff water quality control.

The requirements of the Ku ring gai Council DCP 47 are less than the adopted standards and as such, the proposed runoff water quality controls for the development readily exceed the Council requirements.

9. Stormwater Drainage Concept Plan

Rainfall and runoff on the proposed development would be managed in a pipe system for storms up to a 50 year ARI event and then as overland flow for storms of greater severity. The stormwater drainage system will also include a range of water sensitive urban design features to ensure that rainwater is reused, peak flows are not increased above existing rates, runoff pollutant loads are reduced substantially and that runoff from the site can contribute to the long term improvement in water quality in the natural streams downstream of the site. The details of this WSUD system is presented in the Stormwater Drainage Concept Plan (refer Figure 6).

The Stormwater Drainage Concept Plan is complemented by the Landscape Plan which removes the extensive weeds, embellishes the Blue Gum Forest and understorey and establishes habitat for a range of fauna. The Plan uses natural features such as pools, vegetation and an ephemeral wetland (similar to works in Sheldon Forest) to slow flows and improve the water quality of flows from areas upstream of the site. This would further enhance the habitat quality through the site as well as contribute to the long term improvement in water quality in streams downstream of the site. This enhanced natural valley forest setting can then be an important component of the local environment to be enjoyed by the local residents.

A maintenance regime would be implemented for all the proposed stormwater pipe and treatment infrastructure which would be the responsibility of the body corporate. This would comprise:

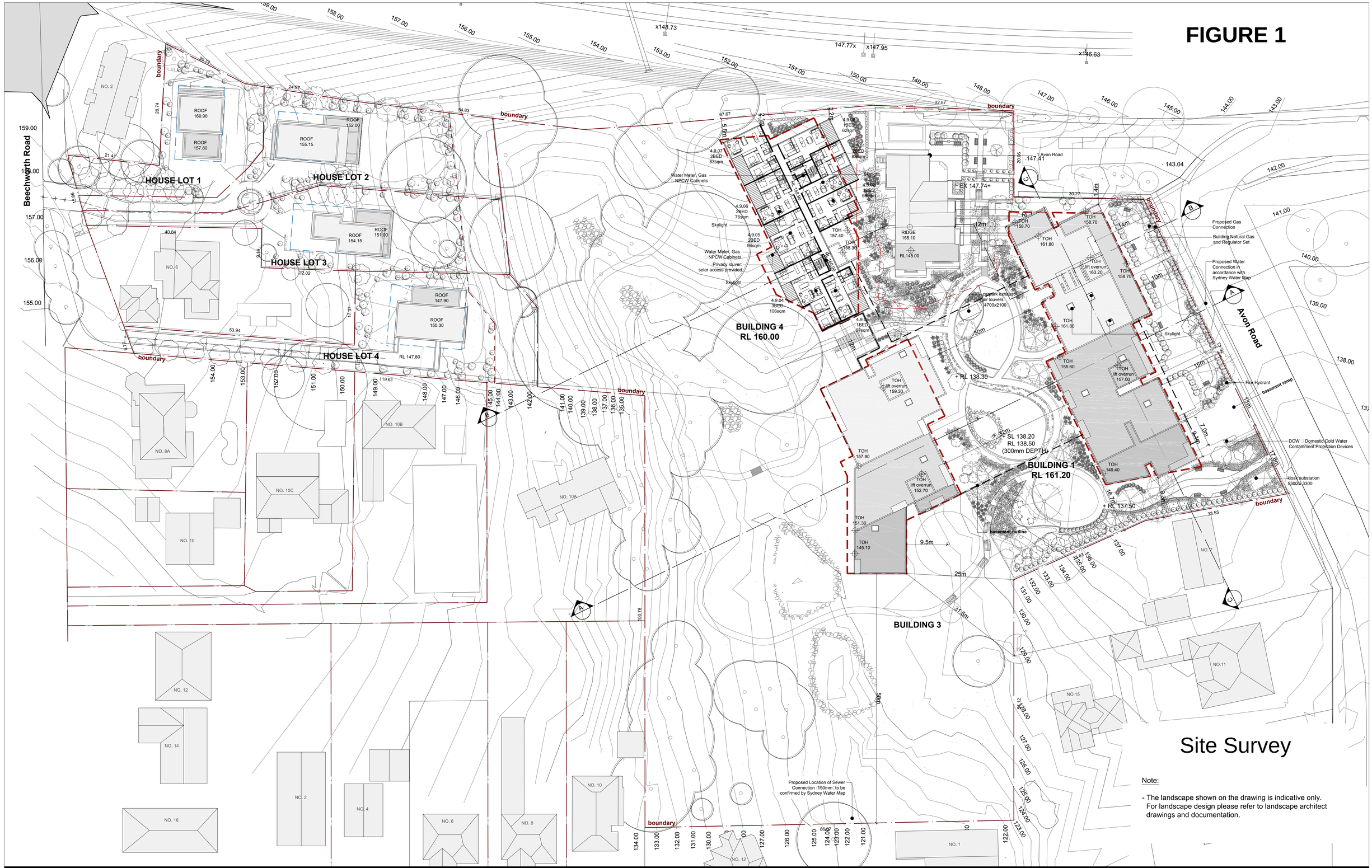
- Periodic (6 monthly) inspection and removal of any gross pollutants or coarse sediment that is deposited in the stormwater pipe system and ephemeral wetland;
- Periodic (3 monthly) and episodic (post severe storms) inspection and if required, removal of trapped pollutants from the litter baskets; and
- Periodic (annually) inspection of the rainwater tanks.

The drainage pipe and house sewer lines have been located to avoid significant impact on the trees (refer Figure 8). The drainage pipes will range in size from 225mm up to 375mm PVC as depicted on Figure 8. The house sewer lines will be 90mm PVC pipes. The drainage pipe outlets will be designed to NSW Office of Water guidelines and include rock scour protection. The average size of these rocks will be about 200mm for outlet 2 (refer Figure 8 for location), 250mm for outlet 4 and 450mm for outlets 1 and 3. The area of rocks for the scour protection will be about 1.5m x1.5m for outlets 2 and 4 and about 3mx3m for outlets 1 and 3. Vegetation would be planted among the rock areas. The location and dimensions of the OSD tanks are depicted on Figures 9-16.

The ephemeral wetlands would have leaky embankment walls formed with rectangular blocks that would be stacked to form a wall and locked/embedded into an excavated slot across the drainage line. These blocks would be sized to enable small construction equipment to deliver and place them across the drainage line. Rock scour protection would be located immediately downstream of the walls with rocks similar sizes to the drainage outlets. Vegetation would also be planted over these rock areas. The area upstream of the walls would be sculptured to form the ephemeral wetland and storage area.

FIGURES

FIGURE 1



Site Survey

Note:

- The landscape shown on the drawing is indicative only. For landscape design please refer to landscape architect drawings and documentation.

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P	27.11.27	APPROVED BY LEC	PS
Q	27.02.15	FOR SECTION 34 CONFERENCE	PS
S	04.05.15	SUBMISSION TO LEC	PS
T	31.07.15	SUBMISSION TO LEC	PS

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CLIENT: Ausbao, pwc

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT AVON ROAD, PYMBLE

DRAWING TITLE: FLOOR PLAN LEVEL RL+159

SCALE	DATE	DRAWN	CHECKED
1:400 @ A1 1:800 @ A3	01.11.2012		

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12009	MP 22.14	T

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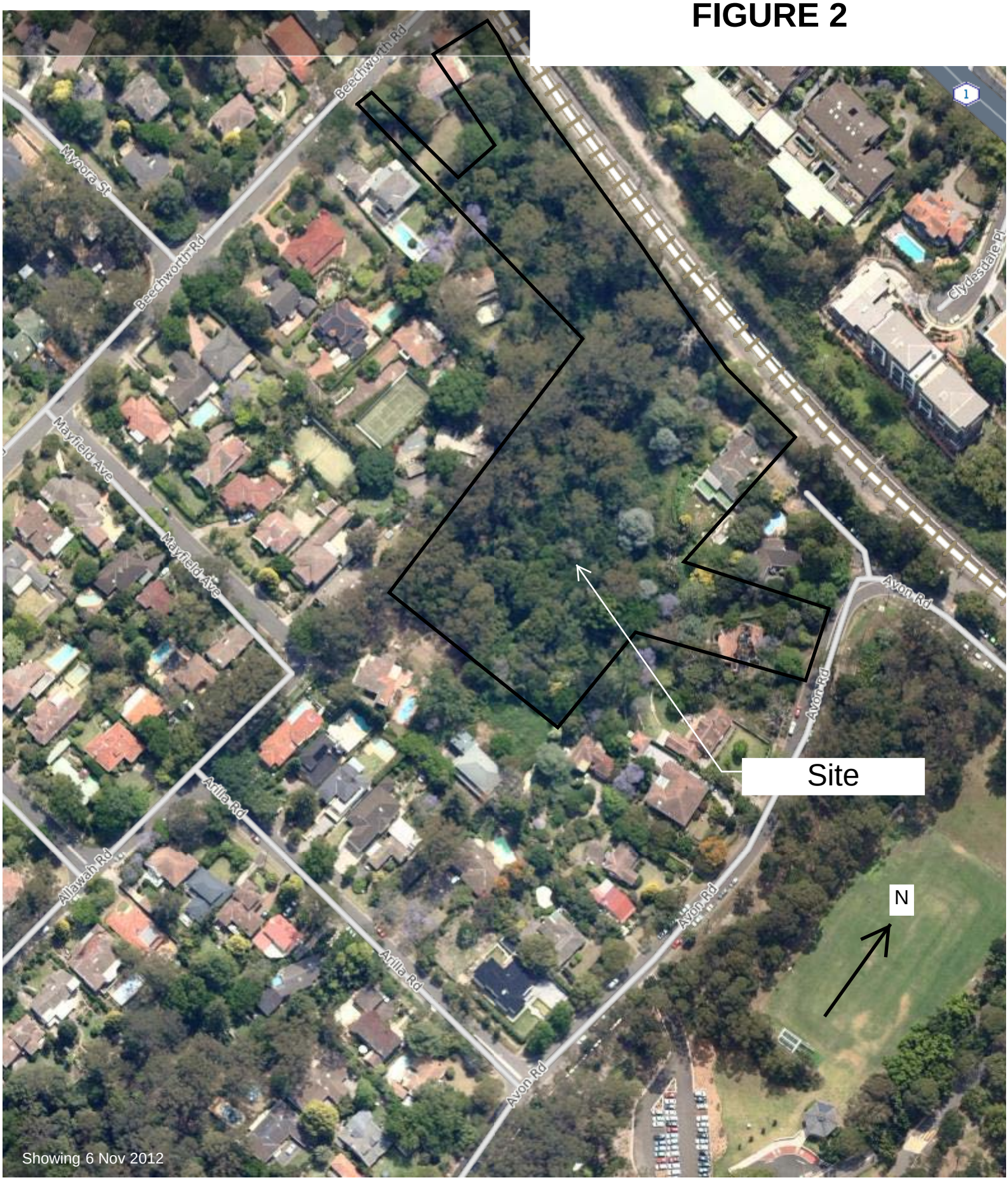
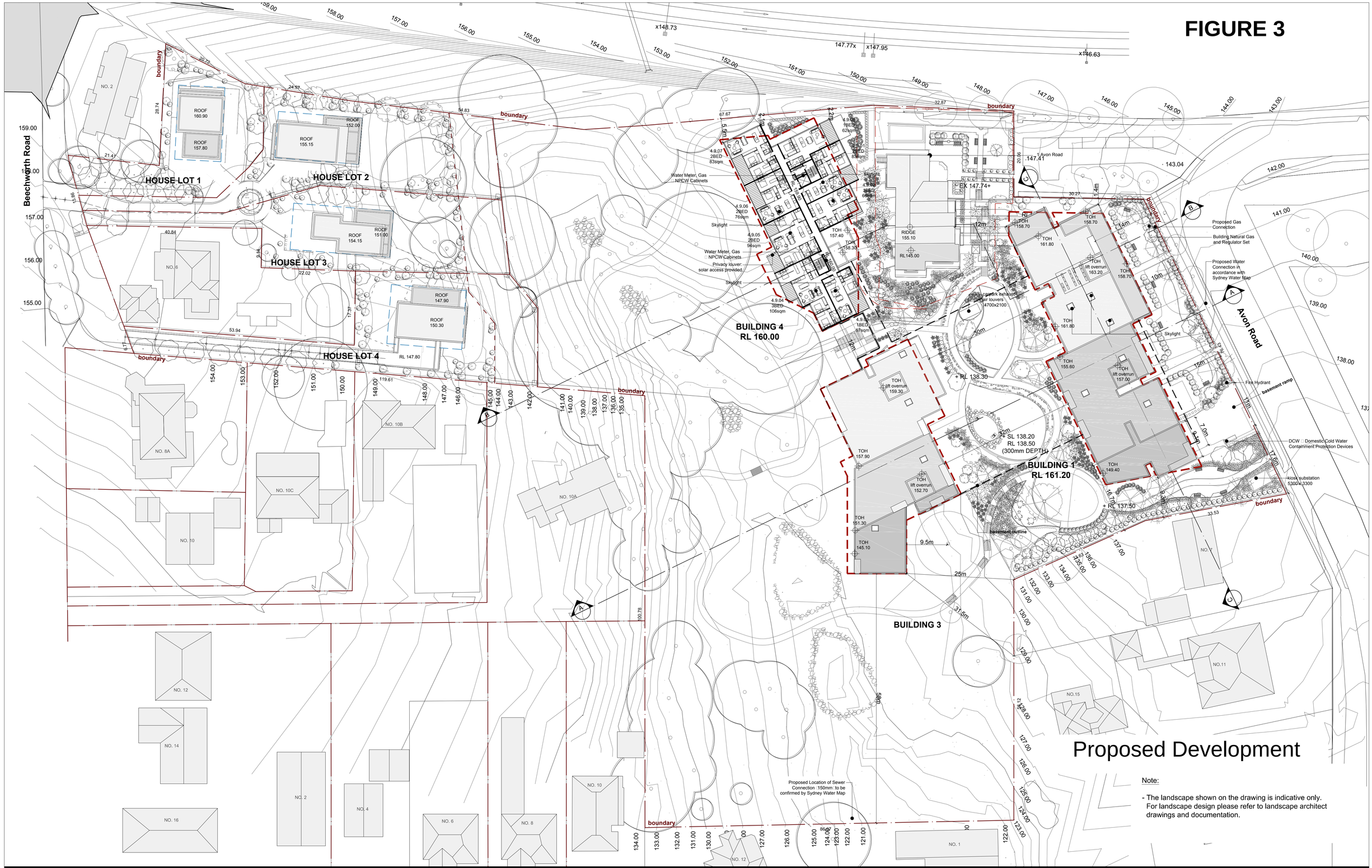
FIGURE 2



EXISTING SITE

FIGURE 3



Proposed Development

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PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT AVON ROAD, PYMBLE

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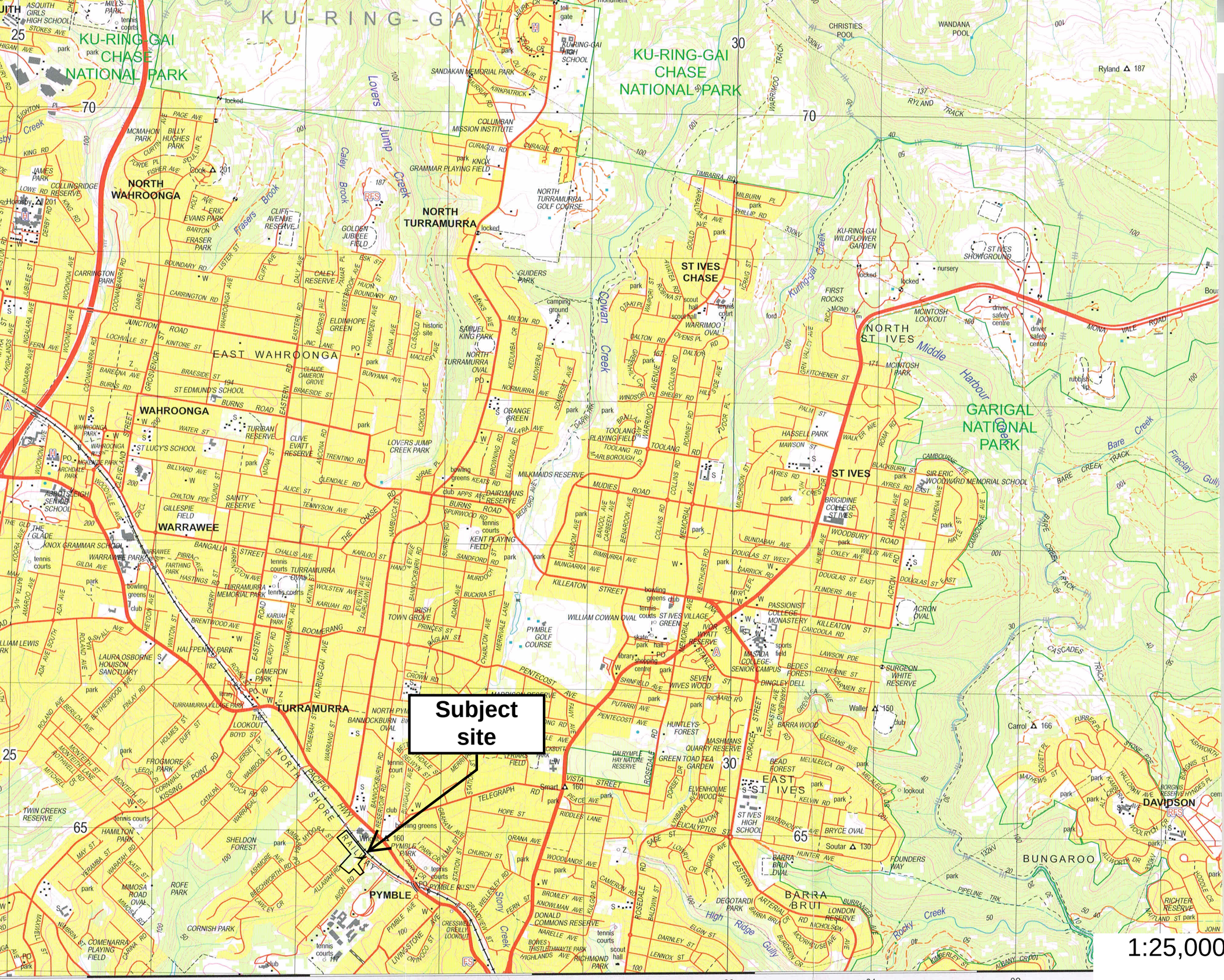
12009	MP 22.14	T

FIGURE 4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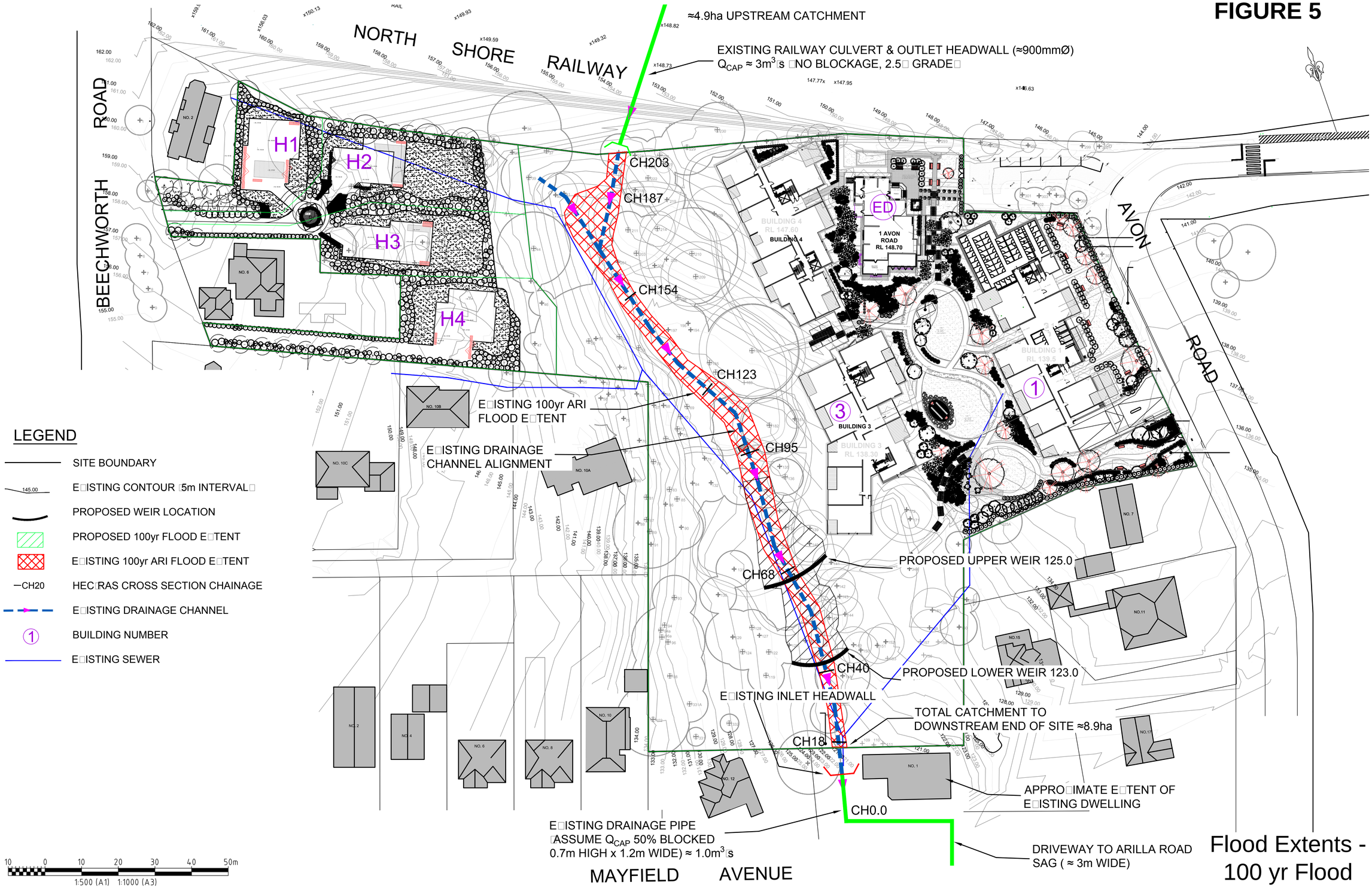
NORTH WAHROONGA
NORTH TURRAMURRA
EAST WAHROONGA
WAHROONGA
WARRAWEE
TURRAMURRA
PYMBLE
ST IVES CHASE
NORTH ST IVES
ST IVES
EAST ST IVES
GARIGAL NATIONAL PARK
BUNGAROO
DAVIDSON
BARRA BRUI
Middle Harbour
Lovers Jump Creek
Clay Brook
Fraser Brook
Kuring-gai Creek
Bare Creek
Rocky Creek
High Ridge
Gully
MONA VALE ROAD
WARRIMOO TRACK
RYLAND TRACK
CASCADES TRACK
PACIFIC HIGHWAY
TELEGRAPH ROAD
BURNS ROAD
TOOLANG ROAD
MUDIES ROAD
KILLEATON STREET
DALTON ROAD
WARRIMOO AVENUE
COLLINS ROAD
MILKMAIDS RESERVE
DAIRYMANS RESERVE
LOVERS JUMP CREEK PARK
SAMUEL KING PARK
NORTH TURRAMURRA OVAL
GUIDERS PARK
GOLDEN JUBILEE FIELD
WARRIMOO OVAL
ST IVES SHOWGROUND
KU-RING-GAI WILDFLOWER GARDEN
MCINTOSH LOOKOUT
MCINTOSH PARK
HASSELL PARK
BRIGIDINE COLLEGE ST IVES
SIR ERIC WOODWARD MEMORIAL SCHOOL
PASSIONIST COLLEGE MONASTERY
MASADA COLLEGE-SENIOR CAMPUS
ST IVES HIGH SCHOOL
ST IVES VILLAGE GREEN
WILLIAM COWAN OVAL
ACRON OVAL
BRYCE OVAL
DEGOTARDI PARK
SURGEON WHITE RESERVE
SEVEN WIVES WOOD
HUNTLEYS FOREST
BEAD FOREST
GREEN TOAD TEA GARDEN
MASHMANS QUARRY RESERVE
DALRYMPLE HAY NATURE RESERVE
PYMBLE GOLF COURSE
NORTH TURRAMURRA GOLF COURSE
KU-RING-GAI HIGH SCHOOL
SANDAKAN MEMORIAL PARK
COLUMBAN MISSION INSTITUTE
KNOX GRAMMAR PLAYING FIELD
KNOX GRAMMAR SCHOOL
ST EDMUND'S SCHOOL
ST LUCY'S SCHOOL
ARNOLD SHEILEIGH SENIOR SCHOOL
TURRAMURRA VILLAGE PARK
LAURA OSBORNE HOUISON SANCTUARY
TWIN CREEKS RESERVE
SHELDON FOREST
CORNISH PARK
ROFE PARK
MIMOSA ROAD OVAL
FROGMORE PARK
HAMILTON PARK
CARRINGTON PARK
FRASER PARK
ERIC EVANS PARK
BILLY HUGHES PARK
MCMAHON PARK
ARCHDALE PARK
WAHROONGA PARK
WARRAWEE PARK
TURRAMURRA MEMORIAL PARK
TURIBAN RESERVE
CLIVE EVATT RESERVE
SAINTY RESERVE
CLIFF AVENUE RESERVE
CALEY RESERVE
ELDINHOPE GREEN
CLAUDE CAMERON GROVE
ORANGE GREEN
IRISH TOWN GROVE
CAMERON PARK
HALFPENNY PARK
FIRST ROCKS
COMENARRA PLAYING FIELD
KENT PLAYING FIELD
TOOLANG PLAYING FIELD
DONALD COMMONS RESERVE
WILLIAM COWAN RESERVE
RICHTER RESERVE
BANNOCKBURN OVAL
KU-RING-GAI CHASE NATIONAL PARK
Hornsby △ 201
Cook △ 201
Ryland △ 187
Waller △ 150
Carroll △ 166
Smart △ 160
Wright △ 160
Soutar △ 130
N
1:25,000 TOPOGRAPHIC PLAN
WEST PYMBLE 4km
CHATSWOOD 6km

FIGURE 5



LEGEND

- SITE BOUNDARY
- 145.00 E□ISTING CONTOUR □5m INTERVAL□
- PROPOSED WEIR LOCATION
- PROPOSED 100yr FLOOD E□TENT
- E□ISTING 100yr ARI FLOOD E□TENT
- —CH20 HEC□RAS CROSS SECTION CHAINAGE
- E□ISTING DRAINAGE CHANNEL
- ① BUILDING NUMBER
- E□ISTING SEWER

10 0 10 20 30 40 50m
1:500 (A1) 1:1000 (A3)

Flood Extents - 100 yr Flood

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
G	EXTRA COUNCIL DETAIL ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
F	CLIENT NAME CHANGED	M.S.	C.H.	M.S.		11.05.15
E	DA ISSUE V5	M.S.	C.H.	M.S.		22.04.15
D	DA ISSUE V4	M.S.	C.H.	M.S.		21.10.14
C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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Principal
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0412 264 237
mshaw@civilcertification.com

53 Werona Avenue
Gordon NSW 2072

Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

Title: HEC□RAS MODEL
E□ISTING 100yr FLOOD E□TENT
SCALE 1:500

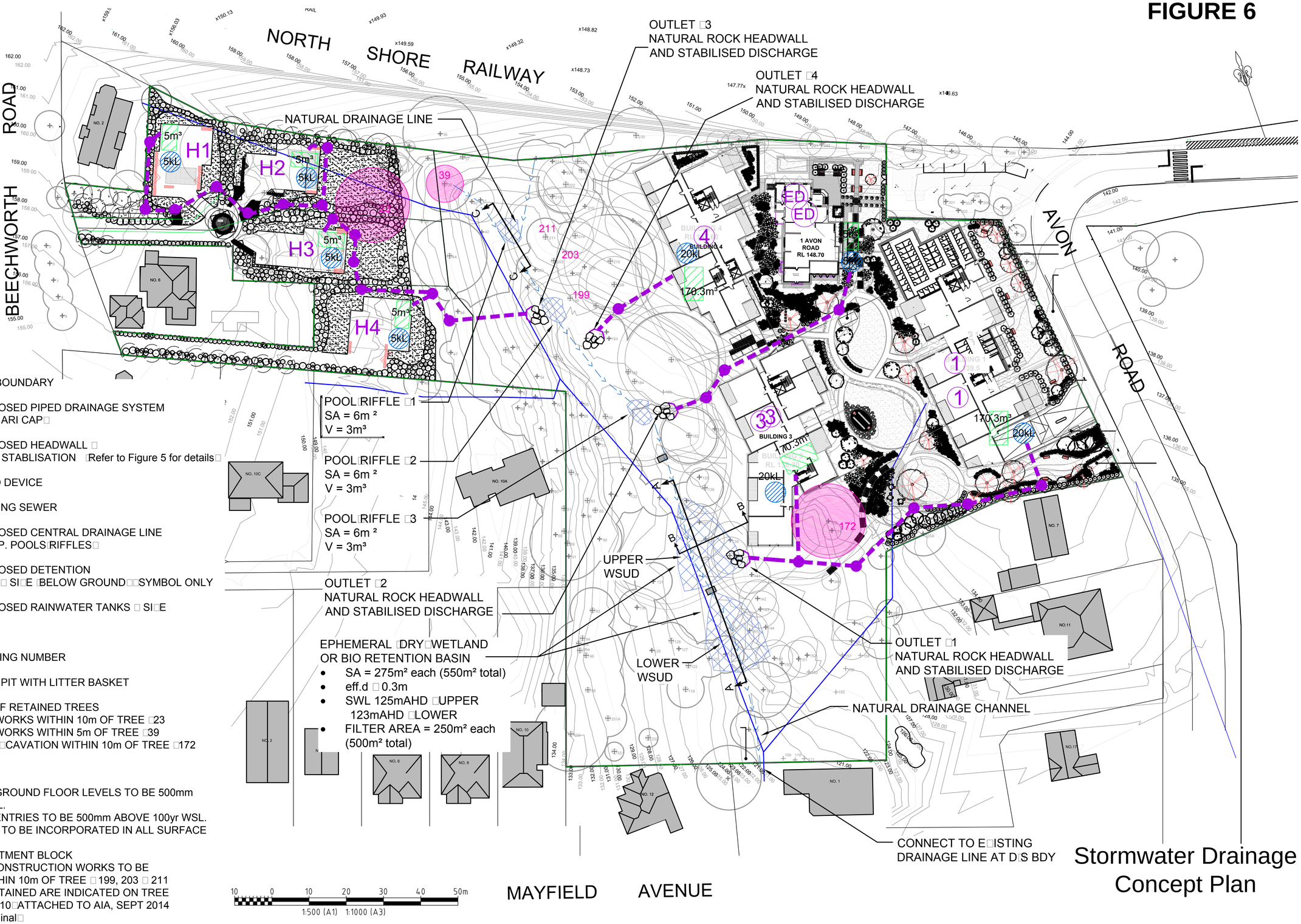
Drawing No. 1 of 5

Issue: Rev [G] 8/08/15

Cad File No.: □ref.□s□ 1002 [G] - 01

A1

FIGURE 6



LEGEND

- SITE BOUNDARY
- PROPOSED PIPED DRAINAGE SYSTEM 50YR ARI CAP
- PROPOSED HEADWALL ROCK STABLISATION Refer to Figure 5 for details
- WSUD DEVICE
- EISTING SEWER
- PROPOSED CENTRAL DRAINAGE LINE INCRP. POOLS RIFFLES
- 5m³ PROPOSED DETENTION TANK SIE BELOW GROUND SYMBOL ONLY
- 5kL PROPOSED RAINWATER TANKS SIE
- (1) BUILDING NUMBER
- INLET PIT WITH LITTER BASKET
- (23) TP OF RETAINED TREES
  NO WORKS WITHIN 10m OF TREE 23
  NO WORKS WITHIN 5m OF TREE 39
  NO ECAVATION WITHIN 10m OF TREE 172

NOTES

1. ALL HABITABLE GROUND FLOOR LEVELS TO BE 500mm ABOVE 100yr WSL.
2. ALL BASEMENT ENTRIES TO BE 500mm ABOVE 100yr WSL.
3. LITTER BASKETS TO BE INCORPORATED IN ALL SURFACE INLET PITS
4. 20kL RWT APARTMENT BLOCK
5. WSUD DEVICE CONSTRUCTION WORKS TO BE MONITORED WITHIN 10m OF TREE 199, 203 211
6. TREES TO BE RETAINED ARE INDICATED ON TREE SCHEDULE REV.10 ATTACHED TO AIA, SEPT 2014 Ref 2325 Ls34BFinal

10 0 10 20 30 40 50m
1:500 (A1) 1:1000 (A3)

Stormwater Drainage Concept Plan

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
G	EXTRA COUNCIL DETAIL ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
F	CLIENT NAME CHANGED	M.S.	C.H.	M.S.		11.05.15
E	DA ISSUE V5	M.S.	C.H.	M.S.		22.04.15
D	DA ISSUE V4	M.S.	C.H.	M.S.		21.10.14
C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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53 Werona Avenue
Gordon NSW 2072

Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

Title: PROPOSED STORMWATER DRAINAGE CONCEPT PLAN SDCP

SCALE 1:500

Drawing No. 2 of 5

Issue: Rev [G] 8/08/15

Cad File No.: ref.s 1002 [G] - 02

A1

FIGURE 7

LEGEND

- SITE BOUNDARY
- SEDIMENT BASIN BB SD6 4
- SILT FENCE BB SD6 8
- STABILISED SITE ACCESS BB SD6 14
- POTENTIAL STOCKPILE SITE BB SD4 1
- DIVERSION CHANNEL MOUND BB SD5 5
- STABILISED LOW FLOW CHANNEL
- ① BUILDING NUMBER
- OVERLAND FLOW DIRECTION

NOTES

1. REFER TO BLUE BOOK FOR STANDARD MEASURE DETAIL.DWGs
2. FLOWS AT END OF DIVERSION DRAINS TO BE DISCHARGED VIA LEVEL SPREADER TO PREVENT CONCENTRATION OF FLOWS

10 0 10 20 30 40 50m
1:500 (A1) 1:1000 (A3)

Erosion and Sediment Control Plan

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
G	EXTRA COUNCIL DETAIL ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
F	CLIENT NAME CHANGED	M.S.	C.H.	M.S.		11.05.15
E	DA ISSUE V5	M.S.	C.H.	M.S.		22.04.15
D	DA ISSUE V4	M.S.	C.H.	M.S.		21.10.14
C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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53 Werona Avenue
Gordon NSW 2072

Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

Title: EROSION SEDIMENT CONTROL PLAN DURING CONSTRUCTION

SCALE 1:500

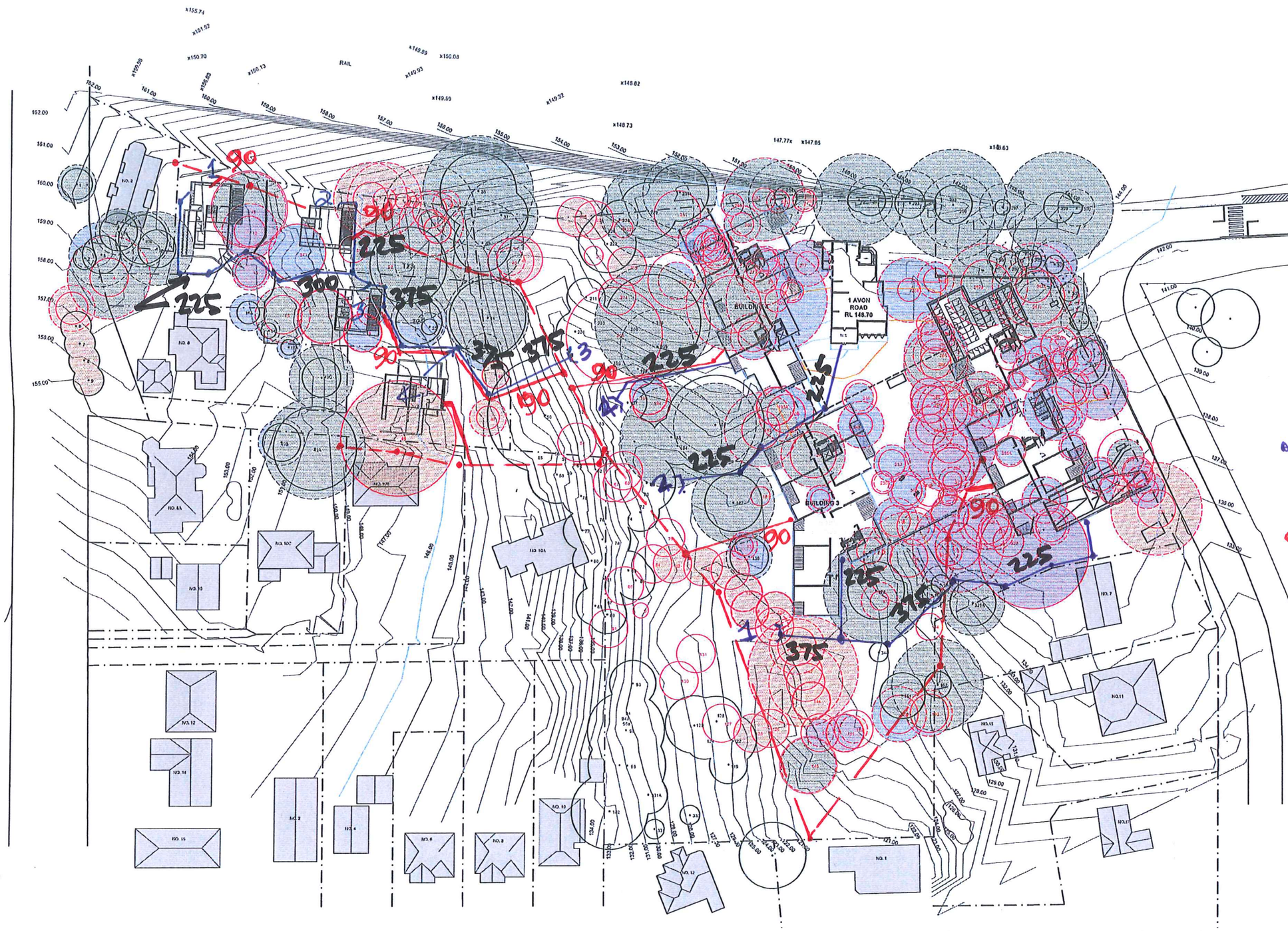
Drawing No. 3 of 5

Issue Rev [G] 8/08/15

Cad File No. ref.s 1002 [G] - 03

A1

FIGURE 8



Stormwater and House Sewer Pipe Sizes

TaylorBrammer

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Woollahra NSW 2025
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LEGEND:
- SITE BOUNDARY
- EXISTING TREE CANOPY
- TREE PROTECTION FENCING
- EXISTING TREE REMOVED CANOPY
- TPZ RETENTION VALUE A
- TPZ RETENTION VALUE B
- TPZ RETENTION VALUE C
- TPZ RETENTION VALUE D

NOTE:
- REFER TO ARBORICULTURAL IMPACT ASSESSMENT AND ENCLOSED TREE SCHEDULE, JUNE 2015, BY TREE WISE MEN AUSTRALIA FOR TPZ, RETENTION VALUES AND TREE PROTECTION MEASURES FOR RETAINED TREES.
- INFORMATION ON THIS PLAN AS PER TREE WISE MEN AUSTRALIA PTY LTD ARBORICULTURAL CONSULTANCY 131 FULLER STREET HARRABEEN N.SW 2101 PH: +61 2 9981 5219
- ADDITIONAL FENCING MAY BE REQUIRED DURING VMP AND STORMWATER WORKS

A	For Council Issue	22.07.2015
	DESCRIPTION	DATE

PROJECT: Proposed Residential Development, 1 Avon Rd Pymble

DRAWING TITLE: Tree Protection Plan

CLIENT: AUSBAO PYMBLE PTY LTD

0 5 10 20 30m

SCALE: 1:500 @ A1 | CHECKED: MT | ESTIMATING: | REVISION:
DATE: 27.02.2015 | JOB NO.: 150068 | LA04 | A
DRAWN: MW | EXAMINED: MT

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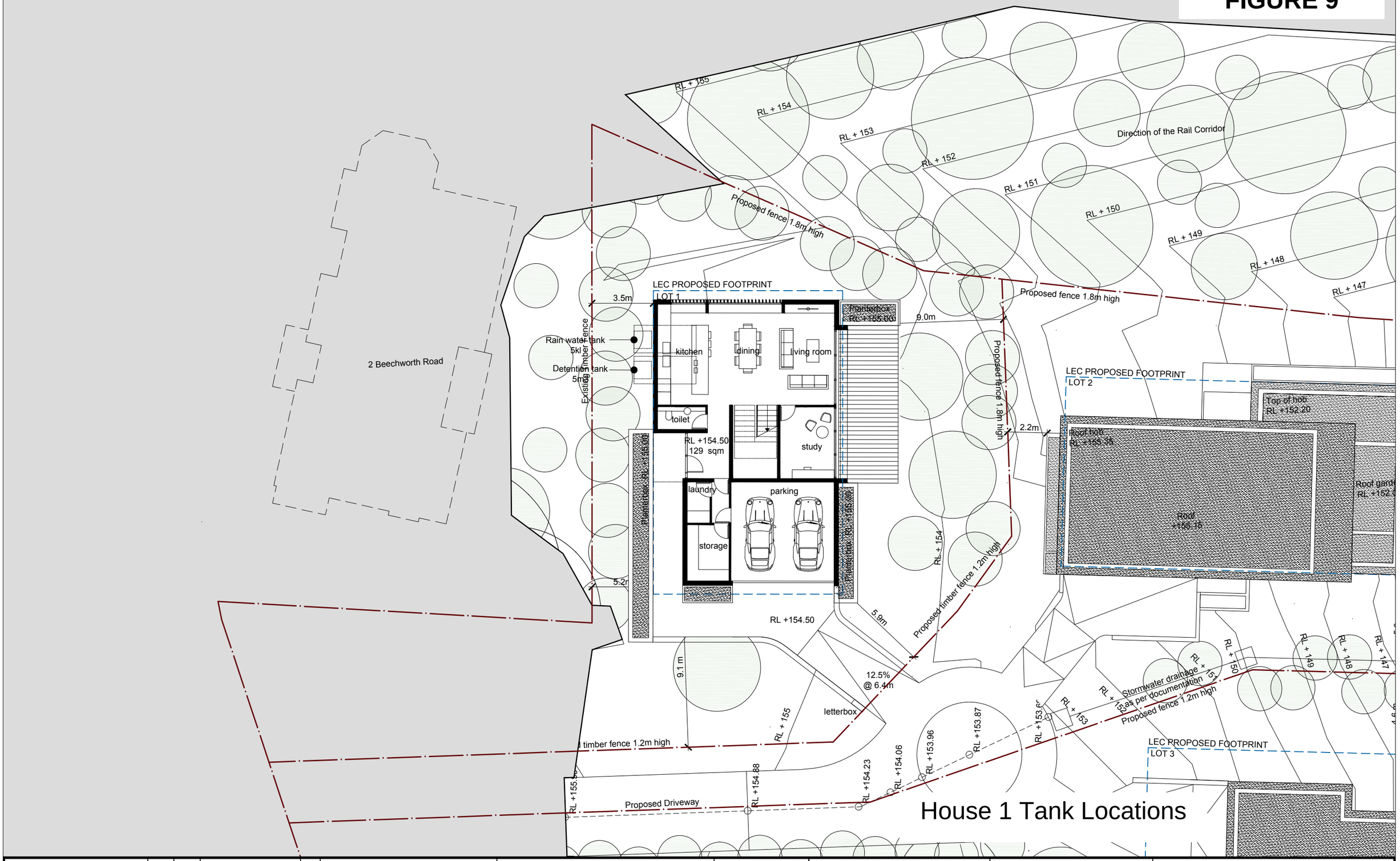
ABN 51 093 724 503

FIGURE 9



House 1 Tank Locations

IMPORTANT NOTES:

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PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

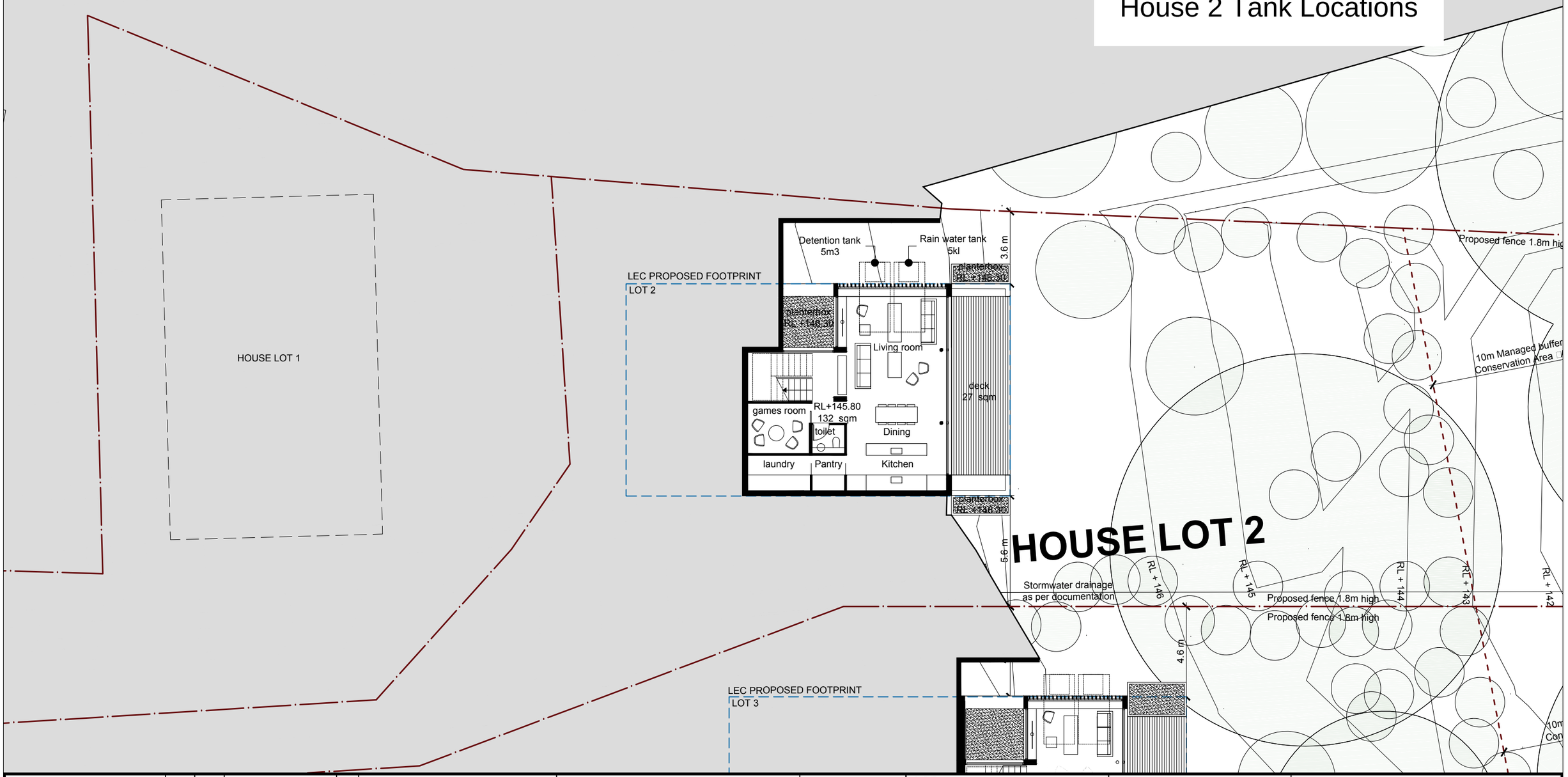
DRAWING TITLE

HOUSE LOT 1
LEVEL 00 RL154.50

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		
JOB 12009	DRAWING MP 41.03		REVISION S4

FIGURE 10

House 2 Tank Locations



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PROJECT
PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE
HOUSE LOT 2
LEVEL 00 RL 145.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 42.04	S4

FIGURE 11

LOT 1

LOT 2

LEC PROPOSED FOOTPRINT
LOT 3

LEC PROPOSED FOOTPRINT
LOT 4

6 Beechworth Road

HOUSE LOT 2

Stormwater drainage
as per documentation

Detention tank
3m3

Rain water tank
5kl

Planterbox
RL +145.40

Living room

RL +144.80
112 sqm

Deck
27 sqm

Toilet

Dining

Laundry

Pantry

Kitchen

Planterbox
RL +145.40

6.6 m

4.9 m

Proposed fence 1.8m high

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area □AP□

RL + 146

RL + 145

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

RL + 139

RL + 138

HOUSE LOT 3

Footprint demolished
8 Beechworth Road

RL + 147

Proposed fence 1.8m high

Detention tank
5m3

Rain water tank
5kl

3.3 m

4 m

master
bedroom

office

livingroom

RL +144.70
157 sqm

bathroom

toilet

pantry

kitchen

dining room

10m Managed buffer to
Conservation Area □AP□

Stormwater drainage
as per documentation

Proposed fence 1.8m high

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area □AP□

10m Managed buffer to
Conservation Area □AP□

House 3 Tank Locations

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PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE

HOUSE LOT 3
LEVEL 00 RL 144.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		
JOB 12009	DRAWING MP 43.04		REVISION S4

FIGURE 12

HOUSE LOT 3

HOUSE LOT 4

House 3

Living room

RL +144.80
112 sqm

Deck
27 sqm

Toilet

Dining

Laundry

Pantry

Kitchen

Planter box
RL +144.40

Footprint demolished
8 Beechworth Road

RL + 147

Proposed fence 1.8m high

Detention tank
5m3

Rain water tank
5kl

3.3

LEC PROPOSED FOOTPRINT
House 4

master bedroom

office

livingroom

RL +144.70
157 sqm

bathroom

toilet

pantry

kitchen

dining room

4 m

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

RL + 143

Stormwater drainage
as per documentation

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

7.3 m

RL + 145

RL + 144

RL + 143

RL + 142

RL + 141

145.00

144.00

143.00

142.00

141.00

Beechworth Road 10B

House 4 Tank Locations

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PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

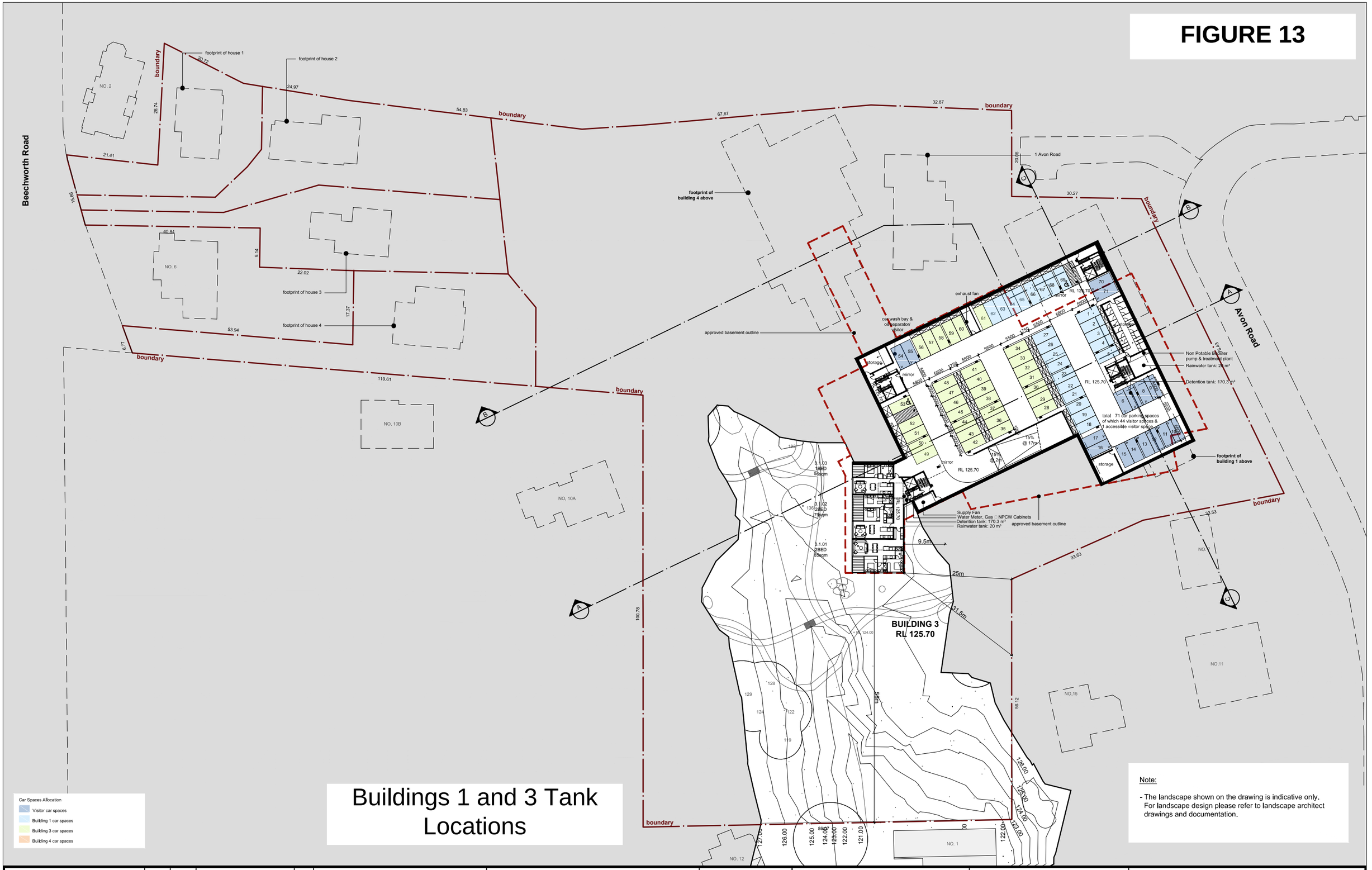
DRAWING TITLE

HOUSE LOT 4
LEVEL 00 147.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 44.03	S4

FIGURE 13



Car Spaces Allocation

- Visitor car spaces
- Building 1 car spaces
- Building 3 car spaces
- Building 4 car spaces

Buildings 1 and 3 Tank Locations

Note:

- The landscape shown on the drawing is indicative only. For landscape design please refer to landscape architect drawings and documentation.

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CLIENT: Ausbao, pwc

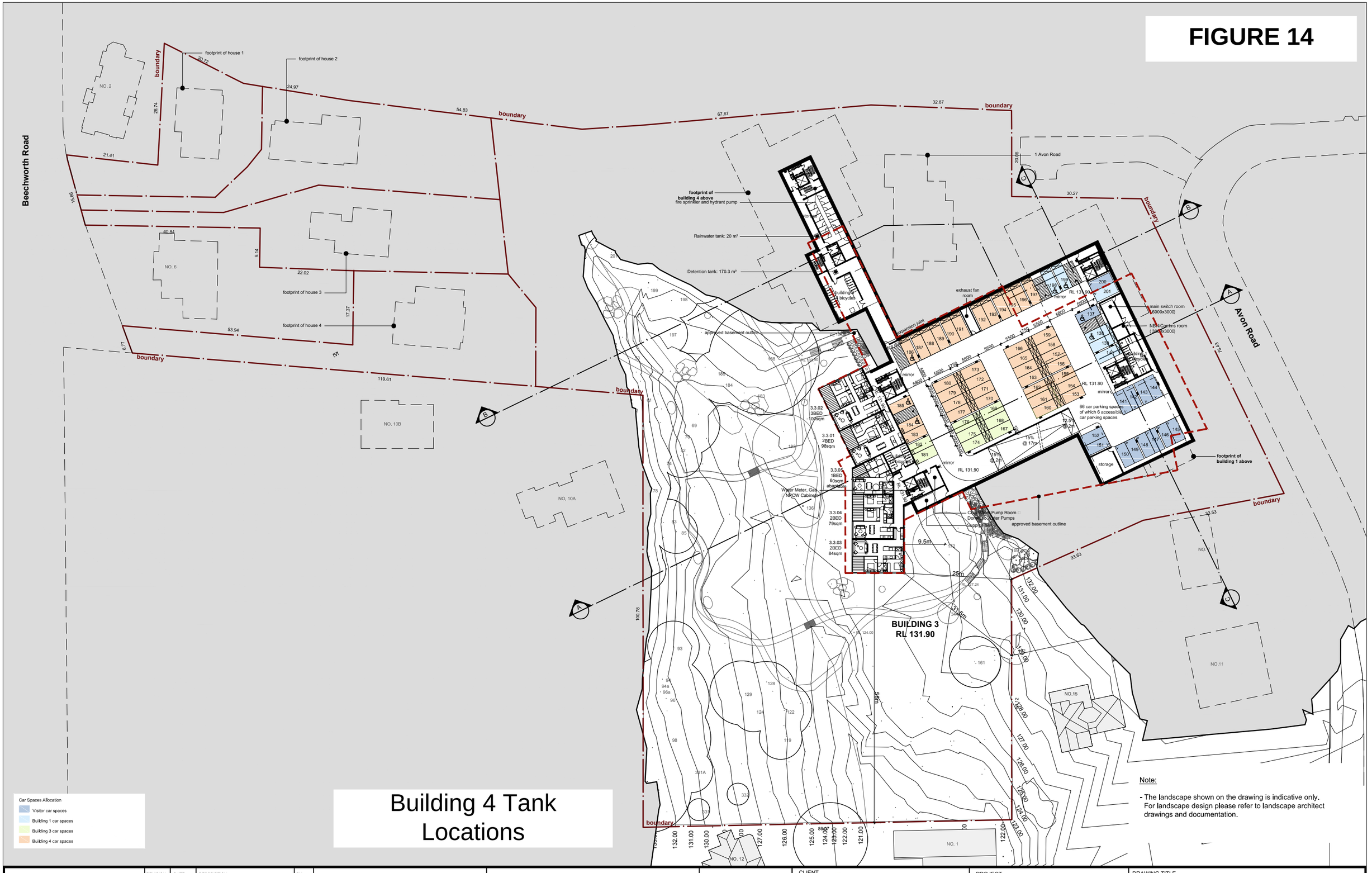
PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT AVON ROAD, PYMBLE

DRAWING TITLE: FLOOR PLAN LEVEL RL+126

SCALE	DATE	DRAWN	CHECKED
1:400 @ A1 1:800 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 22.03	S4

FIGURE 14



Building 4 Tank Locations

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REVISION	DATE	DESCRIPTION	BY
P	27.11.27	APPROVED BY LEC	PS
Q	27.02.15	FOR SECTION 34 CONFERENCE	PS
S	04.05.15	SUBMISSION TO LEC	PS
S3	17.07.15	SUBMISSION TO LEC	PS

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MN TN

CLIENT: Ausbao, pwc

PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT AVON ROAD, PYMBLE

DRAWING TITLE: FLOOR PLAN LEVEL RL+132

SCALE	DATE	DRAWN	CHECKED
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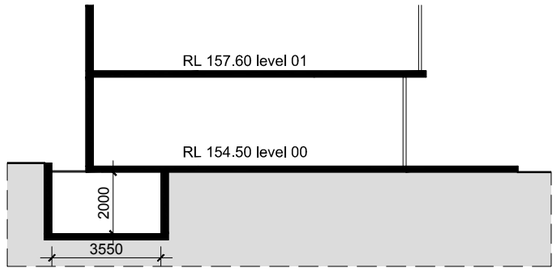
JOB	DRAWING	REVISION
12009	MP 22.05	S4



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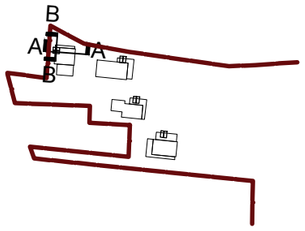

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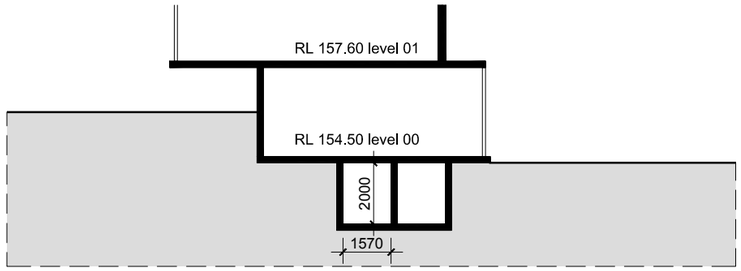

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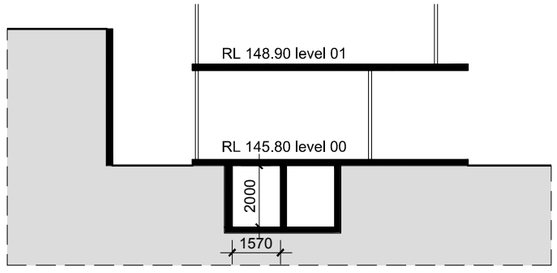

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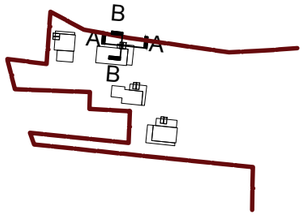

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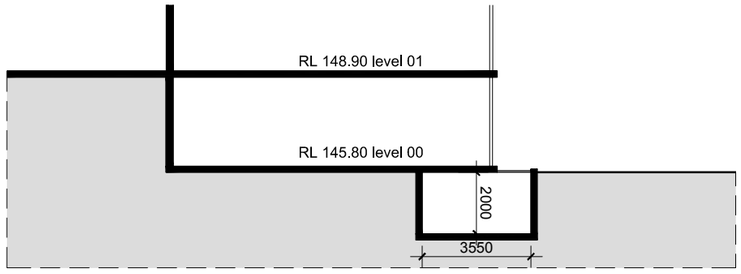

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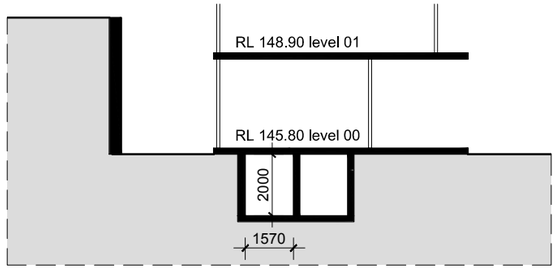

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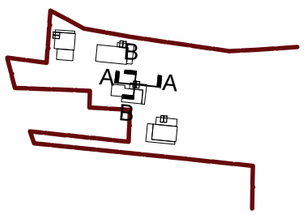

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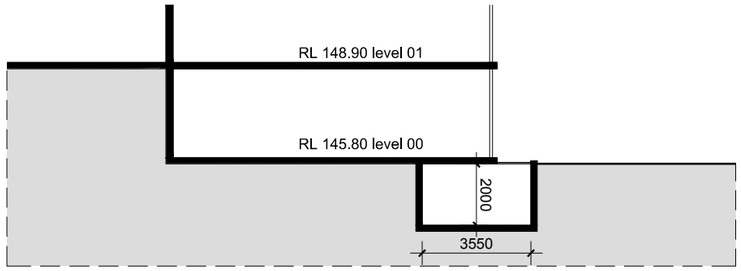

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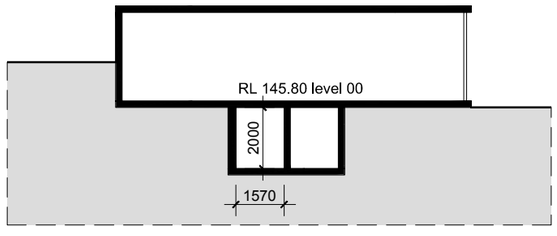

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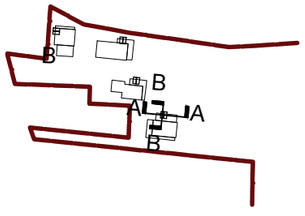

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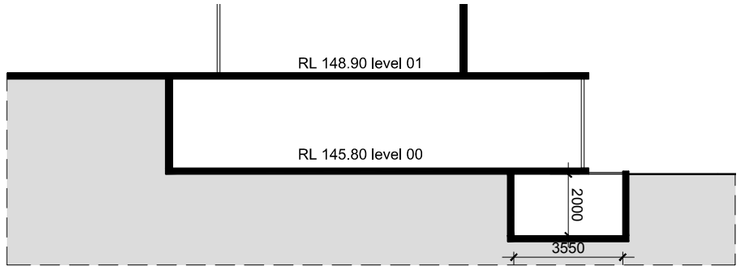
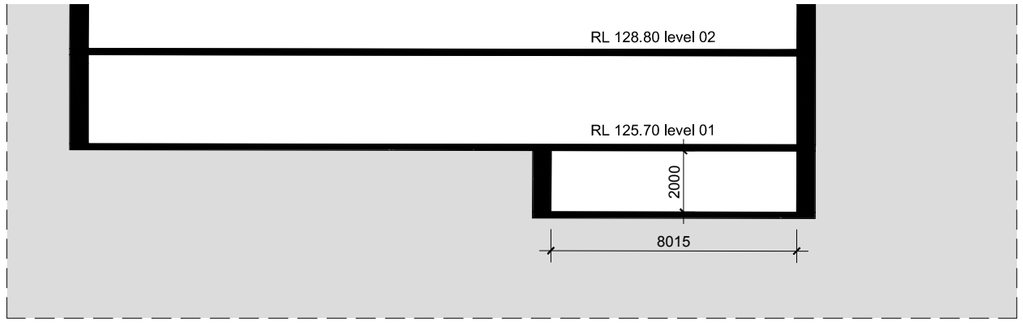


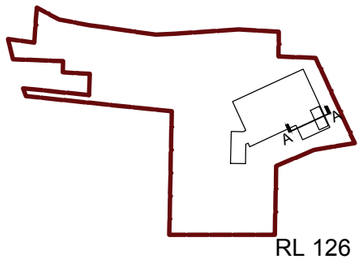
HOUSE 4 SECTION B–B
SCALE 1:200@A3

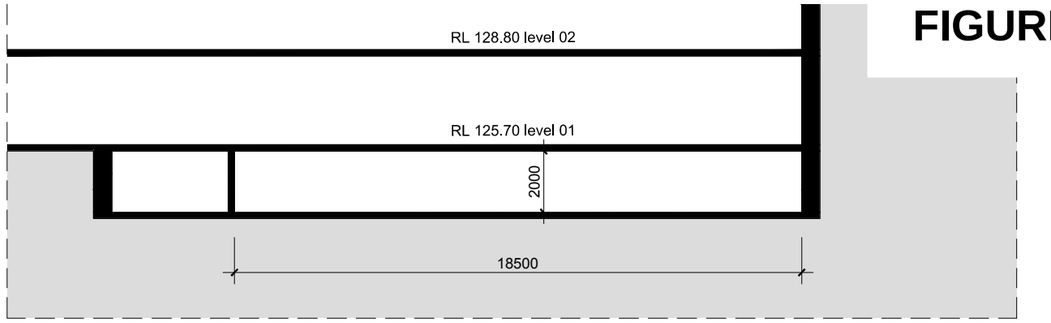
House OSD Tank Cross Sections

FIGURE 16



BUILDING 1 SECTION A-A
SCALE 1:200@A3





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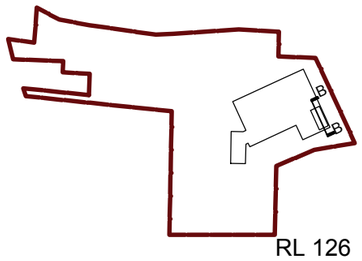
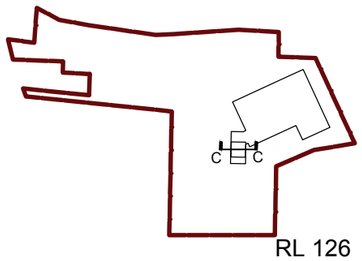


BUILDING 3 SECTION C-C
SCALE 1:200@A3



BUILDING 3 SECTION D-D
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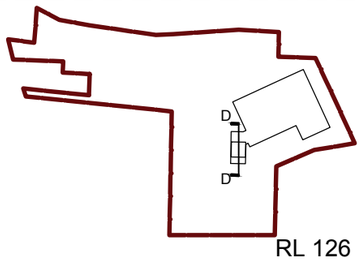
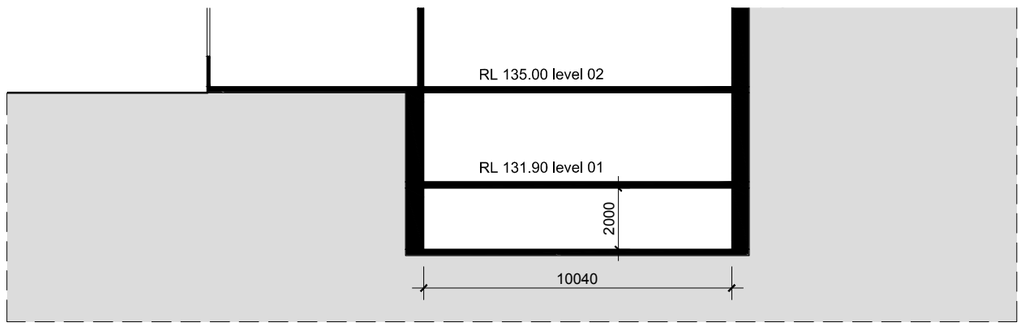
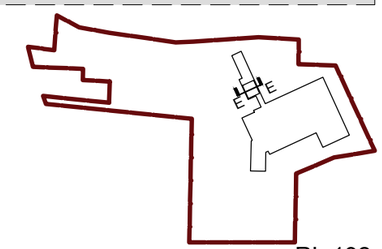
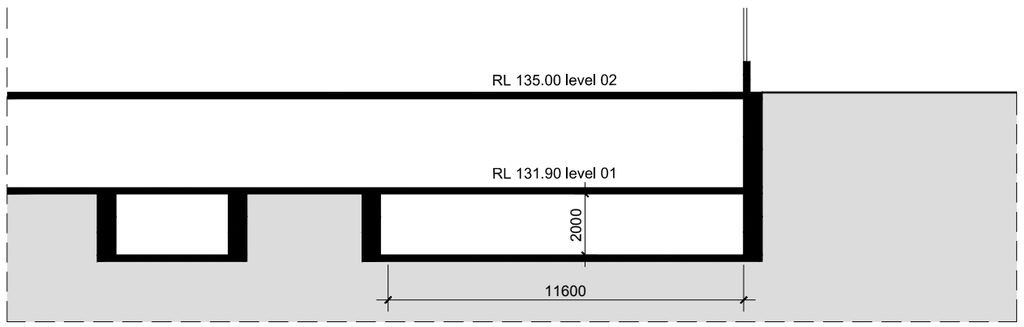




BUILDING 4 SECTION E-E
SCALE 1:200@A3





BUILDING 4 SECTION F-F
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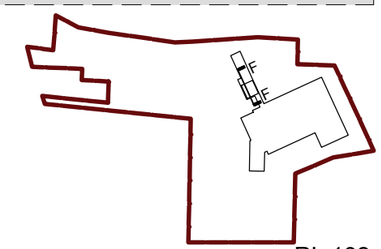
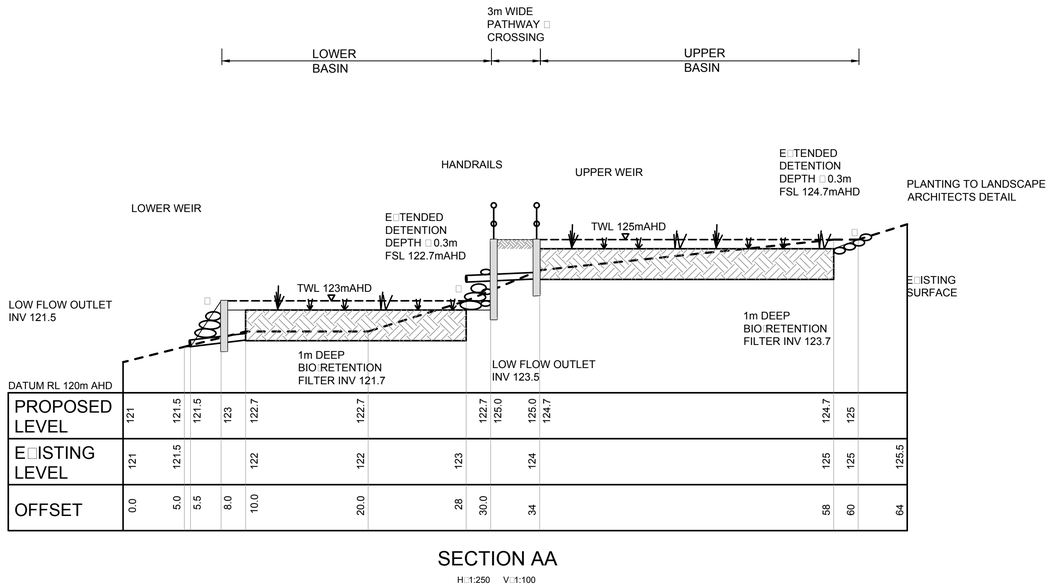


Building OSD Tank Cross Sections

FIGURE 17

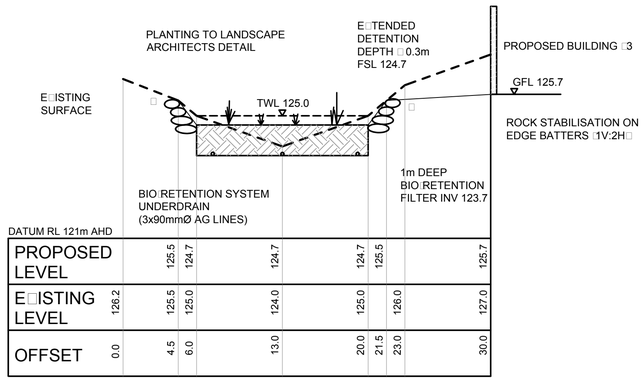


SECTION AA

H 1:250 V 1:100

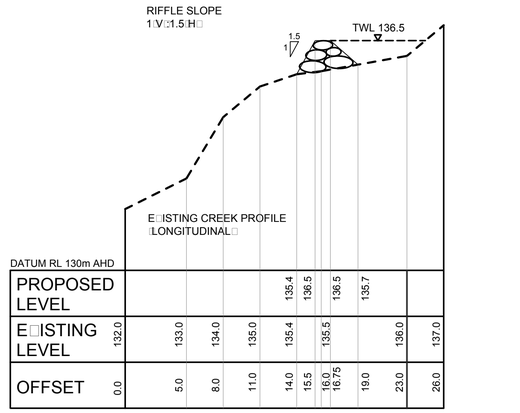
NOTES

1. INDICATES SANDSTONE ROCK RIP RAP D_{90} = Ø500
2. UNDER DRAIN SYSTEM TO CONNECT TO LOW FLOW OUTLETS
3. RIFFLES TO BE LOCATED ON FLAT LEDGES ALONG EXISTING CHANNEL



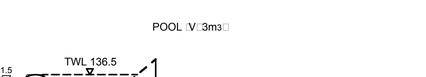
SECTION BB

H 1:250 V 1:100



SECTION CC

H 1:250 V 1:100



Basin and Pool and Riffle Features
Typical Cross sections

5 0 5 10 15 20 25m
1:250 (A1) 1:500 (A3)

2 0 2 4 6 8 10m
1:100 (A1) 1:200 (A3)

G	SECTIONS THROUGH BASINS ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date

INITIALS SHOWN IN THE ADJACENT ISSUE RECORDS INDICATE THE STAGES UNDERTAKEN IN THE DRAWING APPROVAL PROCESS. DRAWINGS ARE ONLY TO BE USED WHEN APPROVED BY CIVIL CERTIFICATION AND THEN ONLY AS NOTED FOR DRG STATUS. THE ORIGINAL SIGNATURES CAN BE FOUND ON THE REVERSE SIDE OF THE ORIGINAL OF THE CIVIL CERTIFIERS DRG REGISTER/TRANSMITTAL

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Gordon NSW 2072

Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

Title: FIGURE 4

BASIN SECTIONS

SCALE 1:250 H
1:100 V

Drawing No. 4 of 5

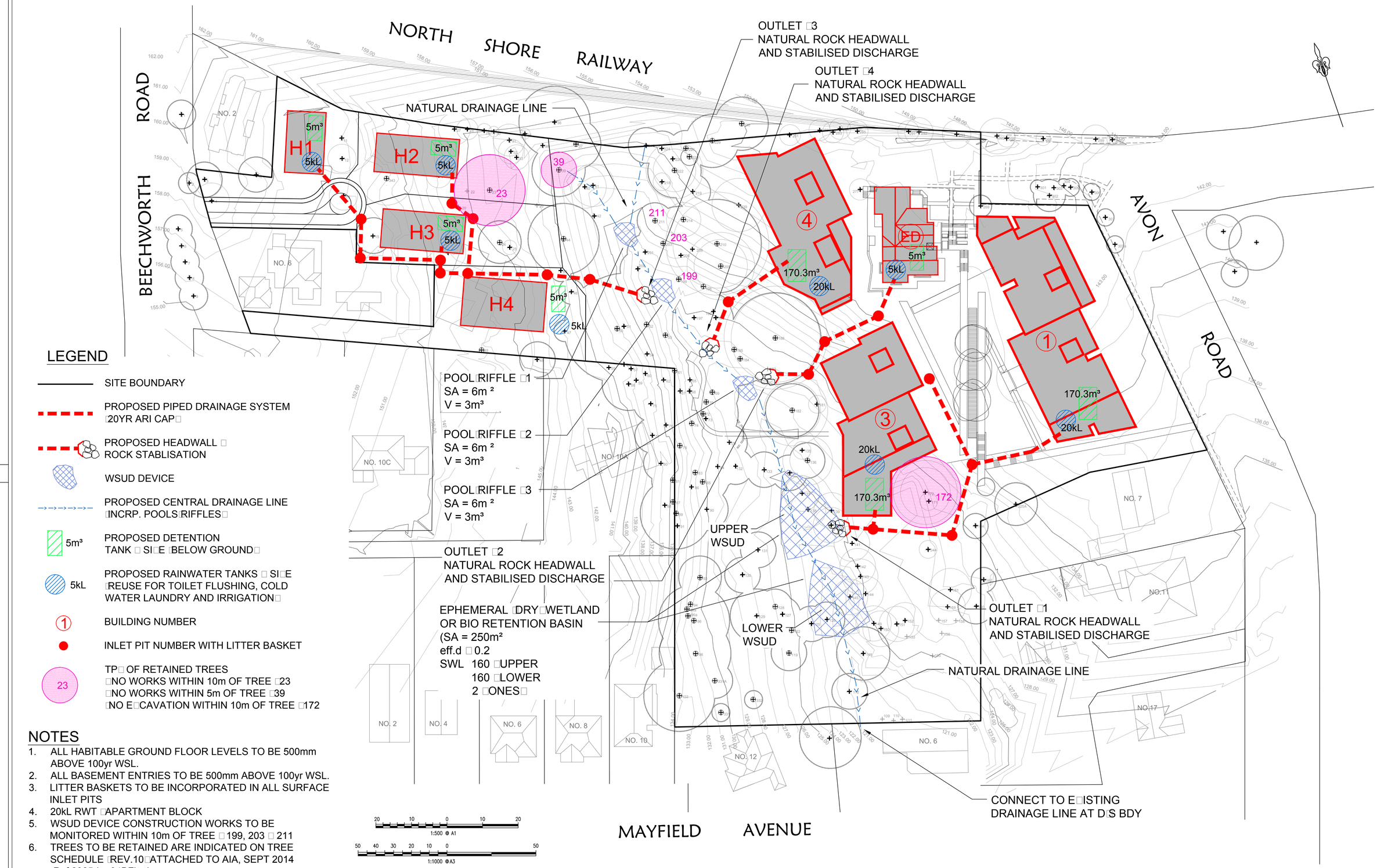
Issue: Rev [G] 06/08/15

Cad File No. ref. s 1002 [G] - 04

A1

APPENDIX A

CONCEPT PLAN APPROVED STORMWATER DRAINAGE CONCEPT PLAN



LEGEND

- SITE BOUNDARY
- PROPOSED PIPED DRAINAGE SYSTEM (20YR ARI CAP)
- PROPOSED HEADWALL / ROCK STABLISATION
- WSUD DEVICE
- PROPOSED CENTRAL DRAINAGE LINE (INCRP. POOLS/RIFFLES)
- 5m³ — PROPOSED DETENTION TANK (SITE BELOW GROUND)
- 5kL — PROPOSED RAINWATER TANKS (SITE REUSE FOR TOILET FLUSHING, COLD WATER LAUNDRY AND IRRIGATION)
- (1) — BUILDING NUMBER
- ● — INLET PIT NUMBER WITH LITTER BASKET
- (23) — TPO OF RETAINED TREES (NO WORKS WITHIN 10m OF TREE 23; NO WORKS WITHIN 5m OF TREE 39; NO EXCAVATION WITHIN 10m OF TREE 172)

NOTES

1. ALL HABITABLE GROUND FLOOR LEVELS TO BE 500mm ABOVE 100yr WSL.
2. ALL BASEMENT ENTRIES TO BE 500mm ABOVE 100yr WSL.
3. LITTER BASKETS TO BE INCORPORATED IN ALL SURFACE INLET PITS
4. 20kL RWT APARTMENT BLOCK
5. WSUD DEVICE CONSTRUCTION WORKS TO BE MONITORED WITHIN 10m OF TREE 199, 203 211
6. TREES TO BE RETAINED ARE INDICATED ON TREE SCHEDULE REV.10 ATTACHED TO AIA, SEPT 2014 Ref 2325_L_s34BFinal

20 10 0 10 20
1:500 @ A1
50 40 30 20 10 0 50
1:1000 @ A3

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
D	DA ISSUE V4	M.S.	C.H.	M.S.		21.10.14
C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14
A	DA ISSUE	M.S.	C.M.	M.S.		19.11.12

INITIALS SHOWN IN THE ADJACENT ISSUE RECORDS INDICATE THE STAGES UNDERTAKEN IN THE DRAWING APPROVAL PROCESS. DRAWINGS ARE ONLY TO BE USED WHEN APPROVED BY CIVIL CERTIFICATION AND THEN ONLY AS NOTED FOR DRG STATUS. THE ORIGINAL SIGNATURES CAN BE FOUND ON THE REVERSE SIDE OF THE ORIGINAL OF THE CIVIL CERTIFIERS DRG REGISTER/TRANSMITTAL

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53 Werona Avenue
Gordon NSW 2072

Client: **JW NEALE PTY LTD**
(RECIEVERS AND MANAGER APPOINTED)

Project: **AVON ROAD, PYMBLE**

Title: AVON ROAD, PYMBLE
PROPOSED STORMWATER DRAINAGE CONCEPT PLAN (SDCP)
SCALE 1:500

Drawing No. 1 of 1
Issue: Rev [D] 21.10.14
Cad File No.: 1002 [D] - 01 (ref.s)

A1

APPENDIX B – CIVILCERT REPORT

Civil Certification
Accredited Certifiers
Civil Engineering

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Gordon, NSW, 2072
0412 264 237

ABN 87 532 718 229

Ausbao Pty Ltd
C/O NPC Pty Ltd
Level 4, 10 Clarke Street
Crows Nest, NSW, 2059

Tuesday, 11 August 2015

Attention: Mark Tooker

Dear Mark,

AVON AND BEECHWORTH RD, PYMBLE
REVISED CONCEPT PLAN
SITE WIDE STORMWATER AND DRAINAGE MANAGEMENT CONCEPT PLAN

REPORT AMENDMENT TO INCORPORATE REVISED BUILDING LAYOUT & COUNCIL COMMENTS

1. INTRODUCTION

Civil Certification has been engaged by NPC on behalf of Ausbao Pty Ltd to update our previous stormwater and drainage management report to reflect the latest change to the sites building layout, to address the latest L&E Court orders and provide additional details requested by Council.

The aim of the report is to provide a background to existing flooding and drainage constraints at the site and to develop a conceptual stormwater and drainage management plan for the proposed development.

Our drainage concept plan has been formulated to align with best practice, Ku-ring-gai Council standards and meet the information requirements stipulated by NSW Planning and Infrastructure.

The areas of stormwater management that are covered by this report are summarised as follows:

- Flooding;
- Drainage (*including pipe sizing and outlet stabilisation*);
- Stormwater Quality;
- Erosion and Sediment Control'
- Stormwater Quantity/Detention; and
- Water Sensitive Urban Design (*WSUD*).

2. LEGAL BACKGROUND

This report has been prepared on behalf of Ausbao Pty Ltd (The Applicant). The Report forms part of the Land and Environment Court of NSW (L&E Court) Proceeding No.10834 of 2013. The proceedings relate to the refusal by the Planning Assessment Commission (PAC), as delegate of the Minister for Planning (Minister), of the Concept Plan Application (MP08_0207) for a multi-unit residential development at 1, 1A & 5 Avon Road and 4 & 8 Beechworth Road, Pymble (Proposed Development) and a Project Application (*MP 10_0219*) for the first stage of the development.

On 5 December 2014, the Land and Environment Court ordered that the appeal be allowed in respect of the Concept Plan. The proceedings relating to the Project Application (*No.10834 of 2014*) were stood over, pending the Courts decision on the Concept Plan proceedings.

The report addresses the revisions to the Stage 1 Project Application as a consequence of the Court approval, the modifications required in Schedule 2 of the Manner of Approval issued by the Planning Assessment Commission following the Court orders and the Further Environmental Assessment Requirements contained in Schedule 3 of the Manner of Approval.

3. SITE

The site is located between Avon Rd and Beechworth Road, Pymble in the local government area of Ku-ring-gai. It is approximately 2.4ha in area and is currently a mix of low density residential development and open space/bushland. The developable portion of the site is estimated to be approximately 1.4ha.

The site has moderate slopes to a central valley which falls in a south west direction from approximately RL 140mAHD adjacent to the low point along the northern boundary with the railway corridor down to RL 119mAHD at the downstream low point of the site. Refer to **Appendix B** for more details of the existing levels across the site.

Refer to **Appendix A** for photographs of the site.

Diagram 1 shows the site and surrounding areas.

It is proposed that the land be redeveloped to contain a mix of high and low density residential dwellings, served by all required servicing infrastructure. The open space at the centre of the site is also proposed to be enhanced by removal of existing noxious vegetation and replacement with indigenous species.

Refer to **Appendix C** for architectural details of the development proposal.

Diagram 1 – Locality Plan (*Courtesy of NearMap*)

4. RELEVANT POLICY/GUIDELINE DOCUMENTS

A summary of the relevant policy and guideline documents regarding stormwater management at the site and surrounding areas is provided below:

- "*Ku-ring-gai LEP (Local Centres) 2012"* KC, July 2012;
- "*Development Control Plan 47 2011* "KC, April, 2005;
- "Draft MUSIC Modelling Guidelines" KC, 2010;
- "*Floodplain Management Manual*" NSW Government, January 2001;
- "*ARQ*" Engineers Australia, 2006; and
- "*ARR*" Engineers Australia, 1987.

Previous reports which were generated for the site and reviewed as part of the current assessment are also provided below:

- "*Stormwater and Flood Study Report for Residential Development at Avon Road, Pymble*" MYD Consulting Engineers, 17 December, 2009; and
- "*Geotechnical Assessment for Proposed Multi Storey development – 1, 1A and 5 Avon Road and 4 & 8 Beechworth Road, Pymble*" Jeffery & Katauskaus, 19 November, 2010;

5. EXISTING DRAINAGE

The site is located in the upper reaches of a small tributary of Lane Cove River. The tributary starts at the North Shore railway line, runs through Avondale Golf Course/Rolf Park and eventually joins the Lane Cove River (*over 3km to the south west of the site*).

A minor drainage channel/overland flow path currently traverses the centre of the site (*ie at the base of the valley*). But this drainage channel does not sustain a permanent presence of water. At the upstream end of the site a 900mm dia. railway culvert discharges into the drainage line. At the downstream end of the site the drainage line joins a 0.75m high x 1.2m wide box culvert. Flows in excess of the downstream culvert capacity flow overland to Arilla Road.

Council classify the drainage channel running through the subject site as a Category 3 riparian zone (*refer to map at **Appendix F***). It is not considered that this section of watercourse is a "*River*" as defined by the Water Management Act 2000. Nor is it considered that any development in the vicinity of the drainage channel would require referral to the NSW Office of Water for a controlled activity approval.

The upstream railway culvert has good capacity, estimated to be capable of conveying the full 100yr ARI flow generated by the 4.9ha catchment draining to it. The downstream culvert is likely to be susceptible to blockage and based on its current size is estimated to have a capacity of between 5-10yr ARI (*assuming 50% blockage*). Based on this, flows are expected to overtop the culvert and run overland to Arilla via the driveway to #1 Arilla Road at an occasional frequency (*ie at least once every 5-10 years*).

The central drainage channel has a moderate slope of approximately 10% draining south towards Arilla Road.

A small sub-catchment exists upstream of the site (*approximately 4.9ha*). The total catchment to the downstream end of the site has been estimated at 8.9ha.

The existing drainage connection point for the site is the central drainage channel.

The existing local catchment for the site, adjoining sites and the small upstream catchment primarily consists of residential landuse and open space, with an estimated impervious fraction of approximately 65% (*average*).

6. HYDROLOGY

A preliminary RAFTS model was setup to predict the flows generated by the development, neighbouring sites and the upstream sub-catchment. A summary of the resultant peak flows at the upstream end of the site and discharge point from the site (*ie at the downstream boundary of the site*) is provided below:

Upstream end of site

- 20yr ARI Peak Q (*Ex.*) = 1.46m^3/s;
- 100yr ARI Peak Q (*Ex.*) = 2.14m^3/s;

- 100yr ARI 15% Increase in Intensity Due to CC Peak Q (Ex.) = 2.47m^3/s; and
- PMF Peak Q (*Ex*.) = 8.77m^3/s.

Downstream end of site (ie Discharge Point)

- 20yr ARI Peak Q (*Ex*.) = 2.14m^3/s;
- 100yr ARI Peak Q (*Ex*.) = 3.18m^3/s;
- 100yr ARI 15% Increase in Intensity Due to CC Peak Q (Ex.) = 3.61m^3/s; and
- PMF Peak Q (*Ex*.) = 15.24m^3/s.

The peak flows generated by RAFTS compared well with those calculated using the Rational Method and the previously reported MYD December 2009 predicted flows.

7. FLOODING

The hydraulic behaviour of the drainage channel/overland flow path running along the centre of the site was assessed using the software package HEC RAS.

7.1. HEC RAS

HEC-RAS is a water surface profile program capable of analysing steady, gradually varied channel flow. Subcritical, supercritical and mixed flow water surface profile computations are possible. It is based on the industry standard Corps of Engineers HEC-2 program.

The program can account for backwater effects created by bridges, culverts, weirs and other floodplain structures. The program can be used to evaluate floodway encroachments, identify flood hazard zones manage floodplains and design and evaluate channel improvements. Water surface profiles with different discharges or initial water surface elevations can be analysed at one time.

The program allows Manning's roughness coefficients to be varied in either horizontal or vertical directions.

7.2. MODEL DESCRIPTION

A HEC RAS model was assembled for the section of the overland flow path running through the centre of the subject site. A model was constructed for both existing and proposed conditions. The model starts just downstream of the site (*Chainage 0*) and extends to the upstream site boundary (*Chainage 203*). Refer to **Figure 1** for details of the flow path alignment and cross section locations.

An illustration of the model geometry is contained in **Diagram 1**.

7.3. MODEL PARAMETERS

Cross Sections

Cross section data was based on the detailed survey completed for the site by Higgins Surveyors (*refer to* ***Appendix B***).

Steady State Flows

The steady state flows derived as part of this study (*refer to* ***Section 6***) were adopted for the HEC RAS modelling.

It has been assumed that flows under proposed conditions would be maintained at existing levels (ie *due to implementation of the proposed detention measures*).

The presence of the box culvert at the downstream end of the site was incorporated in the model by subtracting its capacity from the total flow at this location.

The overland flow path downstream of the site (*ie driveway of No. 1 Arilla Rd*) was replicated by implementation of a typical 4m wide bitumen driveway. It must be noted that the culvert/driveway combination located downstream of the site is sufficiently lower than the subject site so as to not have any significant control on flooding within the proposed development site.

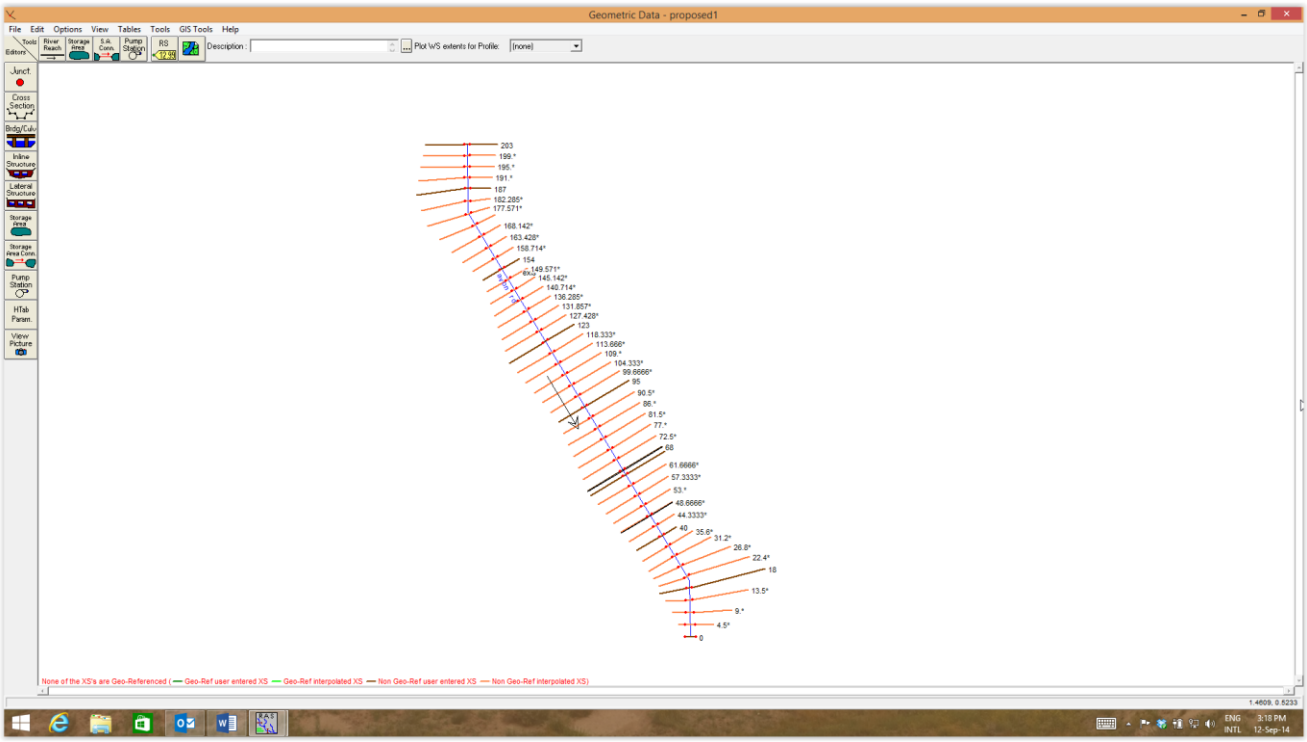


Diagram 1 – HEC RAS Model Geometry (*Proposed Conditions*)

Boundary Conditions

Normal depth was set for the upstream boundary conditions at a slope of 0.001, whilst critical depth was utilised as the downstream boundary condition.

Roughness Co-Efficient's

Roughness co-efficient's were estimated based on visual inspection and the anticipated ultimate conditions.

The adopted Manning's n value for the main channel and overbank were generally set at 0.07 and 0.09 respectively.

Bridges/Weirs/Obstructions

No bridges or weirs were utilised in the existing condition model

Weirs have been implemented in the proposed condition model to represent the flow barriers to be incorporated as part of the proposed online bio-retention basins.

Flow obstructions were incorporated within the model to represent any proposed buildings/encroachments to the floodway.

7.4 MODEL RESULTS

Full details of all the HEC RAS modelling results are included at **Appendix G**.

The modelling demonstrates that the 100 year ARI flood extent under proposed conditions is fully contained within the central open space and is well below the required 500mm freeboard to habitable ground floor levels/basement entries for all proposed buildings.

The lowest proposed building ground floor level on the site (*RL 125.7 at Building 3*) has also been shown to be above both the 100yr ARI event incorporating a 15% increase in rainfall intensity (*ie to represent a possible future climate change scenario*) as well as the PMF.

The lowest habitable floor level in Building 3 is RL125.7mAHD (*ie adjacent to the upper wetland*). The predicted flood levels in the wetlands are presented below:

Flood Event (ARI)	***Upper Wetland/Bio Basin***	***Lower Wetland /Bio Basin***
100yr ARI	125.20mAHD	123.30mAHD
100yr ARI + CC	125.22mAHD	123.33mAHD
PMF	125.51mAHD	123.74mAHD

100yr ARI flooding under proposed conditions does not impact on any adjoining properties. Flooding downstream of the site will not be exacerbated.

8. FLOOD EMERGENCY/EVACUATION

As the proposed habitable dwellings are all set at an appropriate flood planning level (*ie greater than 500mm above the central 100yr ARI overland flow path*) and in fact are also above the PMF level no special flood emergency/evacuation measures would be required.

9. STORMWATER QUALITY/WSUD

As part of the development of the site, implementation of best practice stormwater treatment measures will be required to minimise any detrimental impact on water quality.

This will involve implementation of both short term controls during the construction phase and long term controls as part of the ultimate development.

9.1. CONSTRUCTION PHASE

Prior to executing the construction phase of the development, a detailed erosion and sediment control plan would be developed for the site in accordance with Ku-ring-gai Councils guidelines and the NSW Blue Book (*NSW DECC publication titled "Managing Urban Stormwater – Soils and Construction" January 2008*).

The erosion and sediment control plan will outline the strategies proposed to prevent excessive pollutant loads being exported from the site in runoff during and immediately following construction (*ie primarily as a result of erosion*).

A summary of the principal elements of a preferred erosion and sediment control plan for the site is summarised below:

- Minimising the extent of disturbed surfaces at any one time (*i.e. staging of earthworks etc*);
- Stabilising disturbed surfaces immediately upon completion of works (*i.e. hydromulch or vegetation*);
- Diverting clean runoff around disturbed work areas (*i.e. using earth bunds/diversion mounds/channels*);
- Protecting stockpiles (*i.e. using silt fence, diversion bunds, temporary vegetative cover etc*);
- Implementation of dust control/suppression measures during works(*i.e. perimeter fencing, wind velocity monitoring, cessation of earthworks activities during high wind conditions, watering down disturbed areas, setup of recycled water irrigation sprays etc*);
- Use of sediment basins;
- Use of silt fencing downslope of disturbed surfaces;
- Use of silt socks or equivalent around existing drainage structures;
- Use of rock /haybale/mulch check dams along designated overland flow paths;
- Protection of exposed slopes;
- Restriction of vehicle entry/exit points to construction zones;
- Setup of stabilised site access points; and
- Setup of vehicle washdown/wheel wash baths at exit points of disturbed areas.

An illustration of the conceptual erosion and sediment control plan for the site is contained in **Figure 3.** Sediment basin sizing calculations are included at **Appendix I**.

9.2. OPERATIONAL PHASE

As part of the ultimate development proposal a number of Water Sensitive Urban Design (*WSUD*) measures are proposed as follows:

- Lot based rainwater reuse/recycling systems (*min 20KL tank per apartment block and 5KL per detached dwelling with water being reused*
- Litter baskets installed in all pits within the new subdivision (*ie Ecosol Litter Baskets or equivalent*);
- Two WSUD basins (*ie bio-retention basins*);
- A series of natural pools and riffles constructed along the central drainage channel;
- Minimisation of impervious surfaces; and
- Use of water efficient fixtures for each new dwelling.

These measures will control urban generated pollutants and minimise the export of suspended solids, nutrients and litter from the site.

The software package developed by the CRC for Catchment Hydrology termed "MUSIC" (*Model for Urban Stormwater Improvement Conceptualisation*) was used to assess the effectiveness of the proposed "*treatment train*".

Details of the MUSIC modelling exercise (*including results*) are included at **Appendix D** and summarised in the following sections.

8.2.1 TREATMENT TARGETS

The treatment targets as recommended by DECCW, SWC and Ku-ring-gai Council will be adopted for the proposed development. These targets presented in **Table 1.**

Table 1 – Treatment Targets (*DECCW, SWC and Council*)

	WATER QUALITY % reduction in pollutant load			
	Gross Pollutants GP (> 5mm)	**Total suspended solids (TSS)**	**Total Phosphorus (TP)**	**Total Nitrogen (TN)**
Treatment Targets	90	80	60	45

9.2.2 MUSIC

To ensure the objectives outlined in **Section 8.2.1** can be achieved, a MUSIC model has been established for the proposed development.

MUSIC is a continual-run conceptual water quality assessment model developed by the Cooperative Research Centre for Catchment Hydrology (*CRCCH*). MUSIC can be used to

estimate the long-term annual average stormwater volume generated by a catchment as well as the expected pollutant loads. It is able to conceptually simulate the performance of a group of stormwater treatment measures (*treatment train*) to assess whether a proposed water quality strategy is able to meet specified water quality objectives.

MUSIC was chosen for this investigation because it has the following attributes:

- It can account for the temporal variation in storm rainfall throughout the year;
- Modelling steps can be as low as 6 minutes to allow accurate modelling of treatment devices;
- It can model a range of treatment devices;
- It can be used to estimate pollutant loads at any location within the catchment; and
- It is based on logical and accepted algorithms.

Where appropriate we have utilised the recommendations of Ku-ring-gai Councils 2010 MUSIC modelling guidelines in compiling the MUSIC model for the subject site.

Rainfall

Rainfall data adopted in the MUSIC modelling exercise was sourced from the Bureau of Meteorology (*BOM*). A rainfall range over a number of years (*1996 to 1999 inclusive*) was selected to exceed the annual average for the region. In addition, a mix of dry, average and wet years was included in the selected range.

Evaporation

Monthly areal Potential Evapotranspiration values were obtained for the site from the 'Climate Atlas of Australia, Evapotranspiration' (*Bureau of Meteorology, 2001*) and are shown in **Table 2**.

Table 2 – Adopted Monthly Areal Potential Evapotranspiration

Month	Areal Potential Evapotranspiration (mm)
January	170
February	145
March	130
April	80
May	61
June	45
July	45
August	60
September	90
October	130
November	151
December	165

Sub Catchment Areas

The total site was broken into a number of sub catchments in accordance with the proposed development layout and proposed treatment measure locations. Details of the sub catchment area characteristics are provided in **Table 3**.

The developable area and impervious fraction within the developable areas of the site were calculated to be around 1.4ha and 60% respectively.

Table 3 – Sub catchment Characteristics

Sub catchment Name	Area (m^2)	% Impervious
House 1-4 Roof	940	100%
House 1-4 Non Roof	3,350	30%
Road -Driveway	430	85%
	4,720	
Existing D Roof	361	100%
Existing D Non Roof	821	50%
	1,182	
Building 4 Roof	930	100%
Building 4 Non Roof	870	50%
	1,800	
Building 1 and 3 Roof	2,340	100%
Building 1 and 3 Non Roof	4,320	45%
	6,660	
TOTAL Developable Area (Net)	**14,362**	**61%**
Creek 1	3,036	5%
Creek 2	2,373	5%
Creek 3	2,195	5%
Creek 4	2,091	5%
	9,695	**5%**
TOTAL Site (Gross)	**24,057**	**38%**

Soil Data / Characteristics

For this study the MUSIC soil properties as stipulated in Ku-ring-gai's 2010 MUSIC guidelines have been adopted. This data is summarised in **Table 4.**

Table 4 – Adopted Soil Data

	Units	Post Development
Impervious area parameters		
Rainfall threshold	mm/day	1.5
Pervious area parameters		
Soil storage capacity	mm	300
Initial storage	% of capacity	20
Field capacity	mm	172
Infiltration capacity coefficient – a		200
Infiltration capacity coefficient – b		1
Groundwater properties		
Initial depth	mm	1
Daily recharge rate	%	25
Daily base flow rate	%	5
Daily deep seepage rate	%	4

EMC Values

The EMC values as stipulated in Ku-ring-gai's 2010 MUSIC guidelines have been adopted (*refer to **Table 5***).

Table 5 – EMC Values

	Storm Flow						Base Flow					
	TSS		TP		TN		TSS		TP		TN	
	Mn	SD	Mn	SD	Mn	SD	Mn	SD	Mn	SD	Mn	SD
Land use	*(all values expressed as log_{10} mg/l)*											
General urban	2.20	0.32	-0.45	0.25	0.42	0.19	1.10	0.17	-0.82	0.19	0.32	0.12
Roof	1.55	0.39	-0.92	0.29	0.42	0.19	1.10	0.17	-0.82	0.19	0.32	0.12
Forest /Natural	1.90	0.20	-1.10	0.22	-0.075	0.24	0.9	0.13	-1.50	0.13	-0.14	0.13

9.2.3 PROPOSED TREATMENT TRAIN

An illustration of the latest MUSIC network constructed to represent the site under developed conditions is contained at **Diagram 2**. The treatment train consists of rainwater tanks collecting roof runoff for reuse, litter baskets, OSD tanks, natural pools/riffles and two WSUD basins.

Further details of the individual components of the proposed treatment system are provided below.

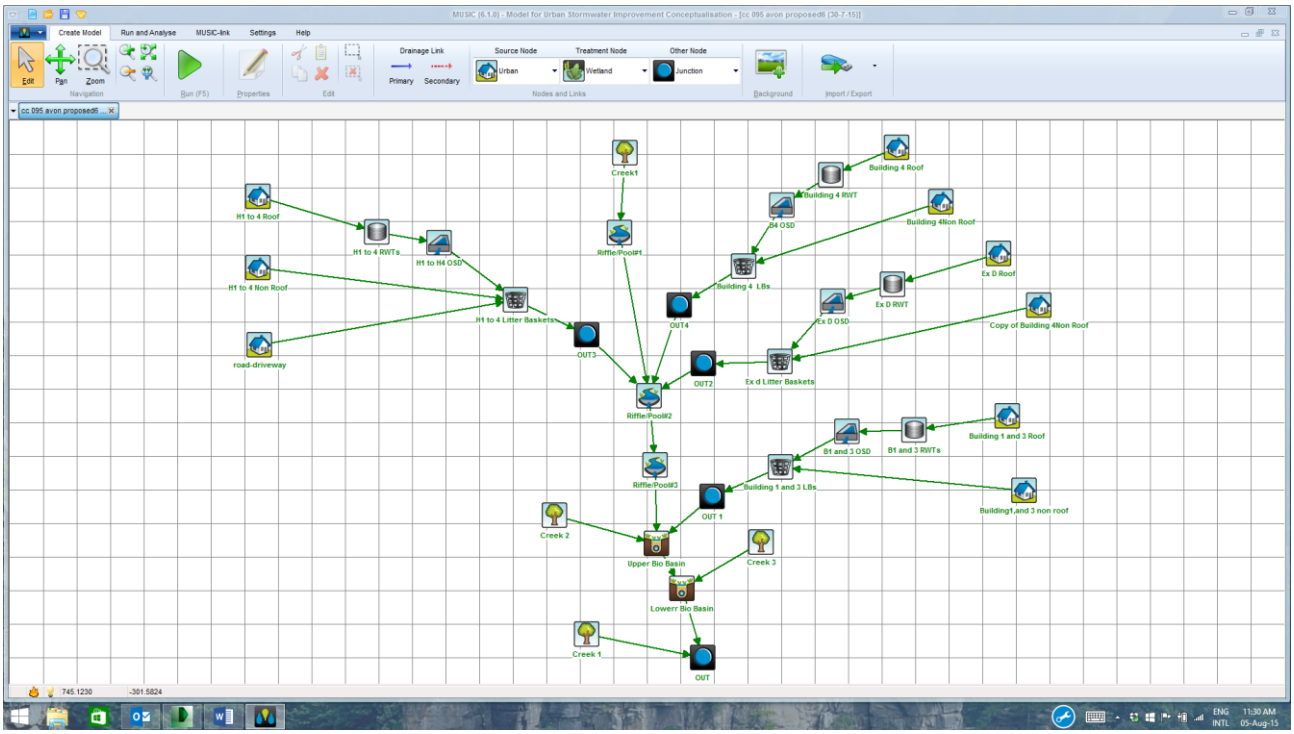


Diagram 2 - Post Development MUSIC Network Diagram

Rainwater Tanks

Rainwater tanks indirectly reduce pollutant load by collecting and storing rainwater for reuse in non-potable applications. If the annual volume of water discharged from the site is reduced then in theory the annual pollutant load carried by this water is also reduced. Rainwater tanks also assist in the reduction of potable water demand. For this site we have assumed adoption of a 20KL storage volume and a reuse rate of 5KL/day per building and 5KL storage volume and a reuse rate of 0.2KL/day for the stand alone residential dwellings (*Total volume for site 85KL*). Water collected from the building/dwelling roofs will be reused

Litter Baskets

Litter baskets are a form of primary stormwater treatment designed to capture litter, debris and coarse sediment.

All stormwater inlet pits serving the site will be fitted with litter baskets (*similar to GPTs but on a smaller scale and close to the source*), as convenient and accessible maintenance points are not available near the main drainage outlets serving the site. The proposed litter baskets will be "*Ecosol Litter Baskets*" or equivalent (refer to hyperlink http://www.ecosol.com.au/ecosol-litter-basket/ for details).

While the pollutant capture efficiency of various traps may vary from model to model, the following generic capture rates have been adopted as a reasonable middle ground for this study:

- Gross pollutants majority (95%);
- Total suspended sediments up to 80%;
- Total phosphorous up to 30%; and
- Total nitrogen 13%.

WSUD Basins

Two bio-retention basins are proposed at the downstream end of the site. Both are proposed to be constructed in the lower reaches of the site, where the drainage line transitions to a gentler grade (*ie adjacent to the old tennis courts*). A large open/flat area currently exists at/near the proposed basin locations, which appears to have previously contained a small waterbody.

The primary treatment mechanism for the proposed WSUD basins will be detention/settling, take up of nutrients by plants, filtering treatment and other biological and chemical process. They are a demonstrated natural treatment system.

The basins will be divided into two zones by weirs. The upper zone basin will have a weir level of RL125.0mAHD and the lower zone basin a weir level of RL123.mAHD. These weirs will allow for an extended detention depth of 0.3m (ie via incorporation of a low flow notch or pipe). Above this level water will overtop and continue downstream. Note that the ground floor level of the nearest building is RL125.7mAHD (*ie 700mm above the highest weir level*).

The proposed WSUD basin properties are summarised below in **Table 6.** Refer to **Figures 1 and 4** for details**.**

Table 6 – Minimum WSUD Basin Properties

	Upper Basin	Lower Basin
Extended Detention Depth	0.3	0.3
Surface Area (m^2)	275	275
Filter Area(m^2)	250	250
Filter depth(m)	1	1
Hydraulic conductivity (mm/hr)	90	90
Exfiltration (mm/hr)	4	4

Pool/Riffle System

A series of natural pools and associated riffles will be constructed as part of the bushland rehabilitation process along the main drainage channel running thru the site.

The riffles will slow flows and promote sedimentation. They will also provide aquatic habitat.

For this preliminary assessment it has been assumed that a total storage volume of $10m^3$ will be provided by the channel pools.

OSD Tanks

Below ground onsite detention tanks are proposed at the source for all new dwellings/apartments. The sizing of these tanks is summarised in **Section 10** of this report.

The tanks will have a small benefit on water quality as coarse sediment and trash will be collected within the sumps of the proposed tanks and outlet litter screens.

The effect of this minor treatment has been included in the latest MUSIC modelling.

8.2.4 MUSIC MODELLING RESULTS

The post development MUSIC modelling results are summarised in **Table 7**.

The results show that implementation of the proposed WSUD features readily allows achievement of the stated treatment targets.

Table 7 – MUSIC MODELLING RESULTS

Music model	Location	Annual Flow and Pollutant Load Results				
		Flow	TSS	TP	TN	GP
		(ML/yr)	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
Developed (With Treatment)						
	All Source Nodes	15.5	1,630	3.58	36.9	331
	Residual Load at Outlet	7.3	78.3	1.41	6.65	5.04
% Treat Train Effectiveness		**53**	**95**	**61**	**82**	**99**
Achieve Objectives			>80%	>60%	>45%	>90%
			Yes	Yes	Yes	Yes

9.2.5 MAINTENANCE OF TREATMENT MEASURES

To maintain effectiveness, a maintenance regime would be implemented for all proposed treatment measures. Maintenance would be the responsibility of the community. This would typically consist of the following:

- Periodic (*6 monthly*) inspection and removal of any gross pollutants & coarse sediment that is deposited in the WSUD bio-retention basins and replacement of vegetation as necessary;
- Periodic (*6 monthly*) inspection and removal of any gross pollutants & coarse sediment that is deposited in the pools/riffles and repair of log/rock riffles as necessary;
- Periodic (*3 monthly*) and episodic (*post storm greater than 1 yr ARI*) inspection and if required removal of trapped pollutants from all litter baskets; and
- Periodic (*annually)* inspection (*and flushing if required*) of the rainwater/OSD tanks.

10. STORMWATER QUANTITY/DETENTION

As the development will result in an increase in impervious fraction compared to existing conditions, stormwater detention is proposed to mitigate any increase in flows.

Ku-ring-gai Councils DCP47 stipulates a detention rate for the subject site as follows:

- Catchment AC1 (*refer to Map at **Appendix E***) ;
- PSD - 102L/s/ha
- SSR - 398m^3/ha.

Based on the developable area for the site (*ie 1.4ha*) this translates to a permitted site discharge (PSD) of 142.8L/s and a total detention storage of 557.2m^3.

It is proposed that below ground detention tanks will be provided for all buildings to temporarily detain site generated flows. These tanks are likely to be constructed within the basement areas of each building. The total detention volume provided by these measures equals 540m^3. A breakdown of the proposed minimum OSD volumes is provided below:

- House 1 5m^3
- House 2 5m^3
- House 3 5m^3
- House 4 5m^3
- Existing Dwelling 5m^3
- Building 1 170.3m^3
- Building 3 170.3m^3
- Building 4 170.3m^3

The remaining detention will be provided within the sites rainwater tanks (*Total RWT volume = 85m^3*). Large rainwater tanks as proposed (*ie 20KL*), particularly those with high reuse rates, have been shown to have an effective detention component of up to 50% of the total storage volume. For this site we are assuming a modest 25% effective detention rate, yielding a total detention volume of 21.25m^3.

The proposed total detention volume of 557.2m^3 matches the minimum required by Councils DCP.

Preliminary RAFTS modellings shows that this volume combined with the allowable PSD will reduce site discharges below existing conditions, leading to a reduction in total peak flows experienced downstream of the site.

- Q100 pre (*Downstream end of site*) = 3.2m^3/s;
- Q100 post (*No Detention*) = 5m^3/s
- Q100 post development (*incl OSD*) = 3.0m^3/s

10.1 OSD TANK LOCATIONS/DETAILS

10.1.1 HOUSING LOTS 1 - 4

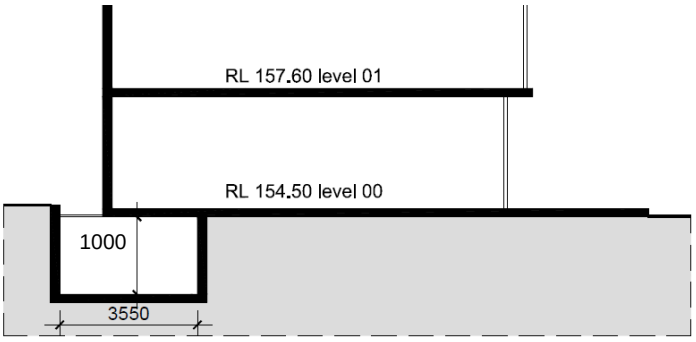
Detailed Architectural drawings have been prepared for the proposed Dwellings on Lots 1 to 4 which include siting of the proposed below ground rainwater and detention tanks (*refer to **Appendix J**).*

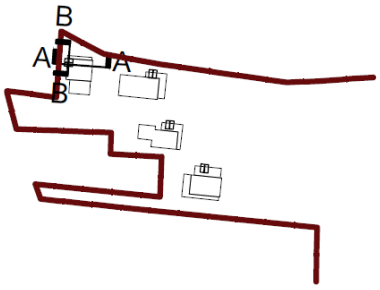
All tanks are proposed to be constructed within the building footprint and do not impact on existing trees to be retained. The tanks will be constructed below ground and will consist of a single 1m deep tank of 10m^3 split into two separate storage zones. The first zone will contain permanent storage for internal reuse (*ie the 5m^3 rainwater tank*). Overflow from the 1st zone will spill into the second zone which will consist of the OSD system to detain and slowly release runoff to pre development levels (*ie the 5m^3 OSD tank*).

Diagrams 3 to 6 illustrate the proposed tank locations for each House.

The invert and top water surface level in the four tanks would be as follows:

	Invert of tanks (mAHD)	***TWL (mAHD)***
House 1	153.2	154.2
House 2	144.5	145.5
House 3	144.5	145.5
House 4	144.5	145.5





RL 153

HOUSE 1 SECTION A-A
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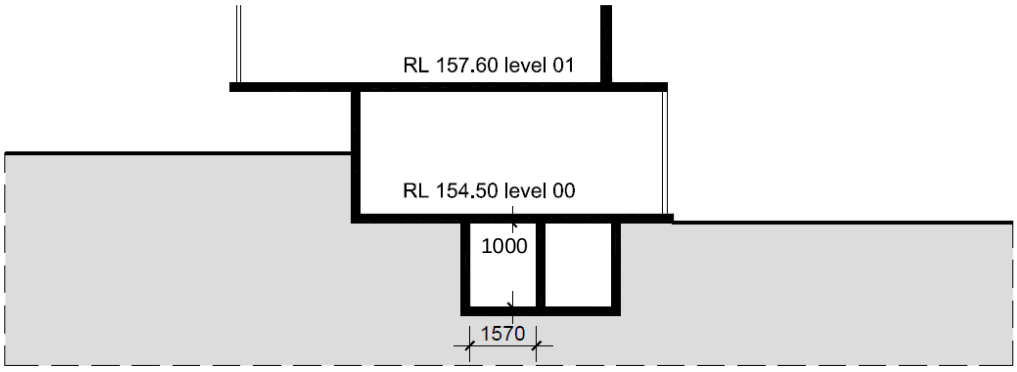

SECTION B-B
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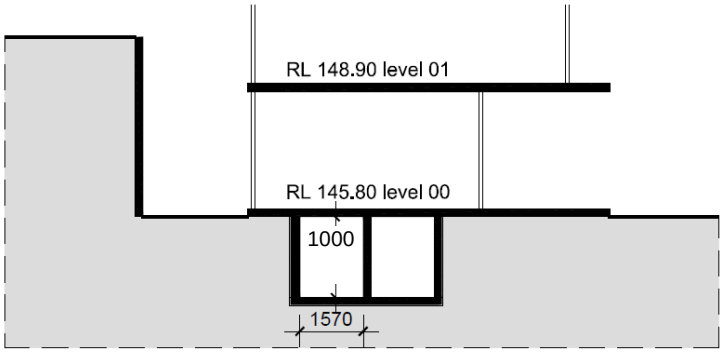
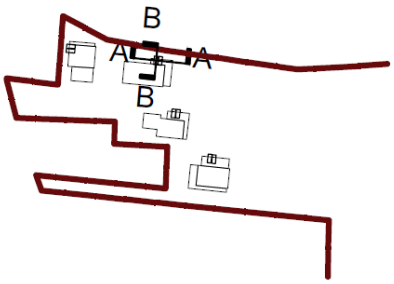
Diagram 3 – OSD and Rainwater Tank Location for House 1 (Invert level 153.2mAHD)





RL 144

HOUSE 2 SECTION A-A
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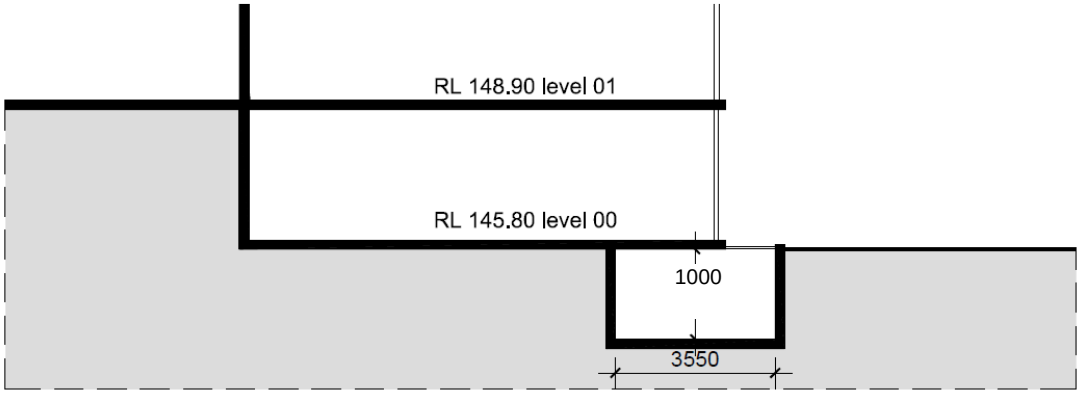

SECTION B-B
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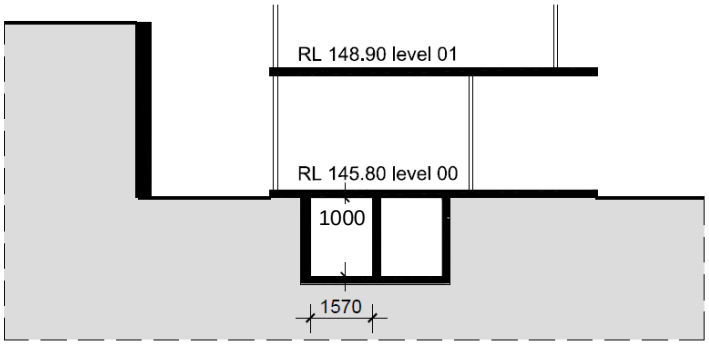
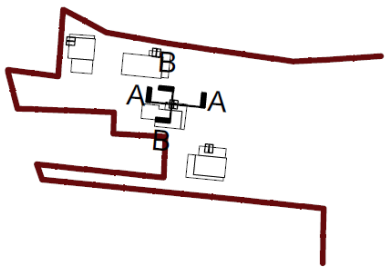
Diagram 4 – OSD and Rainwater Tank Location for House 2 (Invert level 144.5mAHD)





RL 144

HOUSE 3 SECTION A-A
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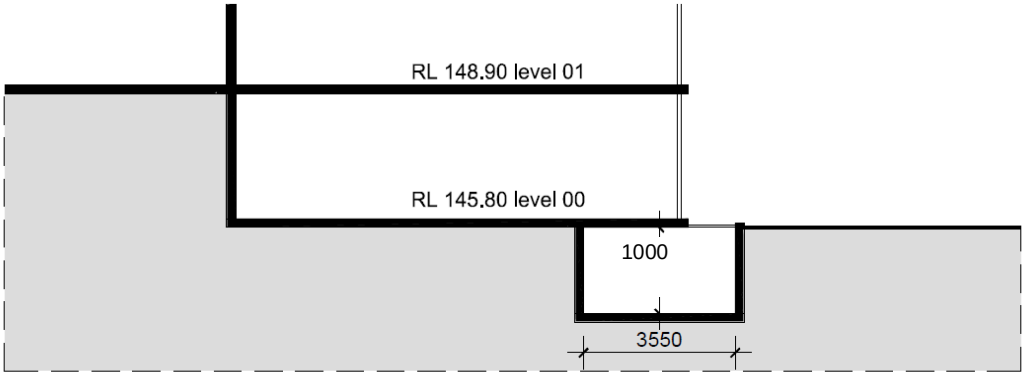

SECTION B-B
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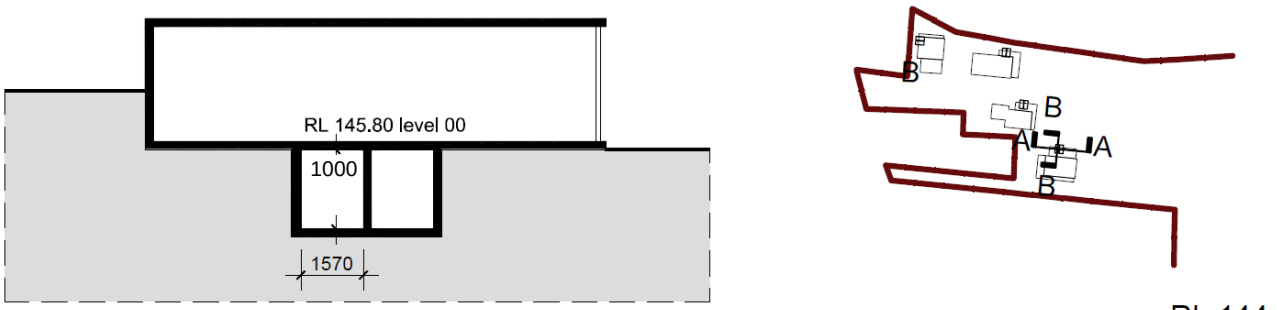
Diagram 5 – OSD and Rainwater Tank Location for House 3 (Invert level 144.5mAHD)



HOUSE 4 SECTION A-A
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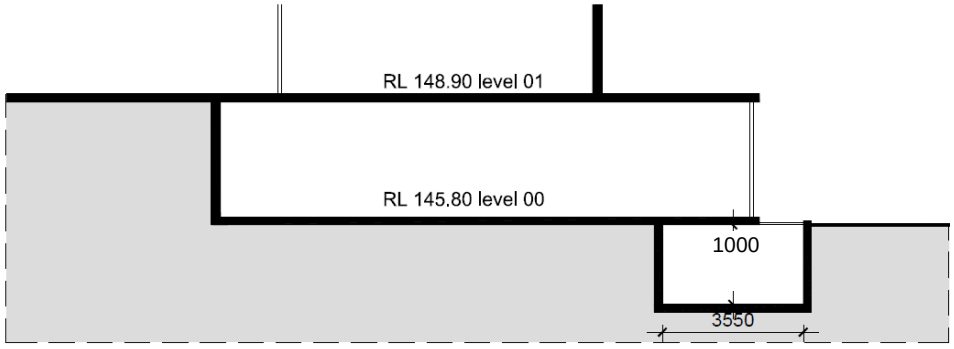

SECTION B-B
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Diagram 6 – OSD and Rainwater Tank Location for House 4 (Invert level 144.5mAHD)

10.1.2 APARTMENT BUILDING 1

Building 1 will contain a large combined Rainwater/OSD tank below the basement. The rainwater storage zone will total 20m^3 and the OSD zone 170.3m^3 (total storage volume of 190.3m^3).

The tank would be approximately 1.3m deep (*invert level 124.1mAHD*). The top water level would be 125.4mAHD.

Diagram 7 illustrates the tank location for Building 1.

10.1.3 APARTMENT BUILDING 3

Building 3 will contain a large combined Rainwater/OSD tank below the basement. The rainwater storage zone will total 20m^3 and the OSD zone 170.3m^3 (total storage volume of 190.3m^3).

The tank would be approximately 1.1m deep (*invert level 124.3mAHD*). The top water level would be 125.4mAHD.

Diagram 8 illustrates the tank location for Building 3.

10.1.4 APARTMENT BUILDING 4

Building 4 will contain a large combined Rainwater/OSD tank below the basement. The rainwater storage zone will total 20m^3 and the OSD zone 170.3m^3 (*total storage volume of 190.3m^3*).

The tank would be approximately 1.7m deep (*invert level 129.9mAHD*). The top water level would be 131.6mAHD.

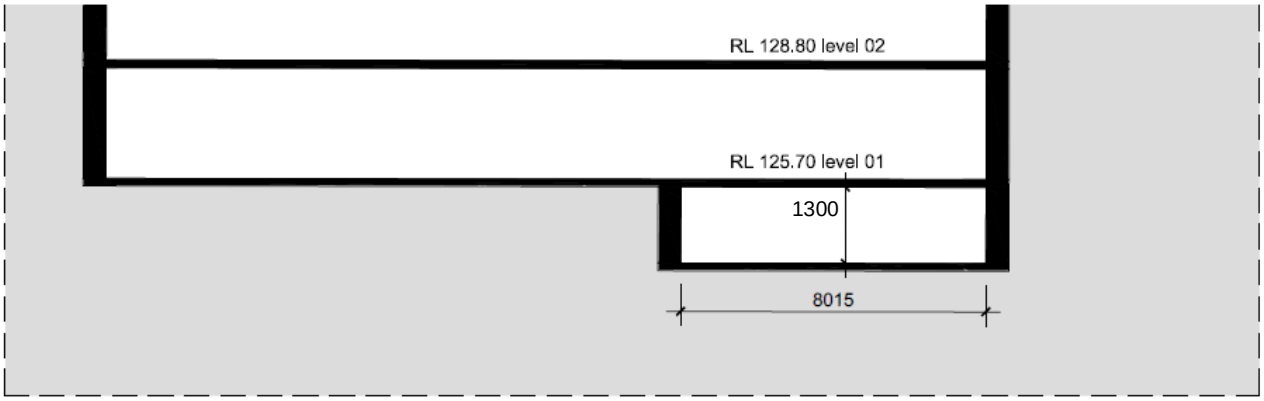
Diagram 9 illustrates the tank location for Building 4.

10.1.5 EXISTING HERITAGE DWELLING

The existing heritage dwelling will also accommodate a detention tank (5m^3) and rainwater tank (5m^3). Both will be below ground located to the east of the existing house.

The approximate tank invert would be 143.9mAHD. The top water level would be 144.9mAHD.

Diagram 10 illustrates the approximate tank locations for the existing heritage dwelling.



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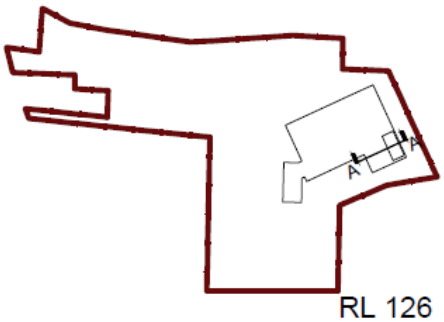

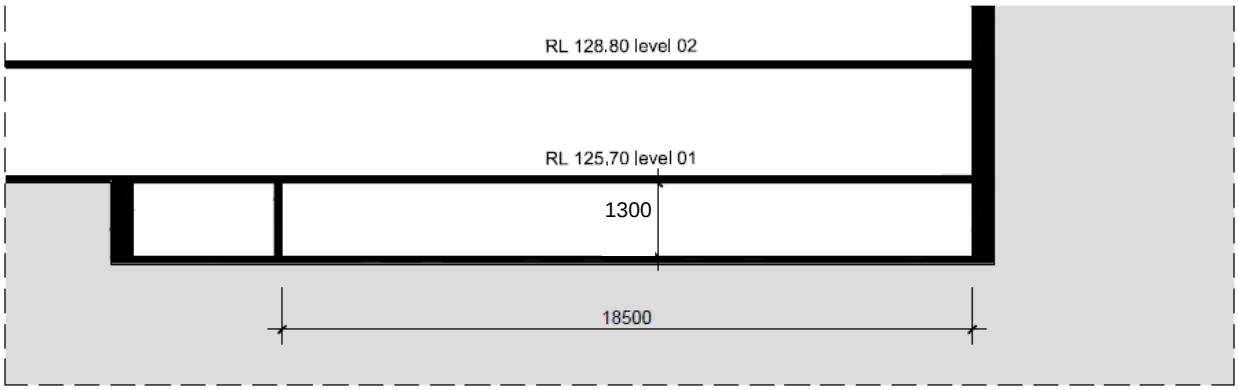

BUILDING 1 SECTION B-B
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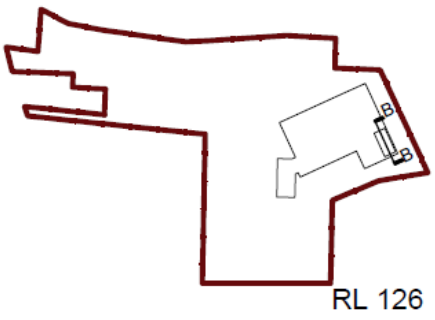
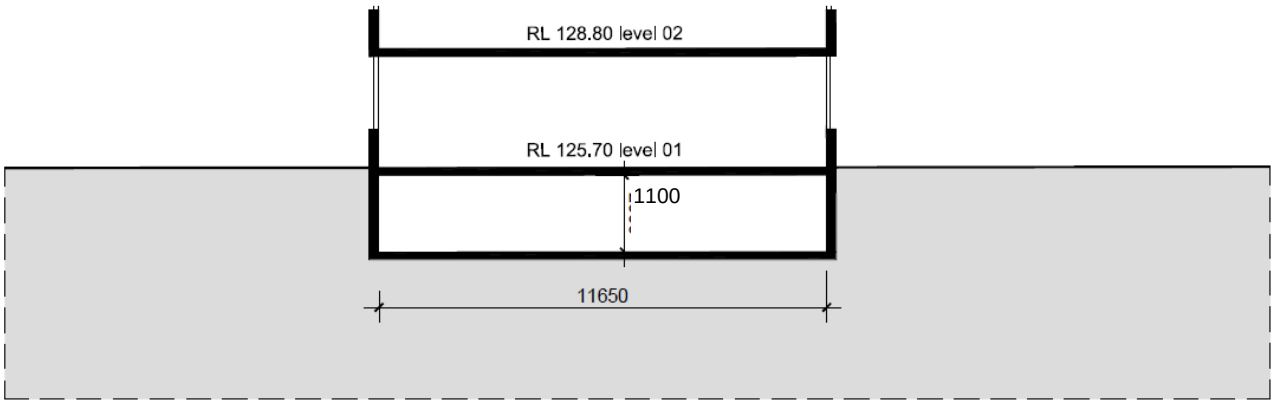
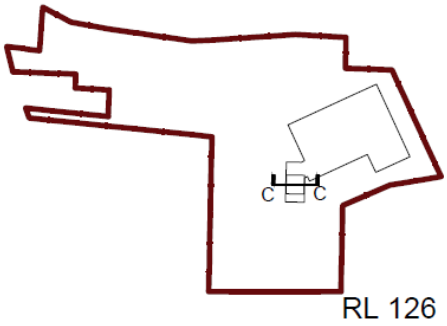
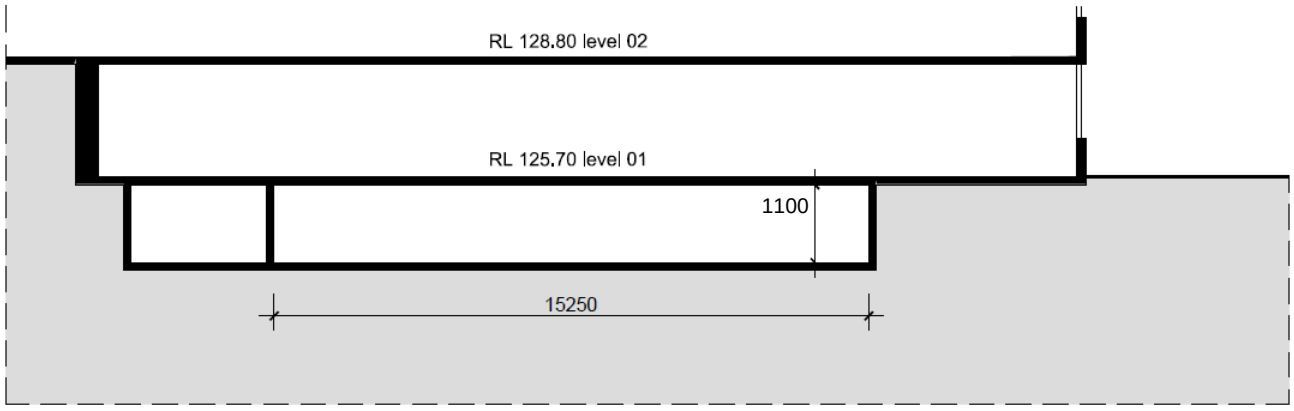


Diagram 7 – OSD and Rainwater Tank Location for Apartment Building 1



BUILDING 3 SECTION C-C
SCALE 1:200@A3





BUILDING 3 SECTION D-D
SCALE 1:200@A3

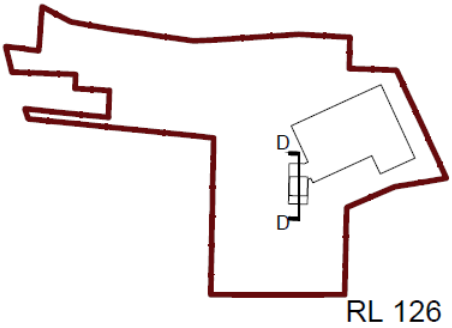
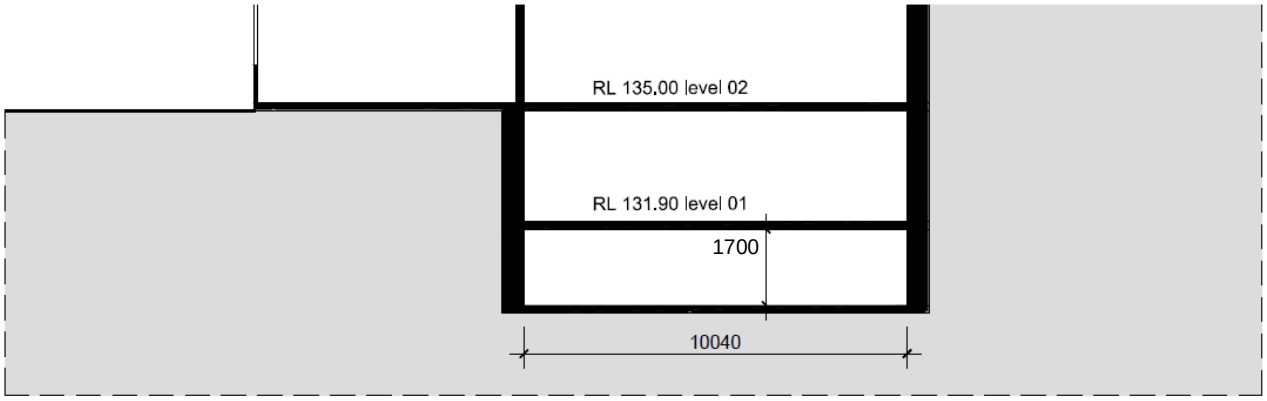
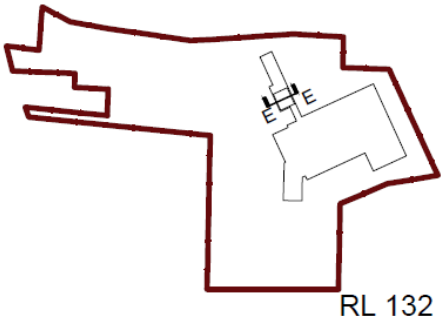
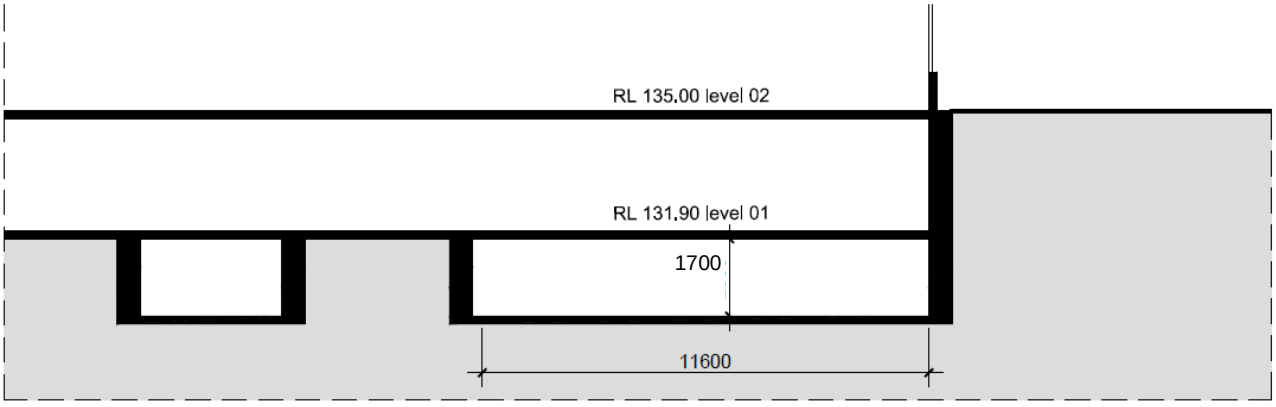


Diagram 8 – OSD and Rainwater Tank Location for Apartment Building 3



BUILDING 4 SECTION E-E
SCALE 1:200@A3





BUILDING 4 SECTION F-F
SCALE 1:200@A3

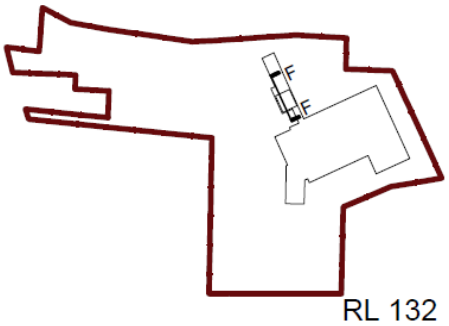


Diagram 9 – OSD and Rainwater Tank Location for Apartment Building 4

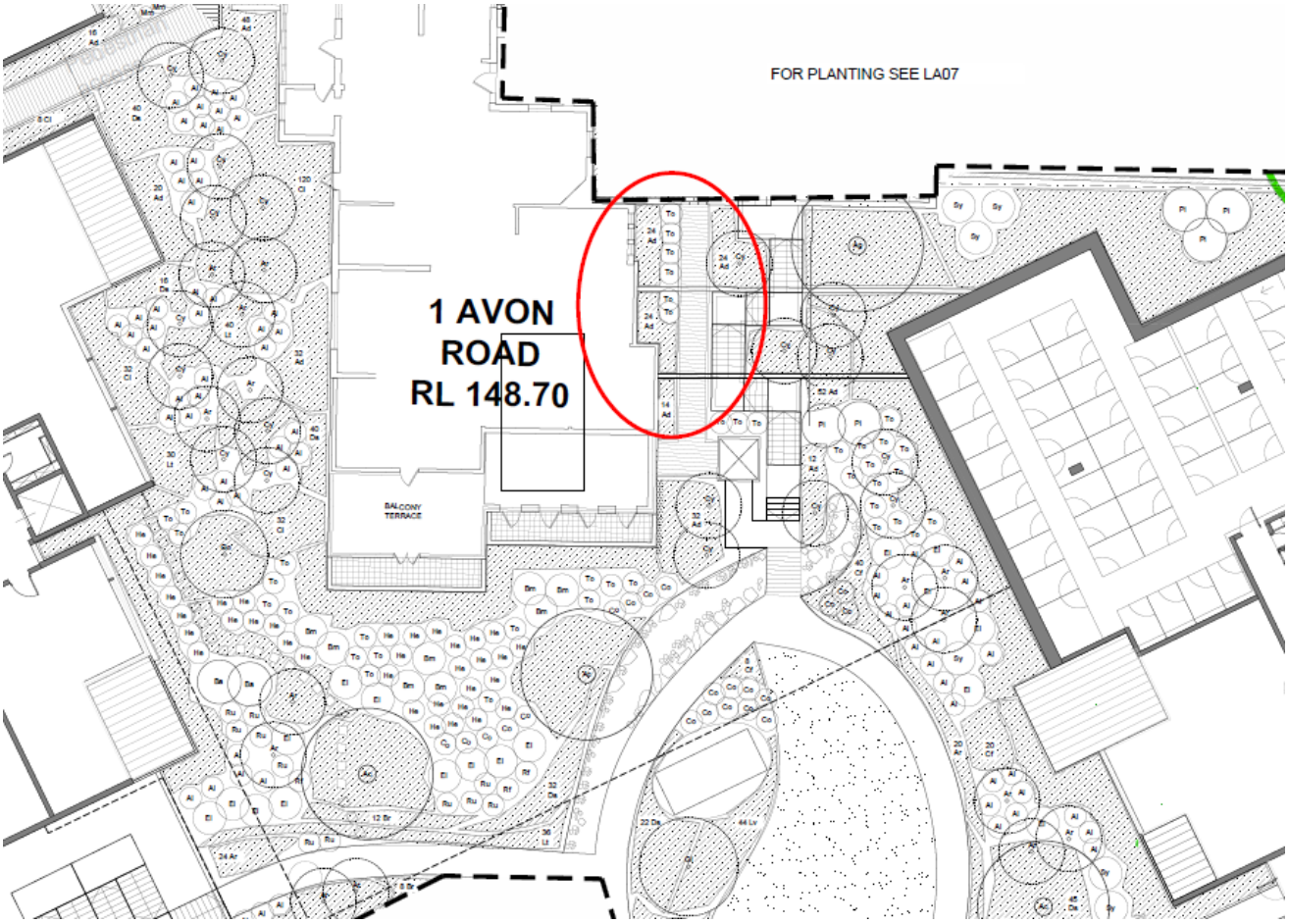


Diagram 10 – OSD and Rainwater Tank Location for Existing Heritage Dwelling

11. STORMWATER DRAINAGE CONCEPT PLAN (SDCP)

Detailed design of the major/minor drainage system within the site would ensure 50yr ARI flows are fully contained within the internal piped drainage system and localised 100yr ARI flooding will be confined to pathways/designated overland flow paths.

Minor flows generated by the developable areas of the site (ie *driveways, landscaped areas, rainwater tank overflow etc*) would be conveyed in internal pipelines which would ultimately discharge to the central drainage channel. All new lines would be accompanied by sufficient inlet pits.

All outlets into the central drainage line would be constructed of natural rock and contain energy dissipation/outlet stabilisation.

The existing drainage channel running through the centre of the site is proposed to be enhanced by natural vegetation. This will not only stabilise the drainage line but provide habitat and treatment. Pools and riffles will be constructed along the drainage line to further enhance these functions.

Refer to **Figure 2** for an illustration of the proposed stormwater drainage concept plan.

12. SIZING OF OUTLET PIPES AND ASSOCIATED STABILISATION

To assess the potential impact of proposed stormwater infrastructure on existing trees, Council has requested details of outlet pipe sizes and the extent of associated outlet stabilisation measures (*ie rip rap*).

A DRAINS model was formulated for the developed area of the site to determine post OSD hydrology, pipe sizes and outlet velocities.

An illustration of the constructed DRAINS network is contained below at **Diagram 11**.

All pipeline were designed to covey the peak 50yr ARI flow to the central drainage channel. The results of the DRAINS modelling are contained in **Table 8** and illustrated in **Diagram 12**.

Table 8 – DRAINS Modelling Outlet Results (50yr ARI)

Outlet #	Post Dev OSD 50yr ARI Flow (m3/s)	V max (m/s)	Dia. Out (mm) and Type	Depth Out Flow (mm)	D50(mm)	Length Apron (m)	Width Apron (m)
1	0.36	6.18	375 uPVC	281	450	6	2.8
2	0.07	4.21	225 uPVC	111	200	3	1.5
3	0.36	6.28	375 uPVC	261	450	6	2.8
4	0.10	4.25	225 uPVC	155	250	3	1.5

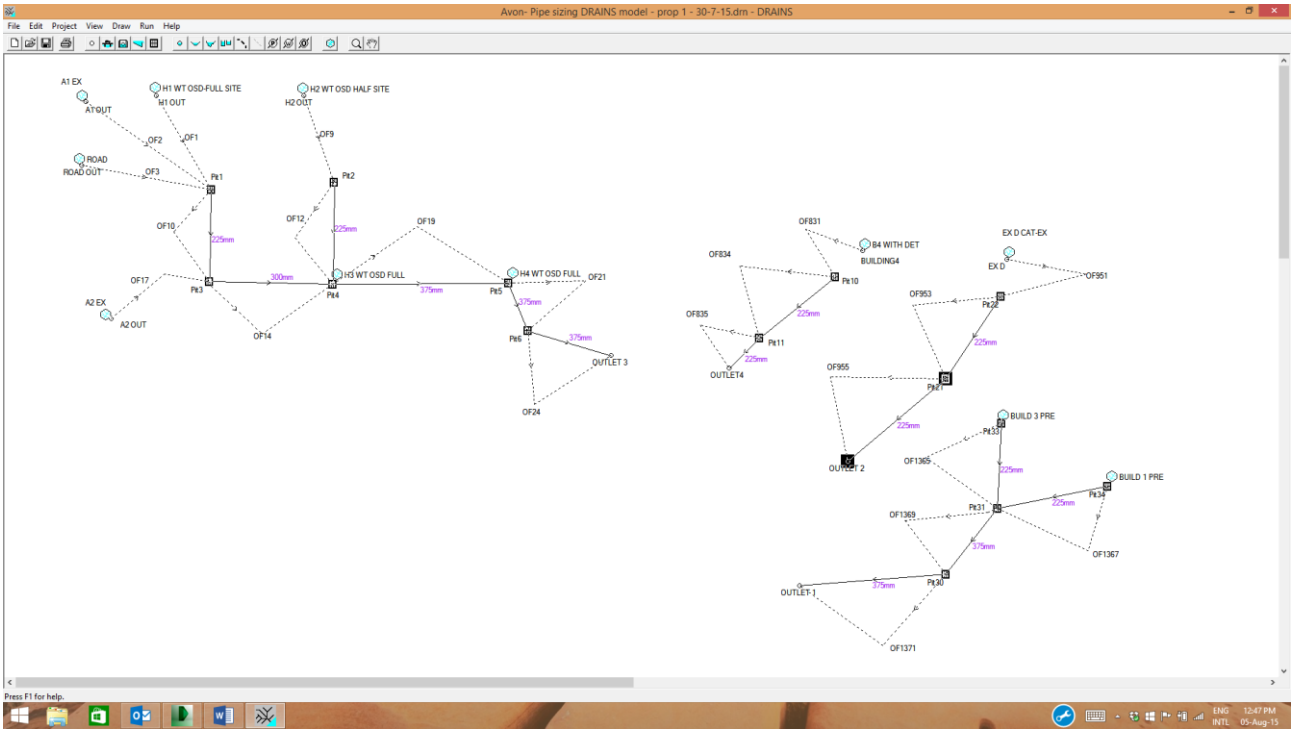


Diagram 11 – DRAINS Model Network Diagram

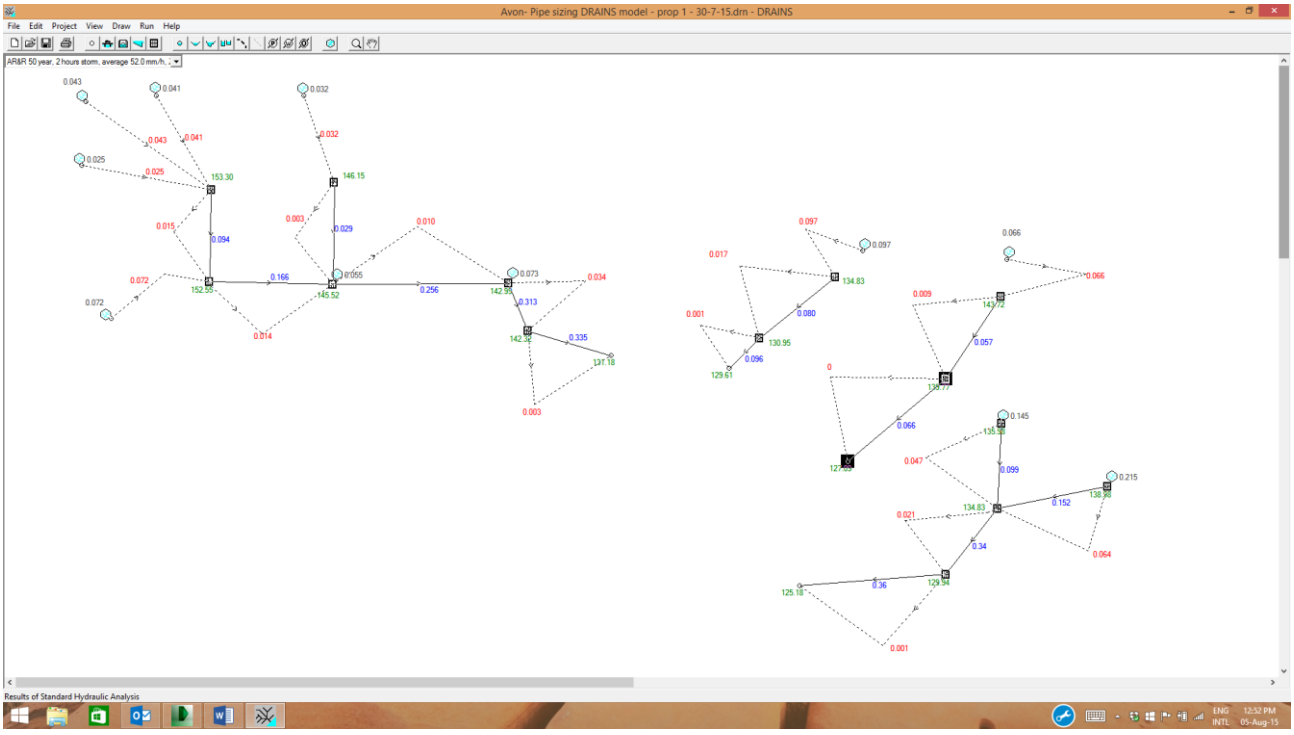


Diagram 12 – DRAINS Model Results (50yr ARI)

The modelling shows that the stormwater line serving housing Lots 1 to 4, and Buildings 1 and 3 require 375mm diameter outlets (*ie Outlets 1 and 3*). It also shows that the smaller catchments for the existing dwelling and Building 4 require a 225mm diameter outlet (*ie Outlets 2 and 4*).

It is proposed that all drainage lines would be constructed from light weight sewer grade PVC pipes. The average drainage trench depth would be 0.5-1.0m and would vary in width from 0.4m to 0.8m.

Based on the above hydraulic results the dimensions of the required outlet rip rap was calculated using the ASCE Practice Note 77 (*1992*). The results are contained in **Table 8**.

Typical details of the proposed natural rock rip rap outlet stabilisation measures are illustrated in **Figure 5**. The concept is to produce a naturalistic outlet as per NSW Office of Water Guidelines for Outlet Structures on Waterfront Land (*refer to* ***Diagram 13***).

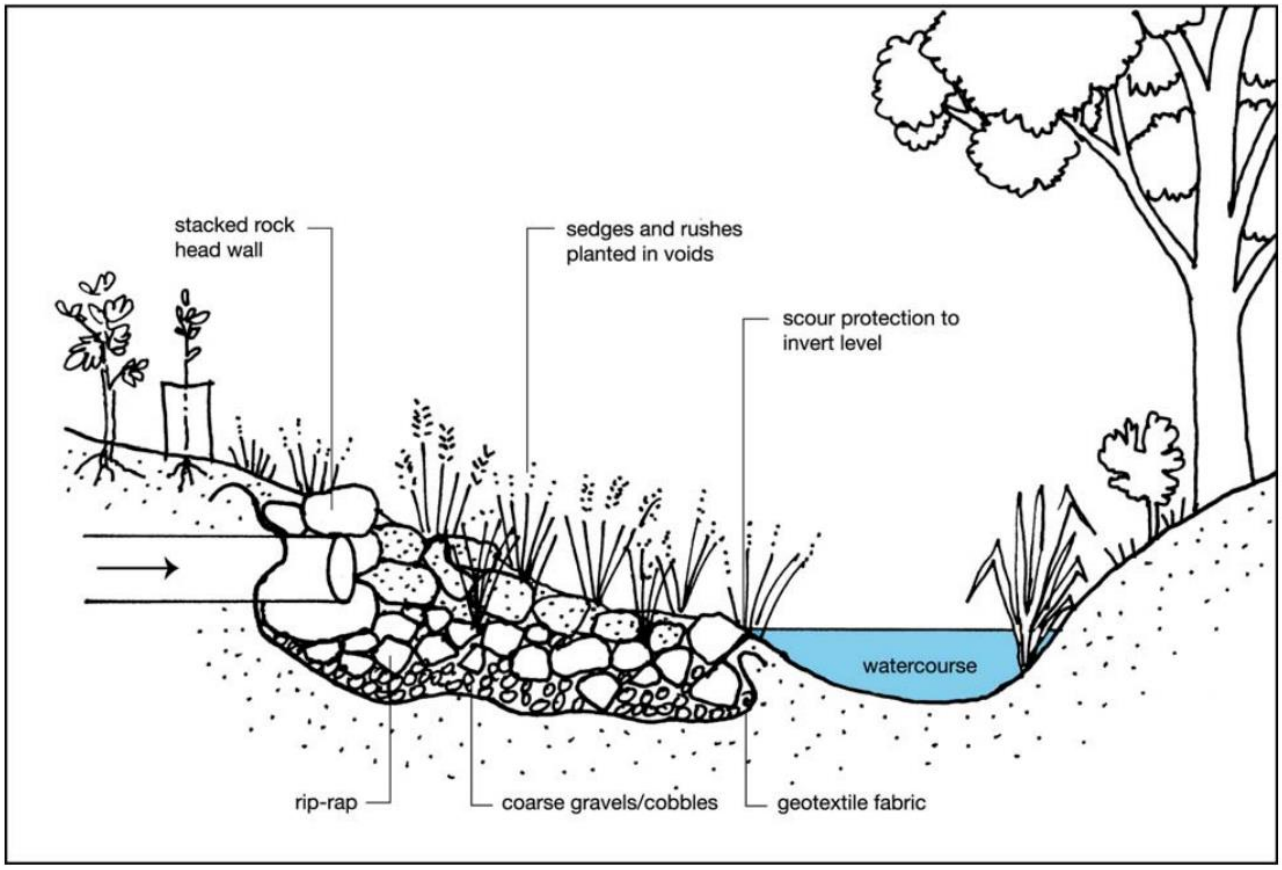


Diagram 13 – Outlet Concept

13. CONCLUSIONS

The following conclusions have been derived from this water management assessment:

- 100yr ARI and PMF flooding does not currently inundate the proposed building locations;
- Flooding under proposed conditions will not be altered downstream of the site;
- All habitable floor levels for the proposed development have more than 500mm freeboard to the 100yr ARI flood level and in fact are sited above the PMF level;
- The proposed development will manage water quality by implementing best practice WSUD treatment facilities. The treatment rates achieved align with best practice and Councils minimum requirements *;*
- On Site Detention (*OSD*) is proposed in accordance with Council's requirements to mitigate any increase in flows generated by the development. Preliminary modelling has shown that peak flows experienced downstream of the site will be reduced;
- OSD tanks and pipe drainage has been sited such that it will minimise disturbance to existing trees to be retained;
- A new site drainage system will be implemented to prevent nuisance flooding and protect the central drainage channel; and
- Outlet pipe sizes and associated rip rap dimensions have been provided.

14. QUALIFIERS

This report has been prepared by Mr Michael John Shaw. A copy of Michael's CV is included at **Appendix G**.

This report has been prepared for the benefit of Ausbao Pty Ltd 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 I 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.

We trust this report is satisfactory. Should you have any further queries, please do not hesitate to contact me on 0412 264 237.

Yours faithfully

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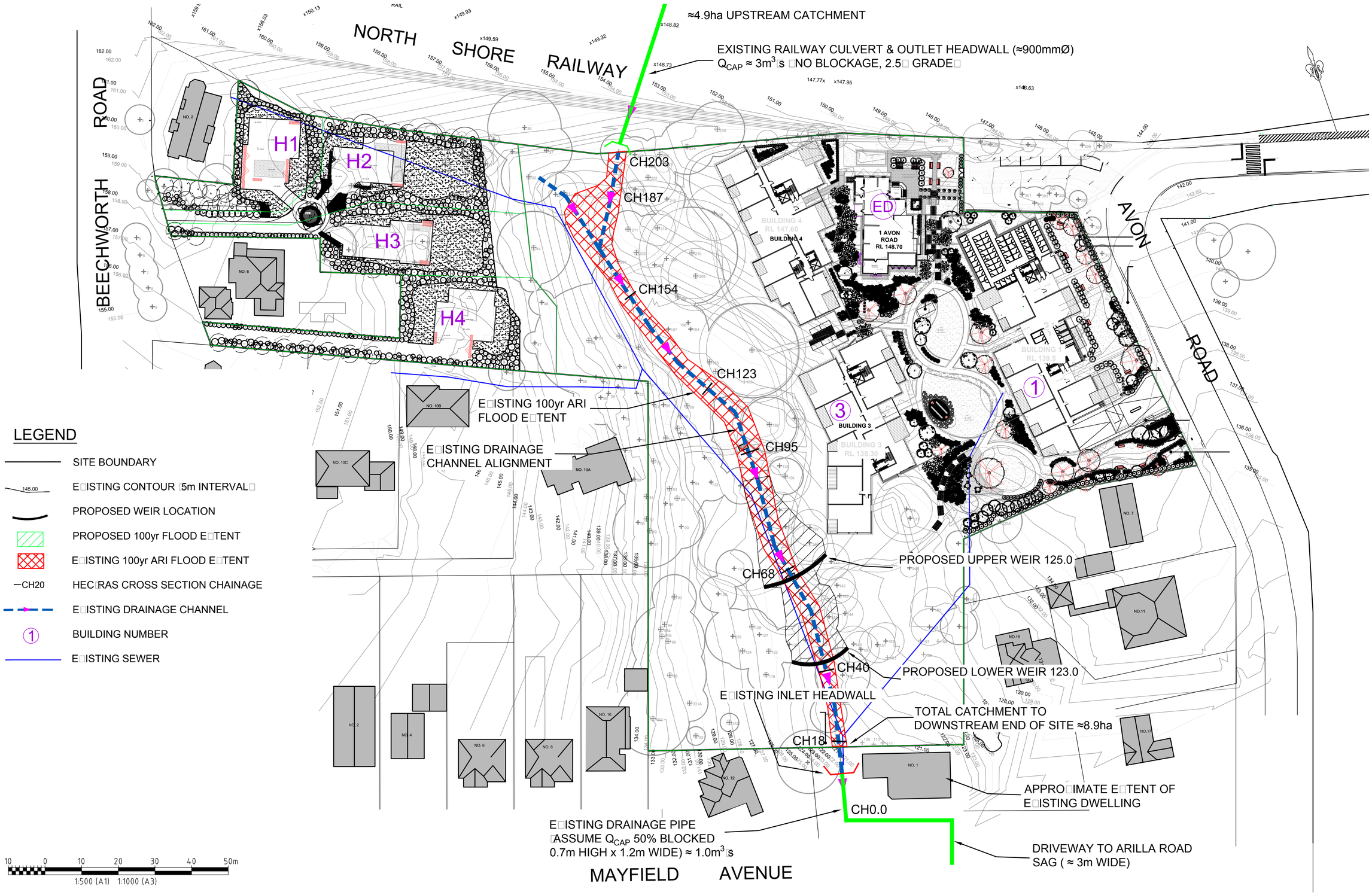
FIGURES



LEGEND

- SITE BOUNDARY
- 145.00 E□ISTING CONTOUR □5m INTERVAL□
- PROPOSED WEIR LOCATION
- PROPOSED 100yr FLOOD E□TENT
- E□ISTING 100yr ARI FLOOD E□TENT
- —CH20 HEC□RAS CROSS SECTION CHAINAGE
- E□ISTING DRAINAGE CHANNEL
- ① BUILDING NUMBER
- E□ISTING SEWER

10 0 10 20 30 40 50m
1:500 (A1) 1:1000 (A3)

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
G	EXTRA COUNCIL DETAIL ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
F	CLIENT NAME CHANGED	M.S.	C.H.	M.S.		11.05.15
E	DA ISSUE V5	M.S.	C.H.	M.S.		22.04.15
D	DA ISSUE V4	M.S.	C.H.	M.S.		21.10.14
C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

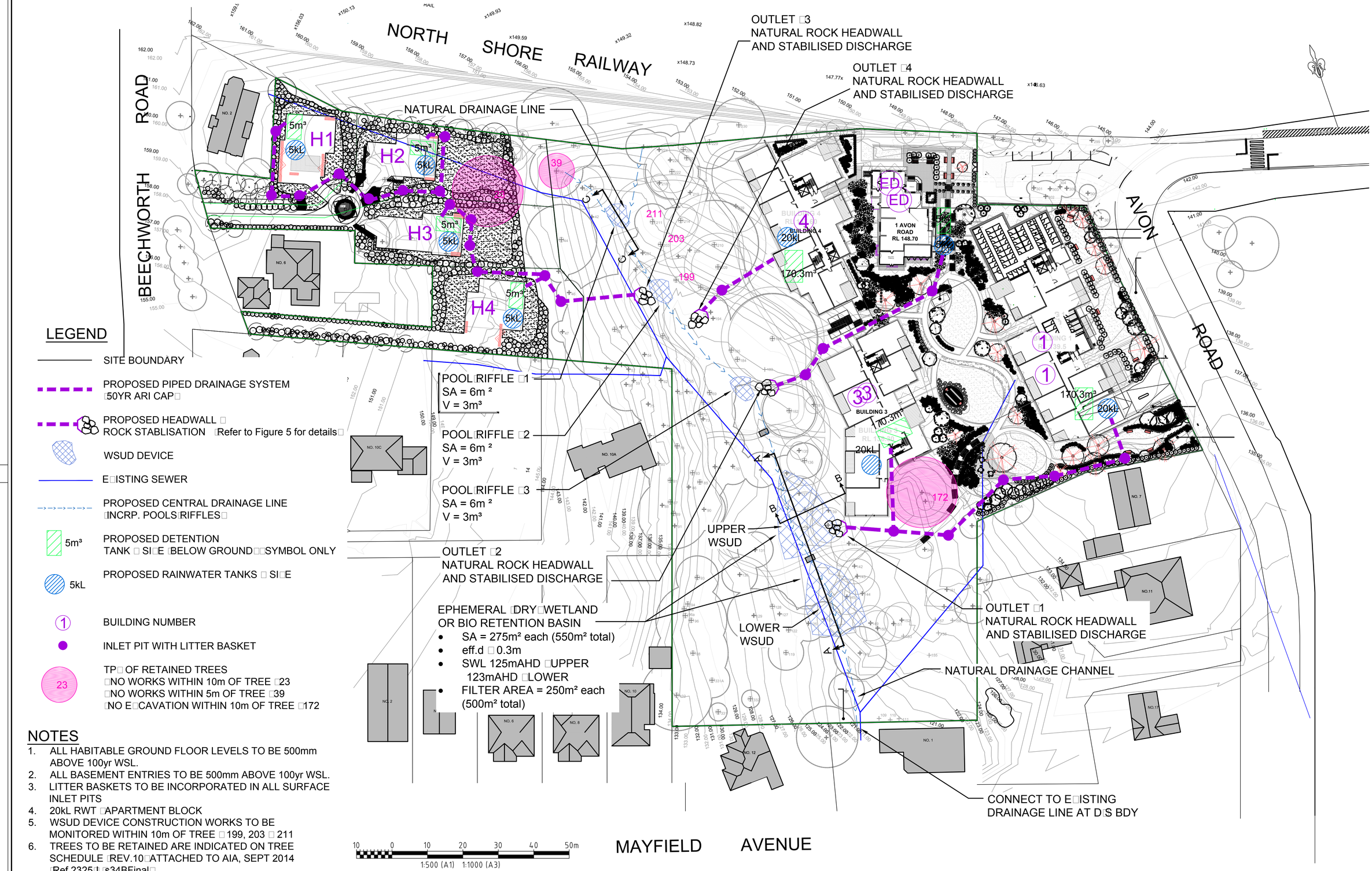
Title: FIGURE 1
HEC□RAS MODEL
E□ISTING 100yr FLOOD E□TENT
SCALE 1:500

Drawing No. 1 of 5

Issue: Rev [G] 8/08/15

Cad File No.: □ref.□s□ 1002 [G] - 01

A1



LEGEND

- SITE BOUNDARY
- PROPOSED PIPED DRAINAGE SYSTEM 50YR ARI CAP
- PROPOSED HEADWALL ROCK STABLISATION Refer to Figure 5 for details
- WSUD DEVICE
- EXISTING SEWER
- PROPOSED CENTRAL DRAINAGE LINE INCRP. POOLS RIFFLES
- 5m³ PROPOSED DETENTION TANK SIZE BELOW GROUND SYMBOL ONLY
- 5kL PROPOSED RAINWATER TANKS SIZE
- (1) BUILDING NUMBER
- INLET PIT WITH LITTER BASKET
- (23) TPO OF RETAINED TREES
  NO WORKS WITHIN 10m OF TREE 23
  NO WORKS WITHIN 5m OF TREE 39
  NO EXCAVATION WITHIN 10m OF TREE 172

NOTES

1. ALL HABITABLE GROUND FLOOR LEVELS TO BE 500mm ABOVE 100yr WSL.
2. ALL BASEMENT ENTRIES TO BE 500mm ABOVE 100yr WSL.
3. LITTER BASKETS TO BE INCORPORATED IN ALL SURFACE INLET PITS
4. 20kL RWT APARTMENT BLOCK
5. WSUD DEVICE CONSTRUCTION WORKS TO BE MONITORED WITHIN 10m OF TREE 199, 203 211
6. TREES TO BE RETAINED ARE INDICATED ON TREE SCHEDULE REV.10 ATTACHED TO AIA, SEPT 2014 Ref 2325 L s34BFinal

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B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

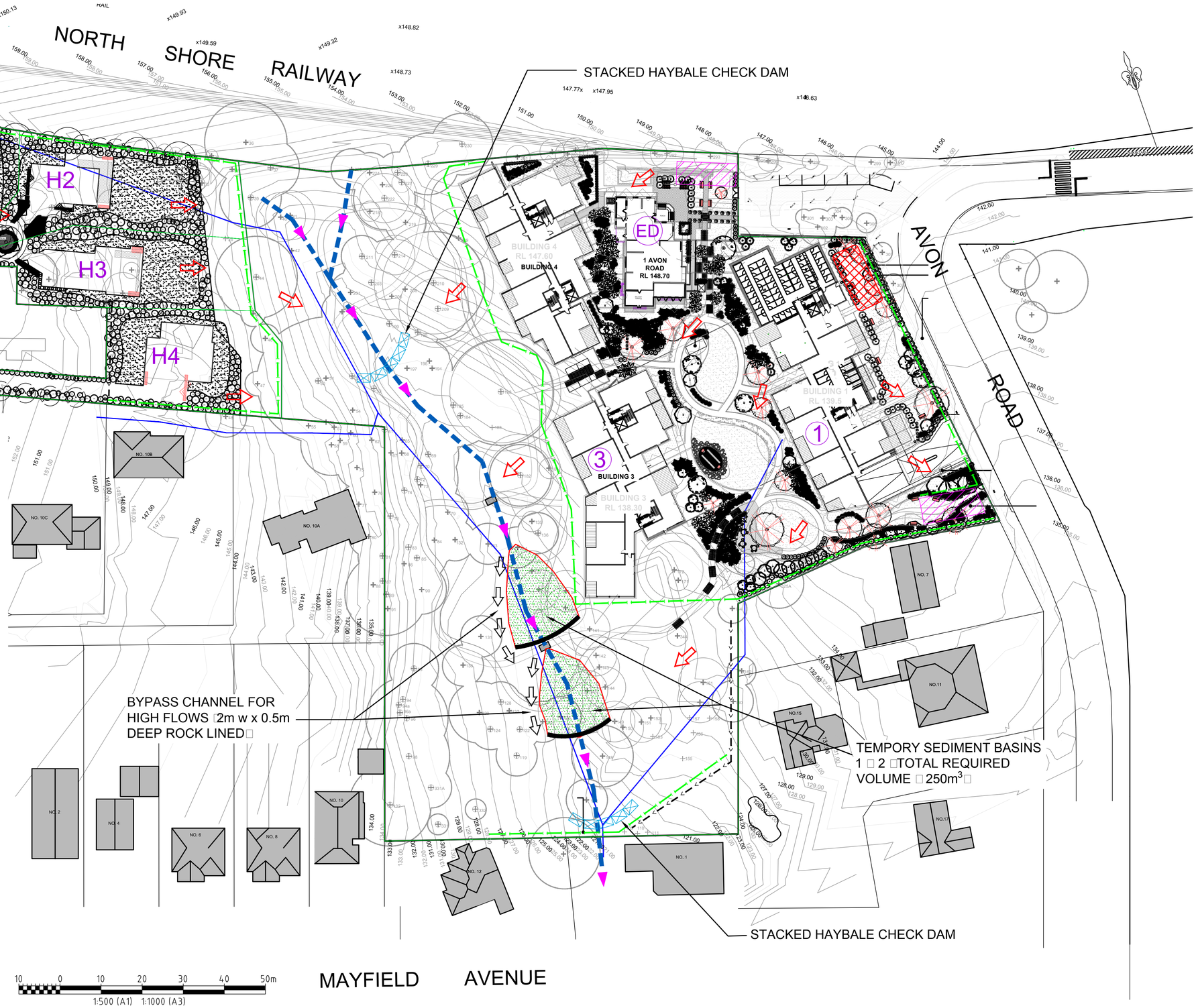
Title: FIGURE 2
PROPOSED STORMWATER DRAINAGE CONCEPT PLAN SDCP
SCALE 1:500

Drawing No. 2 of 5

Issue: Rev [G] 8/08/15

Cad File No.: ref.s 1002 [G] - 02

A1



LEGEND

- SITE BOUNDARY
- SEDIMENT BASIN (BB SD6-4)
- SILT FENCE (BB SD6-8)
- STABILISED SITE ACCESS (BB SD6-14)
- POTENTIAL STOCKPILE SITE (BB SD4-1)
- DIVERSION CHANNEL / MOUND (BB SD5-5)
- STABILISED LOW FLOW CHANNEL
- (1) BUILDING NUMBER
- OVERLAND FLOW DIRECTION

NOTES

1. REFER TO BLUE BOOK FOR STANDARD MEASURE DETAIL.DWGs
2. FLOWS AT END OF DIVERSION DRAINS TO BE DISCHARGED VIA LEVEL SPREADER TO PREVENT CONCENTRATION OF FLOWS

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
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C	DA ISSUE V3	M.S.	C.M.	M.S.		16.09.14
B	DA ISSUE V2	M.S.	C.M.	M.S.		12.06.14

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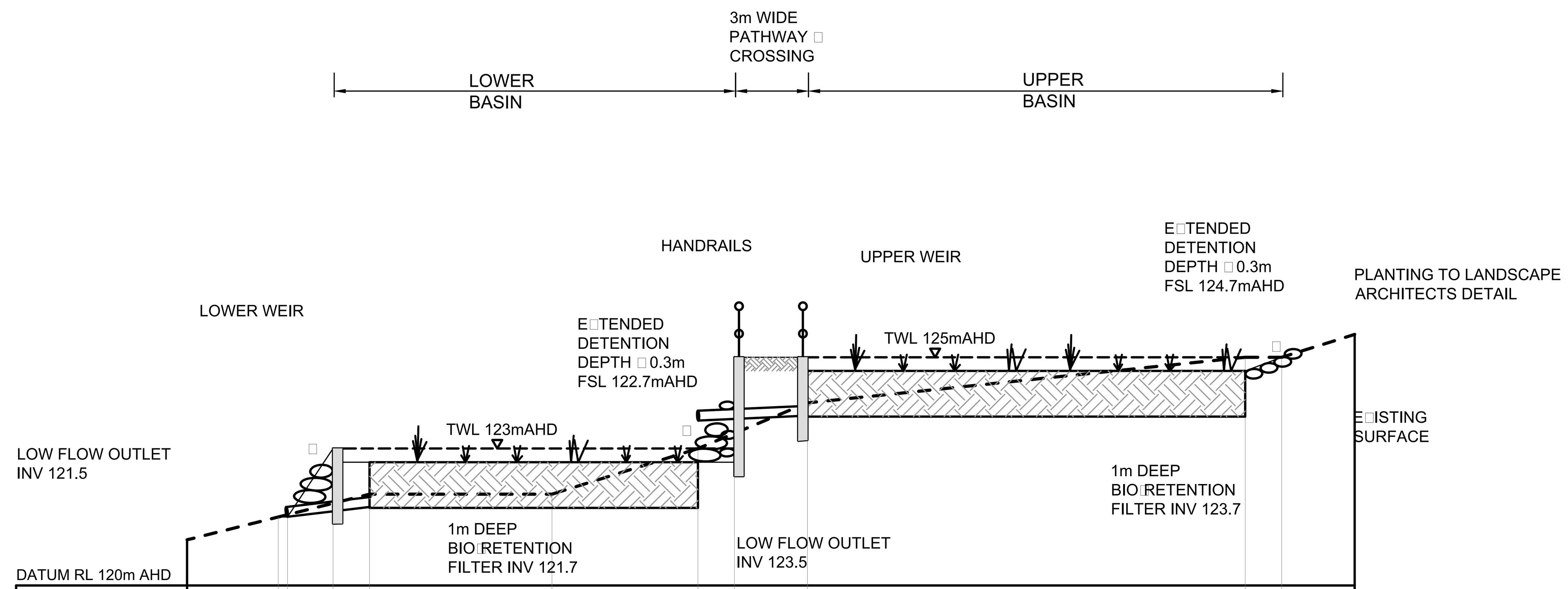
Client: **AUSBAO PTY LTD**

Project: **AVON ROAD, PYMBLE**

Title: FIGURE 3
EROSION / SEDIMENT CONTROL PLAN DURING CONSTRUCTION
SCALE 1:500

Drawing No. 3 of 5
Issue: Rev [G] 8/08/15
Cad File No.: ref.s 1002 [G] - 03

A1



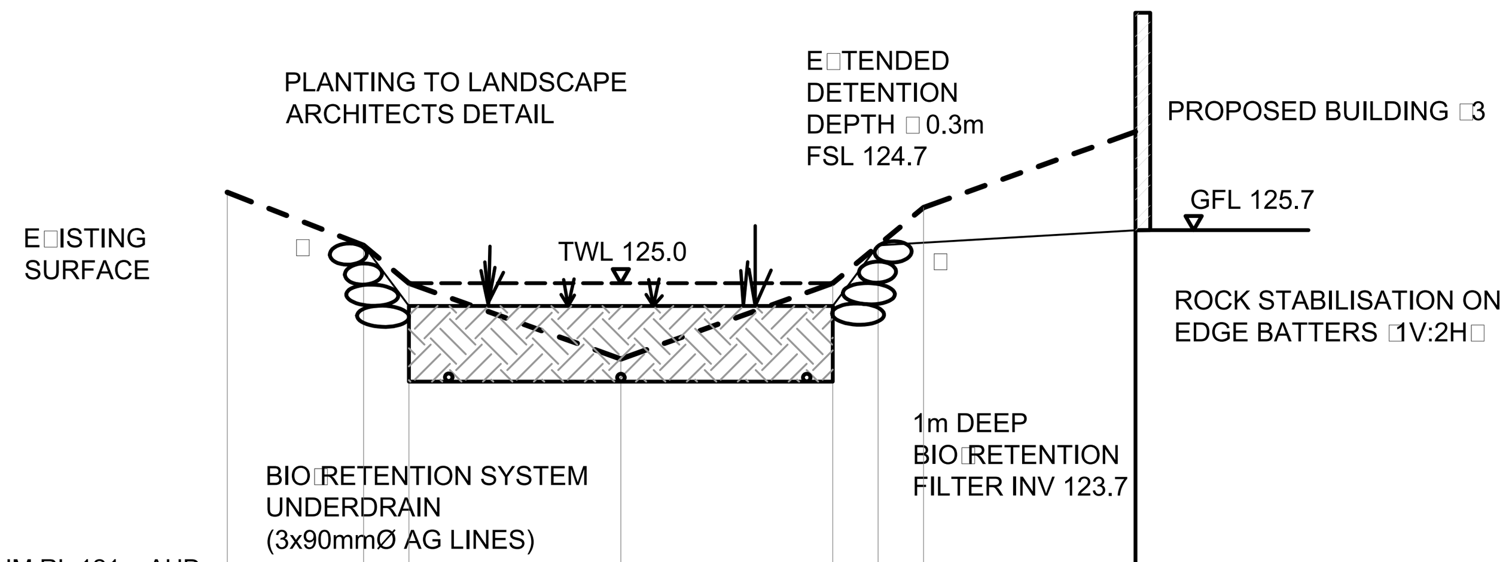
PROPOSED LEVEL	121	121.5	121.5	123	122.7	122.7		122.7 125.0	125.0 124.7	124.7	125	
E□ISTING LEVEL	121	121.5			122	122	123		124	125	125	125.5
OFFSET	0.0	5.0	5.5	8.0	10.0	20.0	28	30.0	34	58	60	64

SECTION AA

H□1:250 V□1:100

NOTES

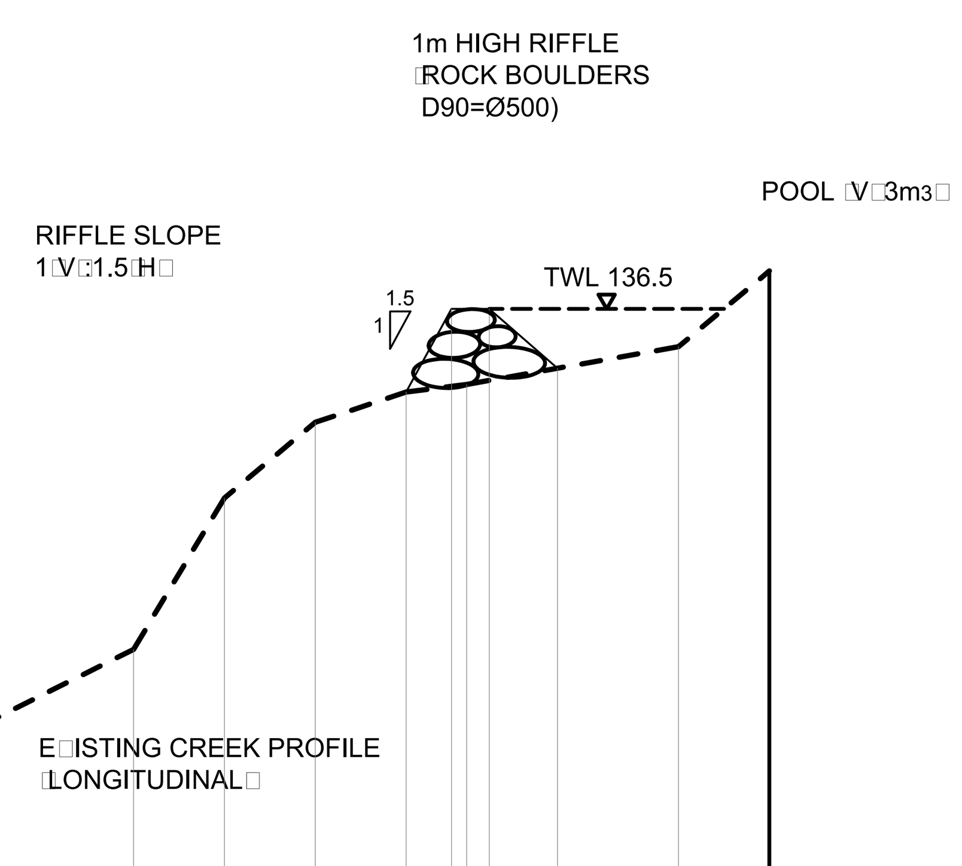
1. □INDICATES SANDSTONE ROCK RIP RAP D_{90} = Ø500
2. UNDER DRAIN SYSTEM TO CONNECT TO LOW FLOW OUTLETS
3. RIFFLES TO BE LOCATED ON FLAT LEDGES ALONG E□ISTING CHANNEL



PROPOSED LEVEL		125.5	124.7	124.7	124.7	125.5		125.7
E□ISTING LEVEL	126.2	125.5	125.0	124.0	125.0		126.0	127.0
OFFSET	0.0	4.5	6.0	13.0	20.0	21.5	23.0	30.0

SECTION BB

H□1:250 V□1:100



PROPOSED LEVEL					135.4	136.5		136.5	135.7		
E□ISTING LEVEL	132.0	133.0	134.0	135.0	135.4		135.5			136.0	137.0
OFFSET	0.0	5.0	8.0	11.0	14.0	15.5	16.0	16.75	19.0	23.0	26.0

SECTION CC

H□1:250 V□1:100

5 0 5 10 15 20 25m

1:250 (A1) 1:500 (A3)

2 0 2 4 6 8 10m

1:100 (A1) 1:200 (A3)

Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date
G	SECTIONS THROUGH BASINS ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15

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Client: **AUSBAO PTY LTD**

Pro□ect: **AVON ROAD, PYMBLE**

Title: FIGURE 4

BASIN SECTIONS

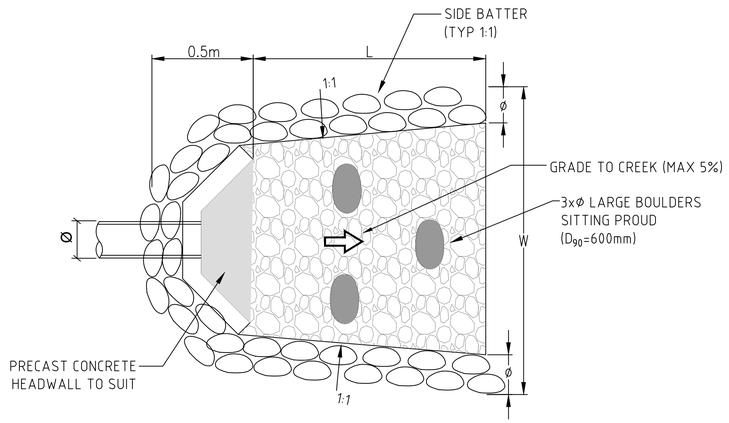
SCALE 1:250 □H□
1:100 □V□

Drawing No. 4 of 5

Issue: Rev [G] 06/08/15

Cad File No. □ref.□s□ 1002 [G] - 04

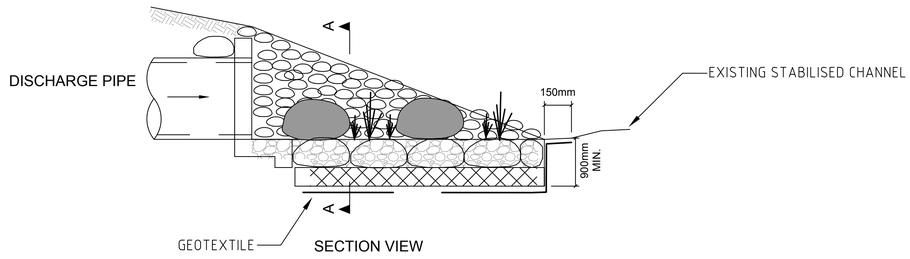
A1



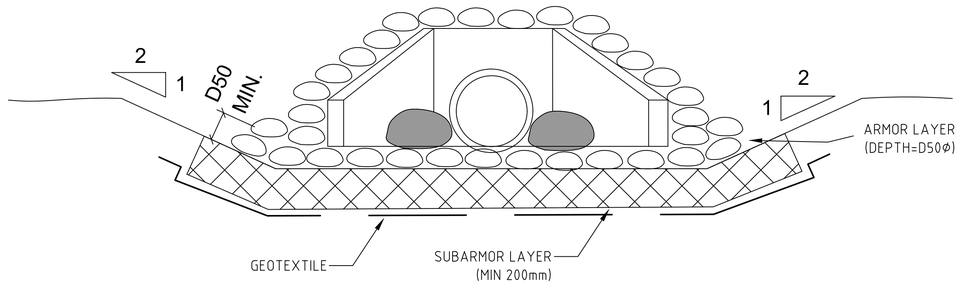
PLAN VIEW

OUTLET No.	Post Dev 50yr ARI Q □m3/s□	Vmax □m/s□	Ø Outlet □mm□ Type [1.]	Depth of Flow □mm□	d50 □mm□	L Lenght of Apron □m□	W Width of Apron □m□
1	0.36	6.18	Ø375	281	Ø450	6.0	2.8
2	0.07	4.21	Ø225	111	Ø200	3.0	1.5
3	0.36	6.28	Ø375	261	Ø450	6.0	2.8
4	0.10	4.25	Ø225	155	Ø250	3.0	1.5

□1. All Outlets are Type □uPVC



SECTION VIEW



CROSS SECTION A □A

ENERGY DISSIPATER DETAIL

NOTES

1. SUBARMOUR TO CONSIST OF
D_{50}=100mm, D_{MIN}=20mm
D_{MAX}=150mm poorly sorted

G	OUTLET DETAILS ADDED	M.S.	A.D.	M.S.	MIKE SHAW	10.08.15
Issue	Details of Issue	Des'd	Drn	Chk'd	Approved	Date

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Title
FIGURE 5

OUTLET STABILISATION DETAILS

NTS

Drawing No.
5 of 5

Issue
Rev [G] 06/08/15

Cad File No.
□ref.□s□ 1002 [G] - 05

A1

APPENDIX A (Photos)

Plate 1

Plate 2

Plate 3

Plate 4

Plate 5

Plate 6

Plate 7

Plate 8

Plate 9

Plate 10

Plate 11

Plate 12

Plate 13

Plate 14

Plate 15

Plate 16

Plate 17

Plate 18

Plate 19

Plate 20

Plate 21

Plate 22

Plate 23

Plate 24

Plate 25

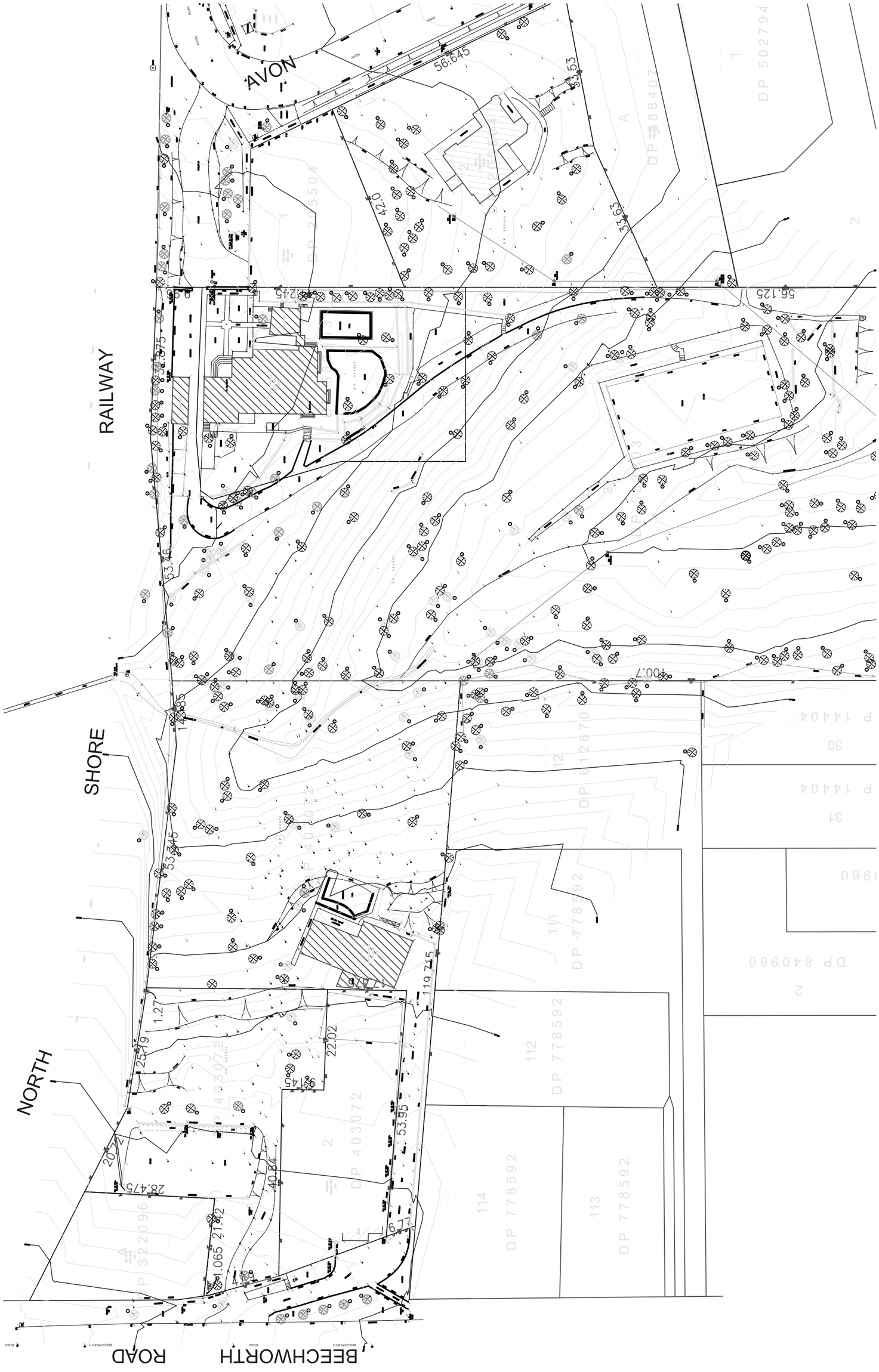
Plate 29

Plate 26

Plate 27

Plate 28

APPENDIX B (Survey Plan)


AVON
RAILWAY
SHORE
NORTH
BEECHWORTH ROAD
56.645
53.53
42.0
33.63
56.125
53.875
53.46
53.345
119.745
22.02
25.19
1.27
53.95
40.84
28.475
20.72
1.065
21.812
DP 502794
DP 88407
DP 403072
DP 778592
DP 840960
DP 14404

APPENDIX C (Proposed Subdivision Layout)

NATIVE LANDSCAPE ENVIRONMENT

PATH WITH EXERCISE EQUIPMENT STATIONS

HERITAGE GARDEN REINTERPRETED

NORTH SHORE RAILWAY

RAIL

BEECHWORTH ROAD

AVON ROAD

1 AVON ROAD RL 148.70

BUILDING 4 RL 147.60

BUILDING 4

BUILDING 1 RL 139.45

BUILDING 3

BUILDING 3 RL 138.30

LOT 1

LOT 2

LOT 3

LOT 4

NO. 2

NO. 6

NO. 8A

NO. 10

NO. 10B

NO. 10C

NO. 10A

NO. 12

NO. 14

NO. 16

NO. 2

NO. 4

NO. 6

NO. 8

NO. 10

NO. 12

NO. 1

NO. 7

NO.11

NO.15

NO.17

T23

T24

FRONT GARDENS CONTINUE LANDSCAPE THEMES OF AVON ROAD

CENTRAL COMMUNAL AREA

ORNAMENTAL WATER FEATURE

GARDEN PAVILION & BBQ SHELTER

BELVEDERE

BLUE GUM HIGH FOREST CONSERVATION AREA

DRAINAGE CHANNEL AND EPHEMERAL WETLANDS

TIMBER PEDESTRIAN BRIDGE

NATIVE VEGETATION RETAINED AND ENHANCED

APPENDIX D (*MUSIC*)

Source nodes

Location,H1 to 4 Non Roof,H1 to 4 Roof,Building 4Non Roof,Building 4 Roof,Building 1 and 3 Roof,Building1_and 3 non roof,Creek1,Creek 2,Creek 3,Creek 4,road-driveway,Ex D Roof,Ex D Non Roof
ID,1,2,4,5,9,10,14,15,24,25,26,30,31
Node Type,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode,ForestSourceNode,ForestSourceNode,ForestSourceNode,ForestSourceNode,UrbanSourceNode,UrbanSourceNode,UrbanSourceNode
Total Area (ha),0.335,0.094,0.087,0.093,0.234,0.432,0.304,0.237,0.219,0.209,0.043,0.036,0.082
Area Impervious (ha),0.100294809688581,0.094,0.0434478125806952,0.093,0.232307750865052,0.19445778443423,0.0137480597014926,0.0107180597014926,0.0099040298507 4628,0.00945179104477613,0.0364088059701493,0.036,0.0409508118576667
Area Pervious (ha),0.234705190311419,0,0.0435521874193048,0,0.00169224913494814,0.23754221556577,0.290251940298507,0.226281940298507,0.209095970149254,0.199548208955224,0.00659119402985074,0,0.0410491881423333
Field Capacity (mm),172,172,172,172,172,172,172,172,172,172,172,172,172
Pervious Area Infiltration Capacity coefficient - a,200,200,200,200,200,200,200,200,200,200,200,200,200
Pervious Area Infiltration Capacity exponent - b,1,1,1,1,1,1,1,1,1,1,1,1,1
Impervious Area Rainfall Threshold (mm/day),1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5,1.5
Pervious Area Soil Storage Capacity (mm),300,300,300,300,300,300,300,300,300,300,300,300,300
Pervious Area Soil Initial Storage (% of Capacity),20,20,20,20,20,20,20,20,20,20,20,20,20
Groundwater Initial Depth (mm),1,1,1,1,1,1,1,1,1,1,1,1,1
Groundwater Daily Recharge Rate (%),25,25,25,25,25,25,25,25,25,25,25,25,25
Groundwater Daily Baseflow Rate (%),5,5,5,5,5,5,5,5,5,5,5,5,5
Groundwater Daily Deep Seepage Rate (%),4,4,4,4,4,4,4,4,4,4,4,4,4
Stormflow Total Suspended Solids Mean (log mg/L),2.2,1.55,2.2,1.55,1.55,2.2,1.9,1.9,1.9,1.9,2.38,1.55,2.2
Stormflow Total Suspended Solids Standard Deviation (log mg/L),0.32,0.39,0.32,0.39,0.39,0.32,0.2,0.2,0.2,0.2,0.4,0.39,0.32
Stormflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Phosphorus Mean (log mg/L),-0.45,-0.92,-0.45,-0.92,-0.92,-0.45,-1.1,-1.1,-1.1,-1.1,-0.6,-0.92,-0.45
Stormflow Total Phosphorus Standard Deviation (log mg/L),0.25,0.29,0.25,0.29,0.29,0.25,0.22,0.22,0.22,0.22,0.5,0.29,0.25
Stormflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Stormflow Total Nitrogen Mean (log mg/L),0.42,0.42,0.42,0.42,0.42,0.42,-0.075,-0.075,-0.075,-0.075,0.42,0.42,0.42
Stormflow Total Nitrogen Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.24,0.24,0.24,0.24,0.19,0.19,0.19
Stormflow Total Nitrogen Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Stormflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Suspended Solids Mean (log mg/L),1.1,1.1,1.1,1.1,1.1,1.1,0.9,0.9,0.9,0.9,1.1,1.1,1.1
Baseflow Total Suspended Solids Standard Deviation (log mg/L),0.17,0.17,0.17,0.17,0.17,0.17,0.13,0.13,0.13,0.13,0.17,0.17,0.17
Baseflow Total Suspended Solids Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Suspended Solids Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Baseflow Total Phosphorus Mean (log mg/L),-0.82,-0.82,-0.82,-0.82,-0.82,-0.82,-1.5,-1.5,-1.5,-1.5,-0.82,-0.82,-0.82
Baseflow Total Phosphorus Standard Deviation (log mg/L),0.19,0.19,0.19,0.19,0.19,0.19,0.13,0.13,0.13,0.13,0.19,0.19,0.19
Baseflow Total Phosphorus Estimation Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Phosphorus Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0

Baseflow Total Nitrogen Mean (log mg/L),0.32,0.32,0.32,0.32,0.32,0.32,-0.14,-0.14,-0.14,-0.14,0.32,0.32,0.32
Baseflow Total Nitrogen Standard Deviation (log mg/L),0.12,0.12,0.12,0.12,0.12,0.12,0.13,0.13,0.13,0.13,0.12,0.12,0.12
Baseflow Total Nitrogen Estimation
Method,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic,Stochastic
Baseflow Total Nitrogen Serial Correlation,0,0,0,0,0,0,0,0,0,0,0,0,0
Flow based constituent generation - enabled,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Flow based constituent generation - flow file, , , , , , , , , , , , ,
Flow based constituent generation - base flow column, , , , , , , , , , , , ,
Flow based constituent generation - pervious flow column, , , , , , , , , , , , ,
Flow based constituent generation - impervious flow column, , , , , , , , , , , , ,
Flow based constituent generation - unit, , , , , , , , , , , , ,
OUT - Mean Annual Flow (ML/yr),1.90,1.15,0.657,1.14,2.84,3.06,1.02,0.793,0.733,0.699,0.465,0.440,0.619
OUT - TSS Mean Annual Load (kg/yr),294,60.6,119,60.1,153,531,36.2,27.4,25.7,24.8,164,22.9,113
OUT - TP Mean Annual Load (kg/yr),0.654,0.173,0.252,0.167,0.431,1.20,55.0E-3,45.0E-3,38.9E-3,35.9E-3,0.222,67.5E-3,0.242
OUT - TN Mean Annual Load (kg/yr),5.02,3.29,1.84,3.28,8.07,8.37,0.860,0.644,0.608,0.575,1.32,1.28,1.75
OUT - Gross Pollutant Mean Annual Load (kg/yr),49.4,27.0,17.6,26.7,66.9,82.1,7.34,5.72,5.28,5.04,11.5,10.3,16.6
Rain In
(ML/yr),4.69628,1.31776,1.21963,1.30374,3.2804,6.05609,4.26171,3.32245,3.0701,2.92992,0.602807,0.504676,1.14954
ET Loss
(ML/yr),2.30085,0.168495,0.471368,0.166702,0.436415,2.4972,2.63902,2.05739,1.90114,1.81433,0.123847,0.0645303,0.444277
Deep Seepage Loss
(ML/yr),0.459047,0,0.0851535,0,0.00458075,0.465115,0.565341,0.440743,0.407269,0.388672,0.0126263,0,0.0802598
Baseflow Out
(ML/yr),0.550856,0,0.102184,0,0.00549675,0.558138,0.678409,0.528893,0.488723,0.466407,0.0151515,0,0.0963118
Imp. Stormflow Out
(ML/yr),1.22874,1.14927,0.531842,1.13704,2.83233,2.37678,0.185839,0.144881,0.133878,0.127764,0.446869,0.440145,0.501277
Perv. Stormflow Out
(ML/yr),0.12395,0,0.022993,0,0.00123675,0.125589,0.152652,0.119008,0.10997,0.104948,0.00340925,0,0.0216715
Total Stormflow Out
(ML/yr),1.35269,1.14927,0.554835,1.13704,2.83357,2.50237,0.338491,0.263889,0.243847,0.232712,0.450278,0.440145,0.522948
Total Outflow
(ML/yr),1.90354,1.14927,0.657019,1.13704,2.83907,3.06051,1.0169,0.792782,0.73257,0.699119,0.46543,0.440145,0.61926
Change in Soil Storage
(ML/yr),0.0328355,0,0.006091,0,0.00032775,0.0332695,0.0404388,0.0315263,0.029132,0.0278018,0.00090325,0,0.005741
TSS Baseflow Out (kg/yr),7.51413,0,1.38589,0,0.074981,7.56629,5.62998,4.38469,4.05841,3.87664,0.206104,0,1.30677
TSS Total Stormflow Out
(kg/yr),286.364,60.558,117.511,60.0573,153.214,523.455,30.5969,23.0554,21.6691,20.9025,163.673,22.9382,111.457
TSS Total Outflow
(kg/yr),293.878,60.558,118.897,60.0573,153.289,531.021,36.2269,27.4401,25.7275,24.7791,163.879,22.9382,112.764
TP Baseflow Out
(kg/yr),0.091447,0,0.0170095,0,0.0009125,0.0930733,0.0223113,0.017497,0.0160783,0.015422,0.00251925,0,0.0160678
TP Total Stormflow Out
(kg/yr),0.563048,0.17261,0.23479,0.167234,0.429938,1.1032,0.0326608,0.0274998,0.0228305,0.0204448,0.219233,0.0675015,0.226347
TP Total Outflow
(kg/yr),0.654495,0.17261,0.251799,0.167234,0.43085,1.19628,0.054972,0.0449968,0.0389088,0.0358668,0.221752,0.0675015,0.242415
TN Baseflow Out
(kg/yr),1.1983,0,0.221957,0,0.0119575,1.20892,0.511617,0.399782,0.370347,0.353212,0.0329543,0,0.209082
TN Total Stormflow Out
(kg/yr),3.82591,3.29425,1.61882,3.28356,8.0576,7.16269,0.34807,0.244487,0.237962,0.222137,1.29194,1.28109,1.53793

TN Total Outflow (kg/yr),5.02421,3.29425,1.84078,3.28356,8.06956,8.37161,0.859687,0.644269,0.608309,0.575349,1.32489,1.28109,1.74701
GP Total Outflow (kg/yr),50.7695,26.9865,17.8252,26.6994,66.8921,83.4218,8.25813,6.43808,5.94912,5.67747,11.4917,10.3353,16.8008

No Imported Data Source nodes

USTM treatment nodes
Location,H1 to 4 RWTs,Building 4 RWT,B1 and 3 RWTs,Riffle/Pool#2,Upper Bio Basin,Riffle/Pool#1,Riffle/Pool#3,Lowerr Bio Basin,Ex D RWT,H1 to H4 OSD,B4 OSD,Ex D OSD,B1 and 3 OSD
ID,3,6,11,16,17,21,22,23,29,32,33,34,35
Node Type,RainWaterTankNode,RainWaterTankNode,RainWaterTankNode,PondNode,BioRetentionNodeV4,PondNode,PondNode,BioRetentionNodeV4,RainWaterTankNode,DetentionBasinNode,DetentionBasinNode,DetentionBasinNode,DetentionBasinNode
Lo-flow bypass rate (cum/sec),0,0,0,0,0,0,0,0,0,0,0,0,0
Hi-flow bypass rate (cum/sec),1,1,1,1,10,1,1,10,1,100,100,100,100
Inlet pond volume,0,0,0,0, ,0,0, ,0,0,0,0,0
Area (sqm),8,10,10,18,275,18,18,275,2.5,20,170.3,5,341
Initial Volume (m^3),8,10,2,10, ,10,10, ,2, , , ,
Extended detention depth (m),0.05,0.05,0.05,0.2,0.3,0.2,0.2,0.3,0.05,1,1,1,1
Number of Rainwater tanks,4,1,2, , , , , ,1, , , ,
Permanent Pool Volume (cubic metres),20,20,40,10, ,10,10, ,5,0.1,0.1,0.1,0.1
Proportion vegetated,0,0,0,0,0.1, ,0.1,0.1, ,0,0,0,0,0
Equivalent Pipe Diameter (mm),50,25,35,50, ,50,50, ,25,100,100,50,150
Overflow weir width (m),10,10,10,3,10,3,3,10,10,0,0,0,0
Notional Detention Time (hrs),85.3E-3,0.427,0.218,0.384, ,0.384,0.384, ,0.107,0.238,2.03,0.238,1.81
Orifice Discharge Coefficient,0.6,0.6,0.6,0.6, ,0.6,0.6, ,0.6,0.6,0.6,0.6,0.6
Weir Coefficient,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7,1.7
Number of CSTR Cells,2,2,2,2,3,2,2,3,2,1,1,1,1
Total Suspended Solids - k (m/yr),400,400,400,1000,8000,1000,1000,8000,400,8000,8000,8000,8000
Total Suspended Solids - C* (mg/L),12,12,12,12,20,12,12,20,12,20,20,20,20
Total Suspended Solids - C** (mg/L),12,12,12,12, ,12,12, ,12,20,20,20,20
Total Phosphorus - k (m/yr),300,300,300,500,6000,500,500,6000,300,6000,6000,6000,6000
Total Phosphorus - C* (mg/L),0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13,0.13
Total Phosphorus - C** (mg/L),0.13,0.13,0.13,0.13, ,0.13,0.13, ,0.13,0.13,0.13,0.13,0.13
Total Nitrogen - k (m/yr),40,40,40,50,500,50,50,500,40,500,500,500,500
Total Nitrogen - C* (mg/L),1.4,1.4,1.4,1.3,1.4,1.3,1.3,1.4,1.4,1.4,1.4,1.4,1.4
Total Nitrogen - C** (mg/L),1.4,1.4,1.4,1.3, ,1.3,1.3, ,1.4,1.4,1.4,1.4,1.4
Threshold Hydraulic Loading for C** (m/yr),3500,3500,3500,3500, ,3500,3500, ,3500,3500,3500,3500,3500
Horizontal Flow Coefficient, , , , ,3, , ,3, , , , ,
Reuse Enabled,On,On,On,Off,Off,Off,Off,Off,Off,On,Off,Off,Off,Off
Max drawdown height (m),2.5,2,4, , , , , ,2, , , ,
Annual Demand Enabled,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Annual Demand Value (ML/year), , , , , , , , , , , , , ,
Annual Demand Distribution, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Jan, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Feb, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Mar, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Apr, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: May, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Jun, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Jul, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Aug, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Sep, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Oct, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Nov, , , , , , , , , , , , , ,
Annual Demand Monthly Distribution: Dec, , , , , , , , , , , , , ,

Daily Demand Enabled,On,On,On,Off,Off,Off,Off,Off,On,Off,Off,Off,Off
Daily Demand Value (ML/day),0.001,0.004,0.01, , , , ,0.00025, , ,
Custom Demand Enabled,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off,Off
Custom Demand Time Series File, , , , , , , , , , , , ,
Custom Demand Time Series Units, , , , , , , , , , , , ,
Filter area (sqm), , , , ,250, , ,250, , , ,
Filter perimeter (m), , , , ,200, , ,200, , , ,
Filter depth (m), , , , ,1, , ,1, , , ,
Filter Median Particle Diameter (mm), , , , , , , , , , , , ,
Saturated Hydraulic Conductivity (mm/hr), , , , ,90, , ,90, , , ,
Infiltration Media Porosity, , , , ,0.35, , ,0.35, , , ,
Length (m), , , , , , , , , , , , ,
Bed slope, , , , , , , , , , , , ,
Base Width (m), , , , , , , , , , , , ,
Top width (m), , , , , , , , , , , , ,
Vegetation height (m), , , , , , , , , , , , ,
Vegetation Type, , , , ,Vegetated with Effective Nutrient Removal Plants, , ,Vegetated with Effective Nutrient Removal Plants, , , ,
Total Nitrogen Content in Filter (mg/kg), , , , ,800, , ,800, , , ,
Orthophosphate Content in Filter (mg/kg), , , , ,80, , ,80, , , ,
Is Base Lined?, , , , ,No, , ,No, , , ,
Is Underdrain Present?, , , , ,Yes, , ,Yes, , , ,
Is Submerged Zone Present?, , , , ,No, , ,No, , , ,
Submerged Zone Depth (m), , , , , , , , , , , , ,
B for Media Soil Texture,-9999,-9999,-9999,-9999,13,-9999,-9999,13,-9999,-9999,-9999,-9999,-9999
Proportion of upstream impervious area treated, , , , , , , , , , , , ,
Exfiltration Rate (mm/hr),0,0,0,0,4,4,4,4,4,0,0,0,0,0
Evaporative Loss as % of PET,0,0,0,125,100,125,125,100,0,100,100,100,100
Depth in metres below the drain pipe, , , , , , , , , , , , ,
TSS A Coefficient, , , , , , , , , , , , ,
TSS B Coefficient, , , , , , , , , , , , ,
TP A Coefficient, , , , , , , , , , , , ,
TP B Coefficient, , , , , , , , , , , , ,
TN A Coefficient, , , , , , , , , , , , ,
TN B Coefficient, , , , , , , , , , , , ,
Sfc, , , , ,0.61, , ,0.61, , , ,
S*, , , , ,0.37, , ,0.37, , , ,
Sw, , , , ,0.11, , ,0.11, , , ,
Sh, , , , ,0.05, , ,0.05, , , ,
Emax (m/day), , , , ,0.008, , ,0.008, , , ,
Ew (m/day), , , , ,0.001, , ,0.001, , , ,
IN - Mean Annual Flow (ML/yr),1.15,1.14,2.84,6.05,10.5,1.02,5.55,8.44,0.440,0.817,0.559,0.354,1.50
IN - TSS Mean Annual Load (kg/yr),60.6,60.1,153,165,257,36.2,137,91.0,22.9,33.1,25.1,14.5,75.8
IN - TP Mean Annual Load (kg/yr),0.173,0.167,0.431,1.19,1.94,55.0E-3,1.03,1.65,67.5E-3,0.117,77.5E-3,52.3E-3,0.214
IN - TN Mean Annual Load (kg/yr),3.29,3.28,8.07,12.5,20.6,0.860,11.3,8.28,1.28,2.26,1.58,0.982,4.15
IN - Gross Pollutant Mean Annual Load (kg/yr),27.0,26.7,66.9,9.50,13.9,7.34,0.00,5.28,10.3,0.00,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),0.817,0.559,1.50,5.55,7.70,0.685,5.16,6.60,0.354,0.813,0.552,0.351,1.49
OUT - TSS Mean Annual Load (kg/yr),33.1,25.1,75.8,137,65.3,19.3,118,53.5,14.5,18.5,11.2,8.38,30.1
OUT - TP Mean Annual Load (kg/yr),0.117,77.5E-3,0.214,1.03,1.61,75.2E-3,0.919,1.38,52.3E-3,0.108,72.6E-3,47.3E-3,0.195
OUT - TN Mean Annual Load (kg/yr),2.26,1.58,4.15,11.3,7.67,0.644,10.4,6.08,0.982,1.94,0.930,0.853,2.55
OUT - Gross Pollutant Mean Annual Load (kg/yr),0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
Flow In (ML/yr),1.14927,1.13703,2.83885,6.04705,10.5039,1.01689,5.5505,8.43473,0.44015,0.81705,0.55936,0.354088,1.49925
ET Loss (ML/yr),0,0,0,0.020059,0.609397,0.0112538,0.0151987,0.493574,0,0.00368778,0.00689218,0.00273613,0.0122654
Infiltration Loss (ML/yr),0,0,0,0.47686,2.18248,0.323308,0.37222,1.33448,0,0,0,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
High Flow Bypass Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0,0

Orifice / Filter Out
(ML/yr),0.532993,0.144432,0.30916,3.07885,5.5487,0.579898,2.80608,4.77911,0.191984,0.813395,0.552488,0.351358,1.48695
Weir Out (ML/yr),0.284058,0.414928,1.19009,2.47158,2.15408,0.104952,2.3581,1.81907,0.162103,0,0,0,0
Transfer Function Out (ML/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
Reuse Supplied (ML/yr),0.329635,0.577295,1.33559,0,0,0,0,0,0.0853853,0,0,0,0
Reuse Requested (ML/yr),0.365568,1.46227,3.64945,0,0,0,0,0,0.091392,0,0,0,0
% Reuse Demand Met,90.1708,39.4793,36.5969,0,0,0,0,0,93.4275,0,0,0,0
% Load
Reduction,28.9072,50.8051,47.1882,8.21268,26.6673,32.6522,6.96027,21.7737,19.5532,0.447341,1.22864,0.770996,0.820577
TSS Flow In
(kg/yr),60.558,60.0573,153.289,164.826,257.296,36.2268,137.172,91.0443,22.9382,33.076,25.1315,14.5141,75.8358
TSS ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TSS Infiltration Loss (kg/yr),0,0,0,6.26688,5.62398,4.30375,4.8048,3.86667,0,0,0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TSS Orifice / Filter Out
(kg/yr),20.8405,6.27188,15.3303,61.2655,11.8308,11.264,50.7275,11.6168,7.59605,18.5258,11.1737,8.37633,30.1453
TSS Weir Out (kg/yr),12.2356,18.8597,60.5055,75.9068,53.4908,8.06317,66.9077,41.927,6.91803,0,0,0,0
TSS Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TSS Reuse Supplied (kg/yr),5.76213,12.8841,41.774,0,0,0,0,0,1.49084,0,0,0,0
TSS Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TSS % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0,0
TSS % Load
Reduction,45.3812,58.1539,50.5276,16.7774,74.6122,46.6493,14.2427,41.1892,36.7252,43.9903,55.5391,42.2884,60.2493
TP Flow In
(kg/yr),0.17261,0.167234,0.430848,1.19379,1.93792,0.0549718,1.03388,1.64634,0.0675015,0.116534,0.0774588,0.052252,0.214153
TP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TP Infiltration Loss (kg/yr),0,0,0,0.0671735,0.485036,0.0396055,0.0516553,0.297859,0,0,0,0,0
TP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TP Orifice / Filter Out
(kg/yr),0.0765408,0.0201717,0.0455513,0.541748,1.26443,0.063748,0.470625,1.10854,0.0279438,0.107567,0.0726253,0.0473483,0.195482
TP Weir Out (kg/yr),0.0399933,0.0572873,0.168601,0.49213,0.343107,0.0114495,0.448158,0.26889,0.0243082,0,0,0,0
TP Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TP Reuse Supplied (kg/yr),0.044145,0.0788958,0.194088,0,0,0,0,0,0.011433,0,0,0,0
TP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TP % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0,0
TP % Load Reduction,32.4871,53.6822,50.2951,13.3955,17.0485,-36.7929,11.1321,16.3335,22.5914,7.69475,6.2401,9.38481,8.71844
TN Flow In
(kg/yr),3.29425,3.28355,8.06953,12.5316,20.5593,0.859683,11.3279,8.28114,1.28109,2.26349,1.57752,0.982478,4.15258
TN ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TN Infiltration Loss (kg/yr),0,0,0,0.831368,1.42002,0.351523,0.632783,0.864317,0,0,0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TN Orifice / Filter Out
(kg/yr),1.46837,0.407503,0.866288,5.97915,3.50609,0.530978,5.39727,3.15604,0.530148,1.94378,0.929908,0.8533,2.55085
TN Weir Out (kg/yr),0.795128,1.17002,3.28628,5.34875,4.16728,0.113068,5.01628,2.92193,0.45233,0,0,0,0
TN Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TN Reuse Supplied (kg/yr),0.744293,1.47867,3.63508,0,0,0,0,0,0.196674,0,0,0,0
TN Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
TN % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0,0

TN % Load
Reduction,31.2895,51.9569,48.5402,9.60496,62.6768,25.0833,8.07187,26.6046,23.3093,14.1249,41.0526,13.1481,38.571
8
GP Flow In (kg/yr),26.9865,26.6995,66.8818,9.497,13.9266,7.3357,0,5.28458,10.3353,0,0,0,0
GP ET Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Weir Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Transfer Function Out (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Reuse Supplied (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP Reuse Requested (kg/yr),0,0,0,0,0,0,0,0,0,0,0,0,0
GP % Reuse Demand Met,0,0,0,0,0,0,0,0,0,0,0,0,0
GP % Load Reduction,100,100,100,100,100,100,100,100,100,100,100,100,100
PET Scaling Factor, , , , ,2.1, , ,2.1, , , , ,

Generic treatment nodes
Location,Building 4 LBs,H1 to 4 Litter Baskets,Ex d Litter Baskets,Building 1 and 3 LBs
ID,7,8,12,28
Node Type,GPTNode,GPTNode,GPTNode,GPTNode
Lo-flow bypass rate (cum/sec),0,0,0,0
Hi-flow bypass rate (cum/sec),1,1,1,1
Flow Transfer Function
Input (cum/sec),0,0,0,0
Output (cum/sec),0,0,0,0
Input (cum/sec),10,10,10,10
Output (cum/sec),10,10,10,10
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Input (cum/sec), , , ,
Output (cum/sec), , , ,
Gross Pollutant Transfer Function
Enabled,True,True,True,True
Input (kg/ML),0,0,0,0
Output (kg/ML),0,0,0,0
Input (kg/ML),100,100,100,100
Output (kg/ML),10,10,10,10
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,

Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Input (kg/ML), , , ,
Output (kg/ML), , , ,
Total Nitrogen Transfer Function
Enabled,True,True,True,True
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),100,100,100,100
Output (mg/L),87,87,87,87
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Total Phosphorus Transfer Function
Enabled,True,True,True,True
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),10,10,10,10
Output (mg/L),7,7,7,7
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Total Suspended Solids Transfer Function
Enabled,True,True,True,True
Input (mg/L),0,0,0,0
Output (mg/L),0,0,0,0
Input (mg/L),1000,1000,1000,1000
Output (mg/L),200,200,200,200
Input (mg/L), , , ,
Output (mg/L), , , ,

Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
Input (mg/L), , , ,
Output (mg/L), , , ,
TSS Flow based Efficiency Enabled,Off,Off,Off,Off
TSS Flow based Efficiency, , , ,
TP Flow based Efficiency Enabled,Off,Off,Off,Off
TP Flow based Efficiency, , , ,
TN Flow based Efficiency Enabled,Off,Off,Off,Off
TN Flow based Efficiency, , , ,
GP Flow based Efficiency Enabled,Off,Off,Off,Off
GP Flow based Efficiency, , , ,
IN - Mean Annual Flow (ML/yr),1.21,3.18,0.971,4.55
IN - TSS Mean Annual Load (kg/yr),130,476,121,561
IN - TP Mean Annual Load (kg/yr),0.324,0.984,0.290,1.39
IN - TN Mean Annual Load (kg/yr),2.77,8.29,2.60,10.9
IN - Gross Pollutant Mean Annual Load (kg/yr),17.6,60.8,16.6,82.1
OUT - Mean Annual Flow (ML/yr),1.21,3.18,0.971,4.55
OUT - TSS Mean Annual Load (kg/yr),26.0,95.3,24.2,112
OUT - TP Mean Annual Load (kg/yr),0.227,0.689,0.203,0.974
OUT - TN Mean Annual Load (kg/yr),2.41,7.21,2.26,9.50
OUT - Gross Pollutant Mean Annual Load (kg/yr),1.76,6.08,1.66,8.21
Flow In (ML/yr),1.20944,3.18221,0.970586,4.5473
ET Loss (ML/yr),0,0,0,0
Infiltration Loss (ML/yr),0,0,0,0
Low Flow Bypass Out (ML/yr),0,0,0,0
High Flow Bypass Out (ML/yr),0,0,0,0
Orifice / Filter Out (ML/yr),0,0,0,0
Weir Out (ML/yr),0,0,0,0
Transfer Function Out (ML/yr),1.20944,3.18221,0.970586,4.5473
Reuse Supplied (ML/yr),0,0,0,0
Reuse Requested (ML/yr),0,0,0,0
% Reuse Demand Met,0,0,0,0
% Load Reduction,0,0,0,0
TSS Flow In (kg/yr),130.063,476.253,121.133,561.13
TSS ET Loss (kg/yr),0,0,0,0
TSS Infiltration Loss (kg/yr),0,0,0,0
TSS Low Flow Bypass Out (kg/yr),0,0,0,0
TSS High Flow Bypass Out (kg/yr),0,0,0,0
TSS Orifice / Filter Out (kg/yr),0,0,0,0
TSS Weir Out (kg/yr),0,0,0,0
TSS Transfer Function Out (kg/yr),26.0122,95.2498,24.2264,112.227
TSS Reuse Supplied (kg/yr),0,0,0,0
TSS Reuse Requested (kg/yr),0,0,0,0
TSS % Reuse Demand Met,0,0,0,0
TSS % Load Reduction,80.0003,80.0002,80.0002,79.9999
TP Flow In (kg/yr),0.324407,0.983769,0.289746,1.39168
TP ET Loss (kg/yr),0,0,0,0
TP Infiltration Loss (kg/yr),0,0,0,0

TP Low Flow Bypass Out (kg/yr),0,0,0,0
TP High Flow Bypass Out (kg/yr),0,0,0,0
TP Orifice / Filter Out (kg/yr),0,0,0,0
TP Weir Out (kg/yr),0,0,0,0
TP Transfer Function Out (kg/yr),0.227087,0.688636,0.202823,0.974191
TP Reuse Supplied (kg/yr),0,0,0,0
TP Reuse Requested (kg/yr),0,0,0,0
TP % Reuse Demand Met,0,0,0,0
TP % Load Reduction,29.9994,30.0002,29.9997,29.999
TN Flow In (kg/yr),2.77053,8.29249,2.6002,10.9219
TN ET Loss (kg/yr),0,0,0,0
TN Infiltration Loss (kg/yr),0,0,0,0
TN Low Flow Bypass Out (kg/yr),0,0,0,0
TN High Flow Bypass Out (kg/yr),0,0,0,0
TN Orifice / Filter Out (kg/yr),0,0,0,0
TN Weir Out (kg/yr),0,0,0,0
TN Transfer Function Out (kg/yr),2.41036,7.21451,2.26212,9.50196
TN Reuse Supplied (kg/yr),0,0,0,0
TN Reuse Requested (kg/yr),0,0,0,0
TN % Reuse Demand Met,0,0,0,0
TN % Load Reduction,12.9999,12.9995,13.0021,13.0011
GP Flow In (kg/yr),17.5844,60.8118,16.5738,82.0764
GP ET Loss (kg/yr),0,0,0,0
GP Infiltration Loss (kg/yr),0,0,0,0
GP Low Flow Bypass Out (kg/yr),0,0,0,0
GP High Flow Bypass Out (kg/yr),0,0,0,0
GP Orifice / Filter Out (kg/yr),0,0,0,0
GP Weir Out (kg/yr),0,0,0,0
GP Transfer Function Out (kg/yr),1.75845,6.08118,1.65738,8.20763
GP Reuse Supplied (kg/yr),0,0,0,0
GP Reuse Requested (kg/yr),0,0,0,0
GP % Reuse Demand Met,0,0,0,0
GP % Load Reduction,100,100,100,100

Other nodes
Location,OUT,OUT3,OUT4,OUT2,OUT 1
ID,13,18,19,20,27
Node Type,JunctionNode,JunctionNode,JunctionNode,JunctionNode,JunctionNode
IN - Mean Annual Flow (ML/yr),7.30,3.18,1.21,0.971,4.55
IN - TSS Mean Annual Load (kg/yr),78.3,95.3,26.0,24.2,112
IN - TP Mean Annual Load (kg/yr),1.41,0.689,0.227,0.203,0.974
IN - TN Mean Annual Load (kg/yr),6.65,7.21,2.41,2.26,9.50
IN - Gross Pollutant Mean Annual Load (kg/yr),5.04,6.08,1.76,1.66,8.21
OUT - Mean Annual Flow (ML/yr),7.30,3.18,1.21,0.971,4.55
OUT - TSS Mean Annual Load (kg/yr),78.3,95.3,26.0,24.2,112
OUT - TP Mean Annual Load (kg/yr),1.41,0.689,0.227,0.203,0.974
OUT - TN Mean Annual Load (kg/yr),6.65,7.21,2.41,2.26,9.50
OUT - Gross Pollutant Mean Annual Load (kg/yr),5.04,6.08,1.76,1.66,8.21
% Load Reduction,53.0,9.55,32.6,8.38,22.9
TSS % Load Reduction,95.2,81.6,85.5,82.1,83.6
TN % Load Reduction,82.0,25.2,53.0,25.3,42.2
TP % Load Reduction,60.5,34.3,45.8,34.6,40.1
GP % Load Reduction,98.5,93.1,96.0,93.8,94.5

Links
Location,Drainage Link,Drainage

Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link,Drainage Link
Source node ID,9,15,18,19,20,8,7,12,14,21,16,22,17,23,24,25,2,1,26,27,28,10,5,4,30,31,3,32,6,33,29,34,11,35
Target node ID,11,17,16,16,16,18,19,20,21,16,22,17,23,13,23,13,3,8,8,17,27,28,6,7,29,12,32,8,33,7,34,12,35,28
Muskingum-Cunge Routing,Not Routed
Muskingum K, ,
Muskingum theta, ,
IN - Mean Annual Flow (ML/yr),2.84,0.793,3.18,1.21,0.971,3.18,1.21,0.971,1.02,0.685,5.55,5.16,7.70,6.60,0.733,0.699,1.15,1.90,0.465,4.55,4.55,3.06,1.14,0.657,0.440,0.619,0.817,0.813,0.559,0.552,0.354,0.351,1.50,1.49
IN - TSS Mean Annual Load (kg/yr),153,27.4,95.3,26.0,24.2,95.3,26.0,24.2,36.2,19.3,137,118,65.3,53.5,25.7,24.8,60.6,294,164,112,112,531,60.1,119,22.9,113,33.1,18.5,25.1,11.2,14.5,8.38,75.8,30.1
IN - TP Mean Annual Load (kg/yr),0.431,45.0E-3,0.689,0.227,0.203,0.689,0.227,0.203,55.0E-3,75.2E-3,1.03,0.919,1.61,1.38,38.9E-3,35.9E-3,0.173,0.654,0.222,0.974,0.974,1.20,0.167,0.252,67.5E-3,0.242,0.117,0.108,77.5E-3,72.6E-3,52.3E-3,47.3E-3,0.214,0.195
IN - TN Mean Annual Load (kg/yr),8.07,0.644,7.21,2.41,2.26,7.21,2.41,2.26,0.860,0.644,11.3,10.4,7.67,6.08,0.608,0.575,3.29,5.02,1.32,9.50,9.50,8.37,3.28,1.84,1.28,1.75,2.26,1.94,1.58,0.930,0.982,0.853,4.15,2.55
IN - Gross Pollutant Mean Annual Load (kg/yr),66.9,5.72,6.08,1.76,1.66,6.08,1.76,1.66,7.34,0.00,0.00,0.00,0.00,0.00,5.28,5.04,27.0,49.4,11.5,8.21,8.21,82.1,26.7,17.6,10.3,16.6,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00
OUT - Mean Annual Flow (ML/yr),2.84,0.793,3.18,1.21,0.971,3.18,1.21,0.971,1.02,0.685,5.55,5.16,7.70,6.60,0.733,0.699,1.15,1.90,0.465,4.55,4.55,3.06,1.14,0.657,0.440,0.619,0.817,0.813,0.559,0.552,0.354,0.351,1.50,1.49
OUT - TSS Mean Annual Load (kg/yr),153,27.4,95.3,26.0,24.2,95.3,26.0,24.2,36.2,19.3,137,118,65.3,53.5,25.7,24.8,60.6,294,164,112,112,531,60.1,119,22.9,113,33.1,18.5,25.1,11.2,14.5,8.38,75.8,30.1
OUT - TP Mean Annual Load (kg/yr),0.431,45.0E-3,0.689,0.227,0.203,0.689,0.227,0.203,55.0E-3,75.2E-3,1.03,0.919,1.61,1.38,38.9E-3,35.9E-3,0.173,0.654,0.222,0.974,0.974,1.20,0.167,0.252,67.5E-3,0.242,0.117,0.108,77.5E-3,72.6E-3,52.3E-3,47.3E-3,0.214,0.195
OUT - TN Mean Annual Load (kg/yr),8.07,0.644,7.21,2.41,2.26,7.21,2.41,2.26,0.860,0.644,11.3,10.4,7.67,6.08,0.608,0.575,3.29,5.02,1.32,9.50,9.50,8.37,3.28,1.84,1.28,1.75,2.26,1.94,1.58,0.930,0.982,0.853,4.15,2.55
OUT - Gross Pollutant Mean Annual Load (kg/yr),66.9,5.72,6.08,1.76,1.66,6.08,1.76,1.66,7.34,0.00,0.00,0.00,0.00,0.00,5.28,5.04,27.0,49.4,11.5,8.21,8.21,82.1,26.7,17.6,10.3,16.6,0.00,0.00,0.00,0.00,0.00,0.00,0.00,0.00

__Catchment Details__
Catchment Name,cc 095 avon proposed6 (30-7-15)
Timestep,30 Minutes
Start Date,1-01-1996
End Date,31-12-1999 11:30:00 PM
Rainfall Station, mid-creek-1995to1999(30min)
ET Station,User-defined monthly PET
Mean Annual Rainfall (mm), 1402
Mean Annual ET (mm), 1268

APPENDIX E (*OSD Catchments*)

Appendix 1
Drainage Catchments for On-site Detention

17-03-2004

APPENDIX F (*Riparian Zones*)

GRID NORTH

The map was is based on guidelines formulated by the Department of Infrastructure and Natural Resources (DIPNR): "Riparian Corridor Management Study: Covering all of the Wollongong Local Government Area and Calderwood Valley in the Shellharbour Local Government Area. Prepared for Wollongong City Council by Department of Infrastructure Planning and Natural Resources, March 2004." The map was created with the assistance of staff from DIPNR and Macquarie University.

This map has been compiled using available data collected from aerial photographs, Council stormwater drainage records, cadastral zoning and topographic maps. Other information used included Council Wildlife Watch, NPWS wildlife Atlas and Australian Museum fauna databases and local and State cultural heritage registers. Field inspections were also employed to confirm some data.

All effort has been made to ensure the accuracy and completeness of the information. Council takes no resposibility for errors or omissions nor any loss or damage which may have resulted from the use of this information

Ku-ring-gai Council

Map of Riparian Systems in the Ku-ring-gai Local Government Area

LEGEND

- Category 1 Environmental Corridor
- Category 2 Terrestrial and Aquatic Habitat
- Category 3 Bed and Bank Stability/Water Quality
- Piped or chanelised streams with potential for recreation of "natural" stream channel (See Report)

500 0 500 1000 2000

1:15000

APPENDIX G (*HEC RAS*)

HEC-RAS Plan: p10 River: avon rd Reach: exis

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	203	100yr ARI	2.14	139.50	140.14	140.14	140.22	0.044093	1.50	2.32	13.17	0.76
exis	203	20yr ARI	1.46	139.50	140.10	140.10	140.17	0.039288	1.32	1.80	12.85	0.71
exis	203	100yr ARI15%CC	2.47	139.50	140.16	140.16	140.24	0.047460	1.59	2.51	13.29	0.79
exis	203	PMF	8.77	139.50	140.37	140.37	140.54	0.062799	2.41	5.48	14.99	0.98
exis	199.*	100yr ARI	2.14	138.37	138.85	138.98	139.40	0.390054	3.49	0.84	8.87	2.16
exis	199.*	20yr ARI	1.46	138.37	138.81	138.93	139.31	0.395535	3.16	0.52	7.37	2.12
exis	199.*	100yr ARI15%CC	2.47	138.37	138.87	139.00	139.42	0.388327	3.61	0.98	9.44	2.18
exis	199.*	PMF	8.77	138.37	139.02	139.21	139.75	0.395013	4.89	2.89	13.90	2.36
exis	195.*	100yr ARI	2.14	137.25	137.68	137.78	138.06	0.307995	3.09	1.01	8.92	1.94
exis	195.*	20yr ARI	1.46	137.25	137.65	137.74	137.97	0.280373	2.71	0.75	8.25	1.81
exis	195.*	100yr ARI15%CC	2.47	137.25	137.70	137.80	138.10	0.316260	3.23	1.13	9.21	1.98
exis	195.*	PMF	8.77	137.25	137.86	138.04	138.52	0.352486	4.67	2.91	12.73	2.27
exis	191.*	100yr ARI	2.14	136.12	136.49	136.59	136.86	0.366507	3.14	1.01	8.84	2.10
exis	191.*	20yr ARI	1.46	136.12	136.46	136.54	136.78	0.359955	2.83	0.74	8.36	2.04
exis	191.*	100yr ARI15%CC	2.47	136.12	136.50	136.61	136.89	0.369014	3.27	1.12	9.05	2.13
exis	191.*	PMF	8.77	136.12	136.66	136.85	137.34	0.384246	4.70	2.78	11.60	2.37
exis	187	100yr ARI	2.14	135.00	135.30	135.39	135.59	0.355863	2.92	1.08	9.04	2.06
exis	187	20yr ARI	1.46	135.00	135.28	135.34	135.52	0.339023	2.59	0.83	8.68	1.96
exis	187	100yr ARI15%CC	2.47	135.00	135.32	135.41	135.63	0.361453	3.06	1.18	9.19	2.10
exis	187	PMF	8.77	135.00	135.47	135.66	136.11	0.390159	4.56	2.77	11.17	2.38
exis	182.285*	100yr ARI	2.14	134.29	134.76	134.77	134.87	0.057641	1.73	1.81	9.06	0.91
exis	182.285*	20yr ARI	1.46	134.29	134.71	134.72	134.80	0.060212	1.59	1.33	8.41	0.91
exis	182.285*	100yr ARI15%CC	2.47	134.29	134.78	134.79	134.89	0.056468	1.79	2.03	9.35	0.91
exis	182.285*	PMF	8.77	134.29	135.05	135.06	135.26	0.059802	2.61	5.01	12.71	1.03
exis	177.571*	100yr ARI	2.14	133.57	134.02	134.13	134.34	0.155205	2.68	1.00	5.56	1.47
exis	177.571*	20yr ARI	1.46	133.57	133.96	134.07	134.24	0.170862	2.44	0.70	3.98	1.49
exis	177.571*	100yr ARI15%CC	2.47	133.57	134.05	134.16	134.38	0.151681	2.78	1.15	6.70	1.47
exis	177.571*	PMF	8.77	133.57	134.32	134.47	134.78	0.130484	3.74	3.47	10.24	1.50

HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	172.857*	100yr ARI	2.14	132.86	133.34	133.46	133.66	0.134029	2.62	0.97	3.94	1.38
exis	172.857*	20yr ARI	1.46	132.86	133.28	133.35	133.52	0.129250	2.26	0.73	3.43	1.32
exis	172.857*	100yr ARI15%CC	2.47	132.86	133.37	133.50	133.71	0.130626	2.73	1.09	4.18	1.39
exis	172.857*	PMF	8.77	132.86	133.70	133.86	134.20	0.112792	3.77	3.37	9.28	1.42
exis	168.142*	100yr ARI	2.14	132.14	132.63	132.75	132.99	0.148178	2.74	0.88	3.32	1.45
exis	168.142*	20yr ARI	1.46	132.14	132.56	132.65	132.85	0.155721	2.42	0.65	2.91	1.43
exis	168.142*	100yr ARI15%CC	2.47	132.14	132.67	132.79	133.05	0.145897	2.87	0.99	3.49	1.46
exis	168.142*	PMF	8.77	132.14	133.04	133.25	133.66	0.114390	3.98	3.05	8.01	1.45
exis	163.428*	100yr ARI	2.14	131.43	131.94	132.05	132.30	0.145117	2.74	0.86	2.98	1.44
exis	163.428*	20yr ARI	1.46	131.43	131.86	131.94	132.14	0.143242	2.37	0.66	2.68	1.38
exis	163.428*	100yr ARI15%CC	2.47	131.43	131.97	132.09	132.37	0.144202	2.89	0.95	3.11	1.45
exis	163.428*	PMF	8.77	131.43	132.38	132.63	133.10	0.116961	4.17	2.76	6.68	1.47
exis	158.714*	100yr ARI	2.14	130.71	131.23	131.34	131.61	0.147885	2.77	0.83	2.72	1.45
exis	158.714*	20yr ARI	1.46	130.71	131.15	131.24	131.45	0.151584	2.41	0.63	2.49	1.41
exis	158.714*	100yr ARI15%CC	2.47	130.71	131.26	131.39	131.68	0.146591	2.92	0.92	2.83	1.46
exis	158.714*	PMF	8.77	130.71	131.70	132.00	132.53	0.121790	4.34	2.50	5.12	1.51
exis	154	100yr ARI	2.14	130.00	130.53	130.64	130.91	0.147966	2.78	0.81	2.55	1.45
exis	154	20yr ARI	1.46	130.00	130.45	130.53	130.74	0.146947	2.39	0.63	2.37	1.39
exis	154	100yr ARI15%CC	2.47	130.00	130.56	130.68	130.98	0.147345	2.93	0.90	2.63	1.47
exis	154	PMF	8.77	130.00	131.01	131.35	131.93	0.127294	4.48	2.34	3.84	1.54
exis	149.571*	100yr ARI	2.14	129.57	130.16	130.19	130.40	0.075224	2.25	1.05	2.95	1.07
exis	149.571*	20yr ARI	1.46	129.57	130.08	130.09	130.26	0.070797	1.91	0.82	2.70	1.00
exis	149.571*	100yr ARI15%CC	2.47	129.57	130.19	130.24	130.47	0.077551	2.39	1.15	3.05	1.10
exis	149.571*	PMF	8.77	129.57	130.57	130.85	131.36	0.113846	4.26	2.55	4.94	1.47
exis	145.142*	100yr ARI	2.14	129.14	129.66	129.75	129.97	0.114569	2.55	0.93	3.02	1.30
exis	145.142*	20yr ARI	1.46	129.14	129.58	129.64	129.83	0.119603	2.24	0.70	2.72	1.28
exis	145.142*	100yr ARI15%CC	2.47	129.14	129.69	129.79	130.04	0.112801	2.68	1.03	3.15	1.30
exis	145.142*	PMF	8.77	129.14	130.09	130.35	130.84	0.116346	4.21	2.66	5.71	1.48

HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	140.714*	100yr ARI	2.14	128.71	129.23	129.30	129.50	0.096011	2.39	1.02	3.40	1.20
exis	140.714*	20yr ARI	1.46	128.71	129.16	129.20	129.36	0.088139	2.03	0.80	3.08	1.11
exis	140.714*	100yr ARI15%CC	2.47	128.71	129.26	129.34	129.56	0.097366	2.53	1.13	3.55	1.22
exis	140.714*	PMF	8.77	128.71	129.61	129.85	130.31	0.118049	4.13	2.79	6.53	1.48
exis	136.285*	100yr ARI	2.14	128.29	128.76	128.84	129.04	0.108958	2.47	1.02	3.71	1.27
exis	136.285*	20yr ARI	1.46	128.29	128.69	128.75	128.91	0.111547	2.16	0.76	3.28	1.24
exis	136.285*	100yr ARI15%CC	2.47	128.29	128.79	128.89	129.10	0.108998	2.59	1.13	3.89	1.29
exis	136.285*	PMF	8.77	128.29	129.13	129.34	129.76	0.119775	4.04	2.95	7.37	1.49
exis	131.857*	100yr ARI	2.14	127.86	128.31	128.39	128.57	0.102531	2.38	1.10	4.26	1.23
exis	131.857*	20yr ARI	1.46	127.86	128.25	128.30	128.44	0.096506	2.04	0.84	3.78	1.16
exis	131.857*	100yr ARI15%CC	2.47	127.86	128.34	128.43	128.62	0.104074	2.51	1.22	4.47	1.26
exis	131.857*	PMF	8.77	127.86	128.65	128.83	129.21	0.120763	3.92	3.13	8.23	1.48
exis	127.428*	100yr ARI	2.14	127.43	127.85	127.92	128.09	0.112012	2.39	1.13	4.97	1.28
exis	127.428*	20yr ARI	1.46	127.43	127.79	127.85	127.98	0.111130	2.10	0.85	4.29	1.23
exis	127.428*	100yr ARI15%CC	2.47	127.43	127.87	127.95	128.14	0.113397	2.51	1.26	5.28	1.30
exis	127.428*	PMF	8.77	127.43	128.16	128.32	128.65	0.120570	3.77	3.33	9.12	1.47
exis	123	100yr ARI	2.66	127.00	127.45	127.50	127.64	0.085775	2.26	1.65	6.88	1.14
exis	123	20yr ARI	1.80	127.00	127.38	127.42	127.54	0.085486	1.99	1.21	5.93	1.11
exis	123	100yr ARI15%CC	3.04	127.00	127.47	127.53	127.68	0.086234	2.36	1.83	7.23	1.16
exis	123	PMF	12.00	127.00	127.88	127.94	128.20	0.069648	3.31	5.87	12.86	1.16
exis	118.333*	100yr ARI	2.66	126.67	127.16	127.17	127.30	0.058573	1.96	1.97	7.94	0.95
exis	118.333*	20yr ARI	1.80	126.67	127.09	127.09	127.20	0.057886	1.73	1.45	6.82	0.92
exis	118.333*	100yr ARI15%CC	3.04	126.67	127.18	127.20	127.33	0.059902	2.06	2.17	8.34	0.97
exis	118.333*	PMF	12.00	126.67	127.49	127.58	127.84	0.080546	3.39	5.30	11.61	1.23
exis	113.666*	100yr ARI	2.66	126.33	126.79	126.84	126.97	0.081454	2.18	1.78	8.06	1.11
exis	113.666*	20yr ARI	1.80	126.33	126.73	126.76	126.87	0.080891	1.93	1.31	6.91	1.07
exis	113.666*	100yr ARI15%CC	3.04	126.33	126.82	126.86	127.00	0.082117	2.27	1.96	8.25	1.12
exis	113.666*	PMF	12.00	126.33	127.19	127.23	127.49	0.066121	3.12	5.69	11.59	1.12

HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	109.*	100yr ARI	2.66	126.00	126.47	126.49	126.61	0.067681	1.99	1.93	8.21	1.01
exis	109.*	20yr ARI	1.80	126.00	126.41	126.43	126.53	0.064783	1.76	1.48	7.73	0.96
exis	109.*	100yr ARI15%CC	3.04	126.00	126.50	126.51	126.64	0.067098	2.06	2.13	8.40	1.01
exis	109.*	PMF	12.00	126.00	126.83	126.89	127.15	0.075093	3.23	5.43	11.19	1.18
exis	104.333*	100yr ARI	2.66	125.67	126.12	126.15	126.27	0.078407	2.05	1.85	8.02	1.07
exis	104.333*	20yr ARI	1.80	125.67	126.06	126.09	126.19	0.080458	1.85	1.38	7.54	1.06
exis	104.333*	100yr ARI15%CC	3.04	125.67	126.14	126.17	126.30	0.078548	2.13	2.03	8.20	1.08
exis	104.333*	PMF	12.00	125.67	126.51	126.55	126.81	0.069418	3.11	5.59	11.17	1.14
exis	99.6666*	100yr ARI	2.66	125.33	125.80	125.80	125.92	0.067911	1.90	1.95	7.98	1.00
exis	99.6666*	20yr ARI	1.80	125.33	125.74	125.74	125.84	0.067199	1.69	1.49	7.50	0.96
exis	99.6666*	100yr ARI15%CC	3.04	125.33	125.82	125.83	125.95	0.067610	1.98	2.14	8.18	1.00
exis	99.6666*	PMF	12.00	125.33	126.17	126.21	126.48	0.072539	3.13	5.49	11.04	1.16
exis	95	100yr ARI	2.66	125.00	125.45	125.46	125.58	0.078586	1.96	1.85	7.71	1.06
exis	95	20yr ARI	1.80	125.00	125.39	125.40	125.50	0.080255	1.74	1.40	7.20	1.04
exis	95	100yr ARI15%CC	3.04	125.00	125.47	125.48	125.61	0.078268	2.04	2.03	7.91	1.07
exis	95	PMF	12.00	125.00	125.84	125.87	126.14	0.071258	3.08	5.53	11.04	1.14
exis	90.5*	100yr ARI	2.66	124.67	125.24	125.20	125.33	0.032751	1.56	2.47	8.63	0.73
exis	90.5*	20yr ARI	1.80	124.67	125.19	125.14	125.25	0.026400	1.29	2.01	8.15	0.64
exis	90.5*	100yr ARI15%CC	3.04	124.67	125.26	125.22	125.36	0.035189	1.66	2.65	8.81	0.77
exis	90.5*	PMF	12.00	124.67	125.61	125.62	125.86	0.049666	2.85	6.27	11.87	1.00
exis	86.*	100yr ARI	2.66	124.33	125.20	124.93	125.22	0.004885	0.86	4.83	11.06	0.32
exis	86.*	20yr ARI	1.80	124.33	125.16	124.87	125.17	0.003007	0.64	4.33	10.64	0.25
exis	86.*	100yr ARI15%CC	3.04	124.33	125.22	124.96	125.25	0.005740	0.94	5.02	11.22	0.35
exis	86.*	PMF	12.00	124.33	125.52	125.34	125.65	0.018756	2.13	8.72	13.49	0.66
exis	81.5*	100yr ARI	2.66	124.00	125.20	124.66	125.21	0.001016	0.52	8.32	13.45	0.16
exis	81.5*	20yr ARI	1.80	124.00	125.15	124.57	125.16	0.000574	0.38	7.72	13.13	0.12
exis	81.5*	100yr ARI15%CC	3.04	124.00	125.22	124.69	125.22	0.001230	0.57	8.55	13.57	0.18
exis	81.5*	PMF	12.00	124.00	125.51	125.08	125.57	0.006132	1.51	12.83	15.65	0.41

HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

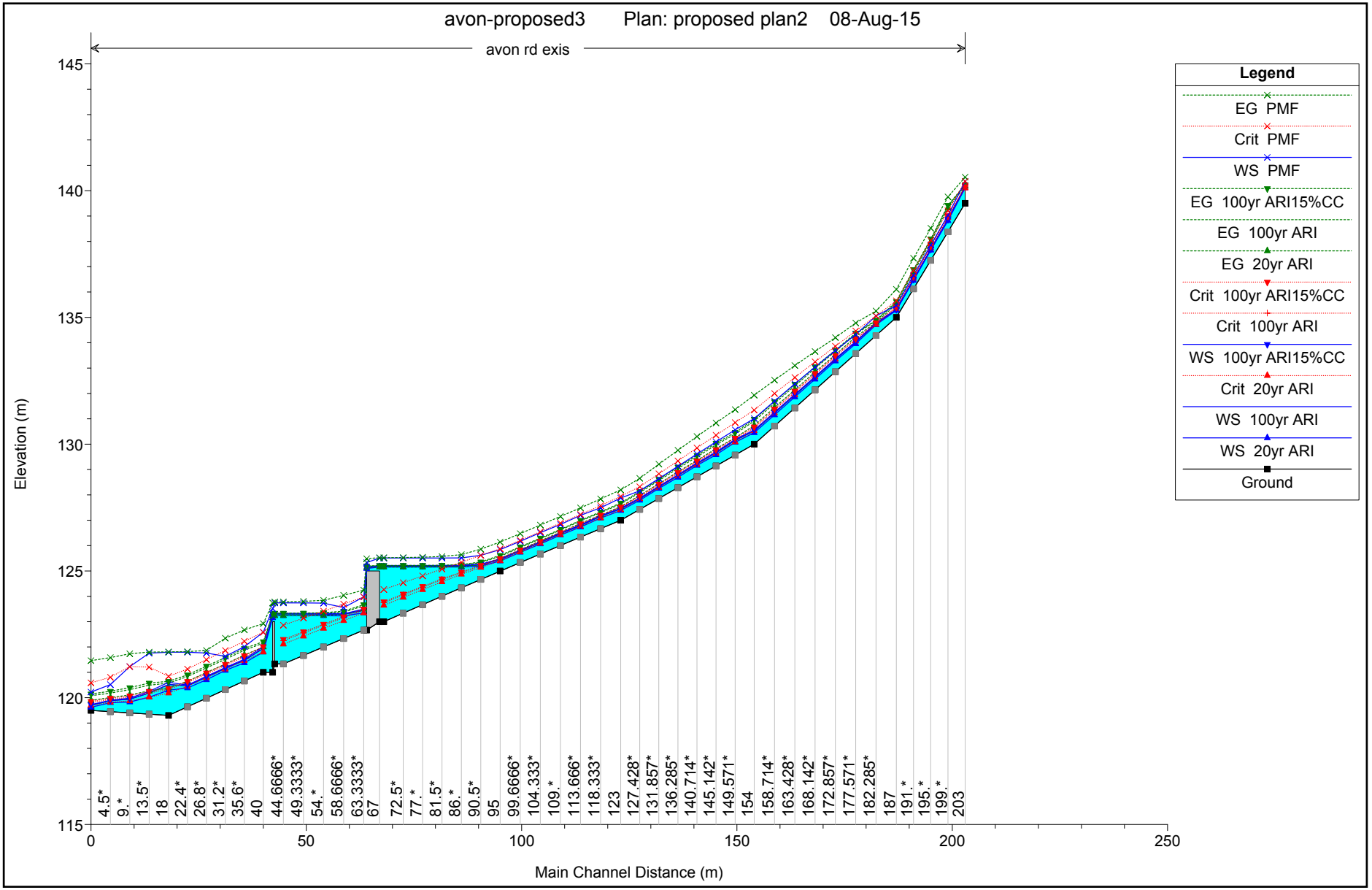
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	77.*	100yr ARI	2.66	123.67	125.20	124.35	125.20	0.000317	0.35	12.52	15.76	0.10
exis	77.*	20yr ARI	1.80	123.67	125.15	124.26	125.16	0.000170	0.25	11.82	15.42	0.07
exis	77.*	100yr ARI15%CC	3.04	123.67	125.22	124.39	125.22	0.000391	0.39	12.79	15.89	0.11
exis	77.*	PMF	12.00	123.67	125.51	124.81	125.54	0.002471	1.13	17.77	18.25	0.28
exis	72.5*	100yr ARI	2.66	123.33	125.20	124.05	125.20	0.000126	0.26	17.52	18.69	0.06
exis	72.5*	20yr ARI	1.80	123.33	125.15	123.96	125.15	0.000066	0.19	16.69	18.25	0.05
exis	72.5*	100yr ARI15%CC	3.04	123.33	125.22	124.09	125.22	0.000157	0.29	17.84	18.85	0.07
exis	72.5*	PMF	12.00	123.33	125.51	124.54	125.53	0.001123	0.88	23.96	22.55	0.20
exis	68	100yr ARI	2.66	123.00	125.20	123.75	125.20	0.000061	0.21	23.81	22.73	0.05
exis	68	20yr ARI	1.80	123.00	125.15	123.65	125.15	0.000031	0.15	22.80	22.22	0.03
exis	68	100yr ARI15%CC	3.04	123.00	125.22	123.79	125.22	0.000076	0.24	24.20	22.92	0.05
exis	68	PMF	12.00	123.00	125.51	124.27	125.52	0.000581	0.73	31.46	26.22	0.15
exis	67		Inl Struct									
exis	63.3333*	100yr ARI	2.66	122.67	123.45	123.45	123.62	0.029649	2.00	1.86	6.45	0.85
exis	63.3333*	20yr ARI	1.80	122.67	123.34	123.34	123.50	0.032553	1.82	1.25	5.02	0.86
exis	63.3333*	100yr ARI15%CC	3.04	122.67	123.49	123.49	123.67	0.028156	2.05	2.15	7.02	0.84
exis	63.3333*	PMF	12.00	122.67	123.98	123.98	124.24	0.026519	2.94	6.93	12.32	0.90
exis	58.6666*	100yr ARI	2.66	122.33	123.29	123.16	123.37	0.012231	1.47	2.71	7.77	0.56
exis	58.6666*	20yr ARI	1.80	122.33	123.23	123.04	123.28	0.008199	1.14	2.28	7.02	0.45
exis	58.6666*	100yr ARI15%CC	3.04	122.33	123.31	123.20	123.41	0.013580	1.59	2.90	8.05	0.60
exis	58.6666*	PMF	12.00	122.33	123.55	123.69	124.04	0.051992	3.78	5.18	10.44	1.22
exis	54.*	100yr ARI	2.66	122.00	123.30	122.86	123.32	0.002252	0.80	5.31	10.03	0.25
exis	54.*	20yr ARI	1.80	122.00	123.23	122.73	123.25	0.001415	0.61	4.68	9.53	0.20
exis	54.*	100yr ARI15%CC	3.04	122.00	123.32	122.90	123.35	0.002592	0.88	5.58	10.25	0.27
exis	54.*	PMF	12.00	122.00	123.73	123.42	123.84	0.008333	1.95	10.42	13.47	0.52
exis	49.3333*	100yr ARI	2.66	121.67	123.30	122.55	123.31	0.000722	0.53	8.11	11.43	0.15
exis	49.3333*	20yr ARI	1.80	121.67	123.23	122.43	123.24	0.000419	0.39	7.38	10.96	0.11
exis	49.3333*	100yr ARI15%CC	3.04	121.67	123.33	122.60	123.34	0.000857	0.59	8.43	11.63	0.16

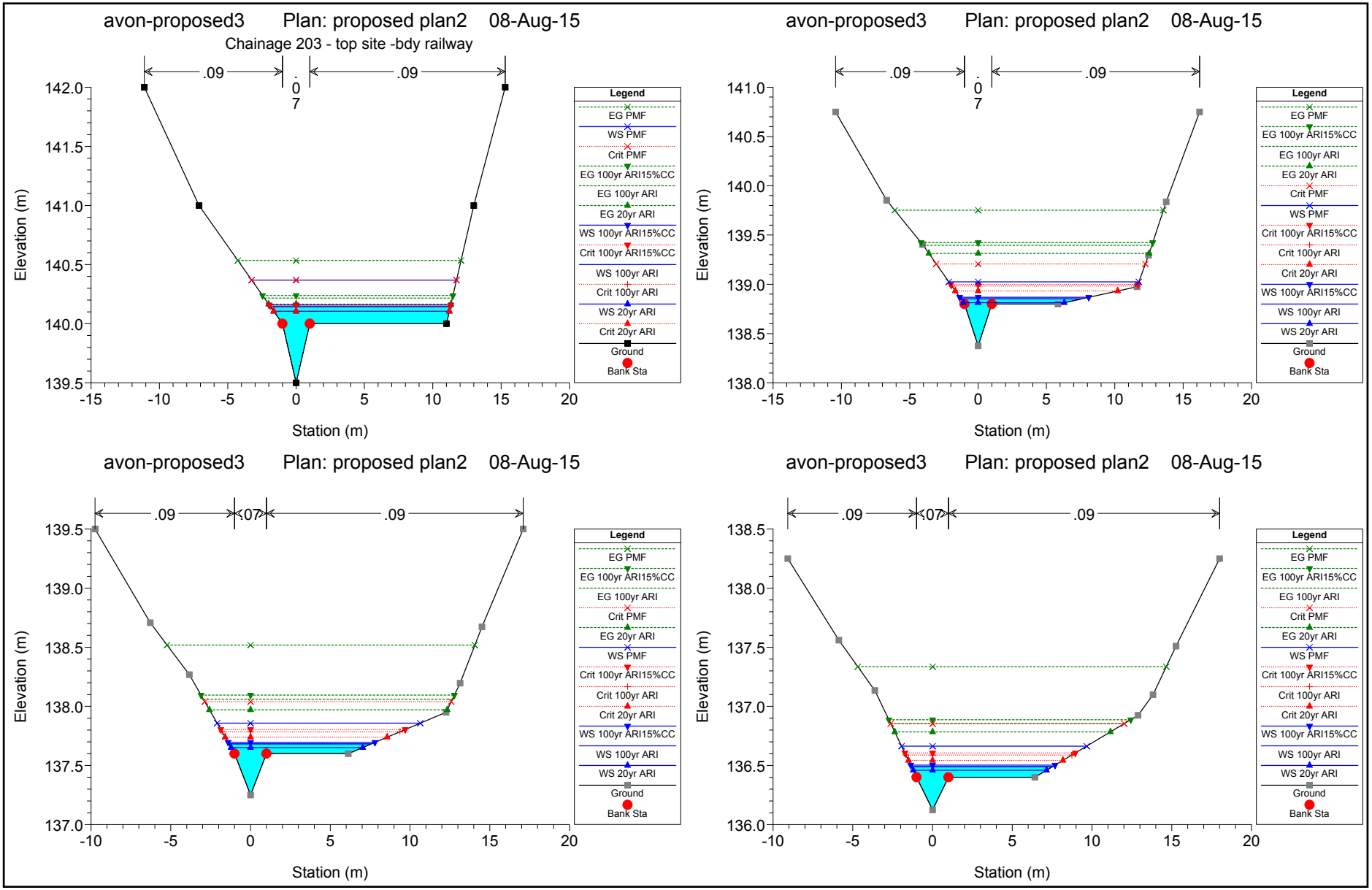
HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	49.3333*	PMF	12.00	121.67	123.74	123.14	123.80	0.003786	1.48	13.87	14.91	0.35
exis	44.6666*	100yr ARI	2.66	121.33	123.30	122.25	123.31	0.000313	0.40	10.98	12.51	0.10
exis	44.6666*	20yr ARI	1.80	121.33	123.24	122.11	123.24	0.000173	0.29	10.18	12.04	0.07
exis	44.6666*	100yr ARI15%CC	3.04	121.33	123.33	122.30	123.33	0.000378	0.44	11.33	12.70	0.11
exis	44.6666*	PMF	12.00	121.33	123.74	122.86	123.78	0.002061	1.20	17.18	15.64	0.26
exis	41		Inl Struct									
exis	40	100yr ARI	2.66	121.00	121.95	121.95	122.16	0.033775	2.08	1.54	4.78	0.86
exis	40	20yr ARI	1.80	121.00	121.80	121.80	122.00	0.044676	1.98	0.96	3.12	0.94
exis	40	100yr ARI15%CC	3.04	121.00	122.02	122.02	122.21	0.028703	2.05	1.88	5.44	0.80
exis	40	PMF	12.00	121.00	122.58	122.58	122.92	0.028590	3.09	5.91	8.75	0.89
exis	35.6*	100yr ARI	2.66	120.66	121.48	121.61	121.87	0.085783	2.81	1.01	3.31	1.31
exis	35.6*	20yr ARI	1.80	120.66	121.37	121.46	121.69	0.093088	2.47	0.73	2.15	1.31
exis	35.6*	100yr ARI15%CC	3.04	120.66	121.52	121.66	121.94	0.083513	2.92	1.15	3.75	1.31
exis	35.6*	PMF	12.00	120.66	122.01	122.23	122.68	0.069513	4.20	4.26	8.49	1.34
exis	31.2*	100yr ARI	2.66	120.32	121.16	121.27	121.51	0.073603	2.67	1.09	3.68	1.22
exis	31.2*	20yr ARI	1.80	120.32	121.07	121.12	121.32	0.065115	2.22	0.83	2.67	1.12
exis	31.2*	100yr ARI15%CC	3.04	120.32	121.19	121.32	121.58	0.074514	2.81	1.22	4.11	1.24
exis	31.2*	PMF	12.00	120.32	121.63	121.86	122.35	0.078987	4.36	4.22	9.38	1.42
exis	26.8*	100yr ARI	2.66	119.98	120.81	120.93	121.18	0.078256	2.72	1.07	3.82	1.26
exis	26.8*	20yr ARI	1.80	119.98	120.71	120.79	121.00	0.082483	2.39	0.76	2.38	1.24
exis	26.8*	100yr ARI15%CC	3.04	119.98	120.84	120.98	121.24	0.078327	2.86	1.22	4.32	1.27
exis	26.8*	PMF	12.00	119.98	121.76	121.50	121.86	0.008808	1.90	11.31	17.53	0.51
exis	22.4*	100yr ARI	2.66	119.64	120.47	120.59	120.83	0.077878	2.71	1.09	4.15	1.25
exis	22.4*	20yr ARI	1.80	119.64	120.38	120.45	120.65	0.072036	2.29	0.80	2.71	1.17
exis	22.4*	100yr ARI15%CC	3.04	119.64	120.50	120.64	120.90	0.078480	2.85	1.24	4.71	1.27
exis	22.4*	PMF	12.00	119.64	121.79	121.13	121.82	0.001916	1.03	21.81	25.77	0.25
exis	18	100yr ARI	3.18	119.30	120.52	120.33	120.57	0.006480	1.17	4.56	13.04	0.40

HEC-RAS Plan: p10 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	18	20yr ARI	2.14	119.30	120.30	120.18	120.38	0.013991	1.41	2.17	7.94	0.56
exis	18	100yr ARI15%CC	3.61	119.30	120.61	120.36	120.65	0.005131	1.11	5.71	14.87	0.36
exis	18	PMF	15.24	119.30	121.80	120.84	121.81	0.000899	0.79	36.42	34.37	0.17
exis	13.5*	100yr ARI	3.18	119.35	120.19	120.19	120.50	0.039585	2.47	1.29	2.09	1.00
exis	13.5*	20yr ARI	2.14	119.35	120.02	120.02	120.27	0.039961	2.24	0.96	1.87	1.00
exis	13.5*	100yr ARI15%CC	3.61	119.35	120.25	120.25	120.58	0.038997	2.53	1.43	2.17	1.00
exis	13.5*	PMF	15.24	119.35	121.76	121.21	121.80	0.002116	1.24	21.13	25.59	0.28
exis	9.*	100yr ARI	3.18	119.40	119.94	120.02	120.32	0.035855	2.73	1.17	2.33	1.23
exis	9.*	20yr ARI	2.14	119.40	119.83	119.88	120.11	0.032866	2.34	0.92	2.26	1.17
exis	9.*	100yr ARI15%CC	3.61	119.40	119.98	120.07	120.40	0.036531	2.85	1.27	2.36	1.24
exis	9.*	PMF	15.24	119.40	121.23	121.23	121.74	0.015825	3.19	5.20	7.73	0.82
exis	4.5*	100yr ARI	3.18	119.45	119.89	119.93	120.18	0.017565	2.40	1.32	3.09	1.17
exis	4.5*	20yr ARI	2.14	119.45	119.80	119.82	120.01	0.015186	2.00	1.07	3.07	1.08
exis	4.5*	100yr ARI15%CC	3.61	119.45	119.90	119.98	120.25	0.020296	2.63	1.37	3.10	1.26
exis	4.5*	PMF	15.24	119.45	120.52	120.81	121.58	0.027171	4.57	3.33	3.25	1.44
exis	0	100yr ARI	2.18	119.50	119.70	119.81	120.08	0.023173	2.72	0.80	3.98	1.94
exis	0	20yr ARI	1.14	119.50	119.62	119.70	119.90	0.030723	2.32	0.49	3.98	2.11
exis	0	100yr ARI15%CC	2.61	119.50	119.73	119.85	120.15	0.022396	2.88	0.91	3.98	1.93
exis	0	PMF	14.24	119.50	120.22	120.59	121.46	0.018302	4.93	2.89	3.99	1.85


avon-proposed3 Plan: proposed plan2 08-Aug-15
avon rd exis
Elevation (m)
Main Channel Distance (m)
145
140
135
130
125
120
115
0
50
100
150
200
250
4.5*
9.*
13.5*
18
22.4*
26.8*
31.2*
35.6*
40
44.6666*
49.3333*
54.*
58.6666*
63.3333*
67
72.5*
77.*
81.5*
86.*
90.5*
95
99.6666*
104.333*
109.*
113.666*
118.333*
123
127.428*
131.857*
136.285*
140.714*
145.142*
149.571*
154
158.714*
163.428*
168.142*
172.857*
177.571*
182.285*
187
191.*
195.*
199.*
203
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground


avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 203 - top site -bdy railway
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
WS 100yr ARI
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
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Elevation (m)
Station (m)
Legend
EG PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit PMF
WS PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
EG 100yr ARI15%CC
EG 100yr ARI
Crit PMF
EG 20yr ARI
WS PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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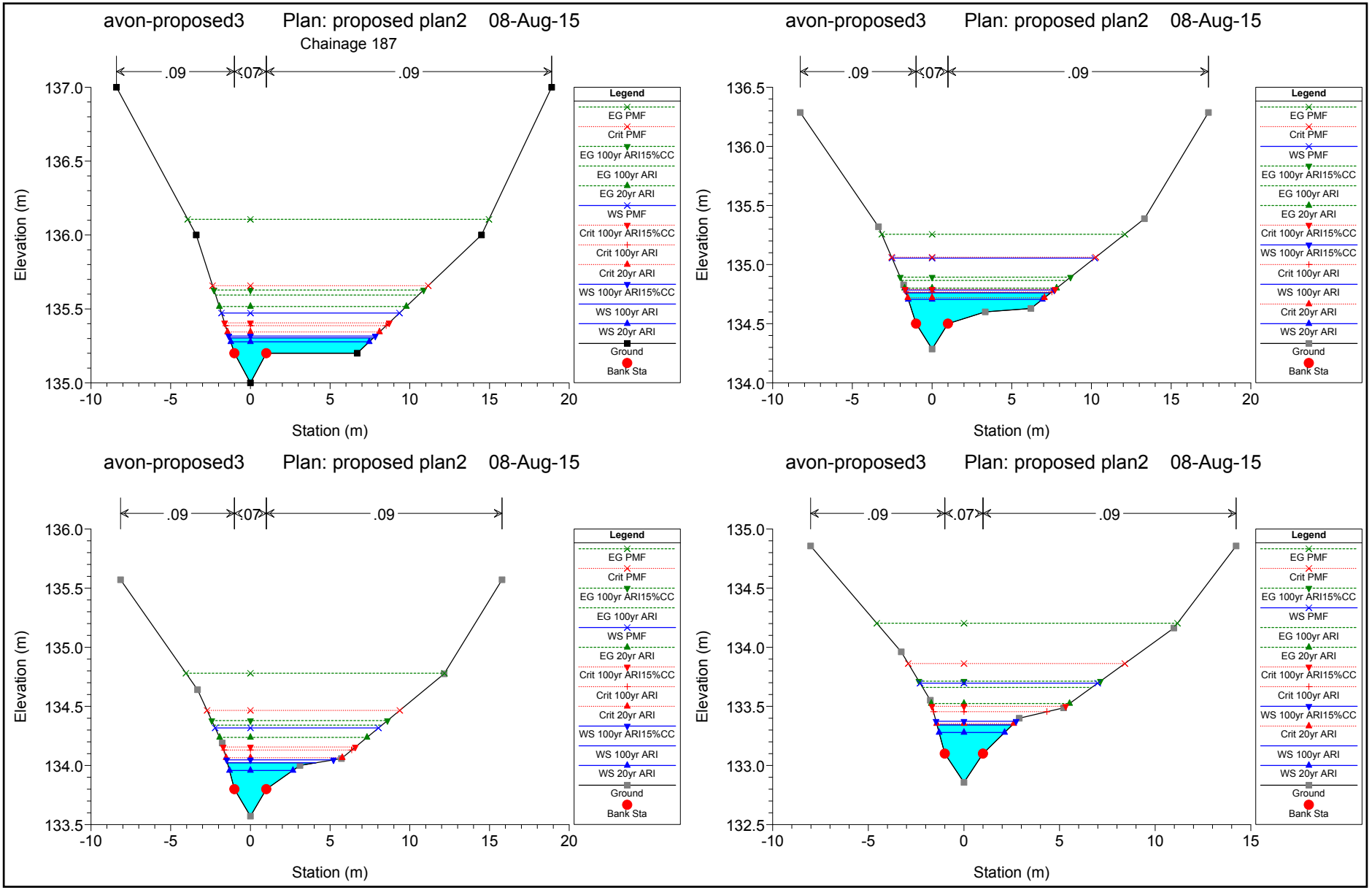
Elevation (m)
Station (m)
Legend
EG PMF
EG 100yr ARI15%CC
EG 100yr ARI
Crit PMF
EG 20yr ARI
WS PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta


avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 187
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
WS 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
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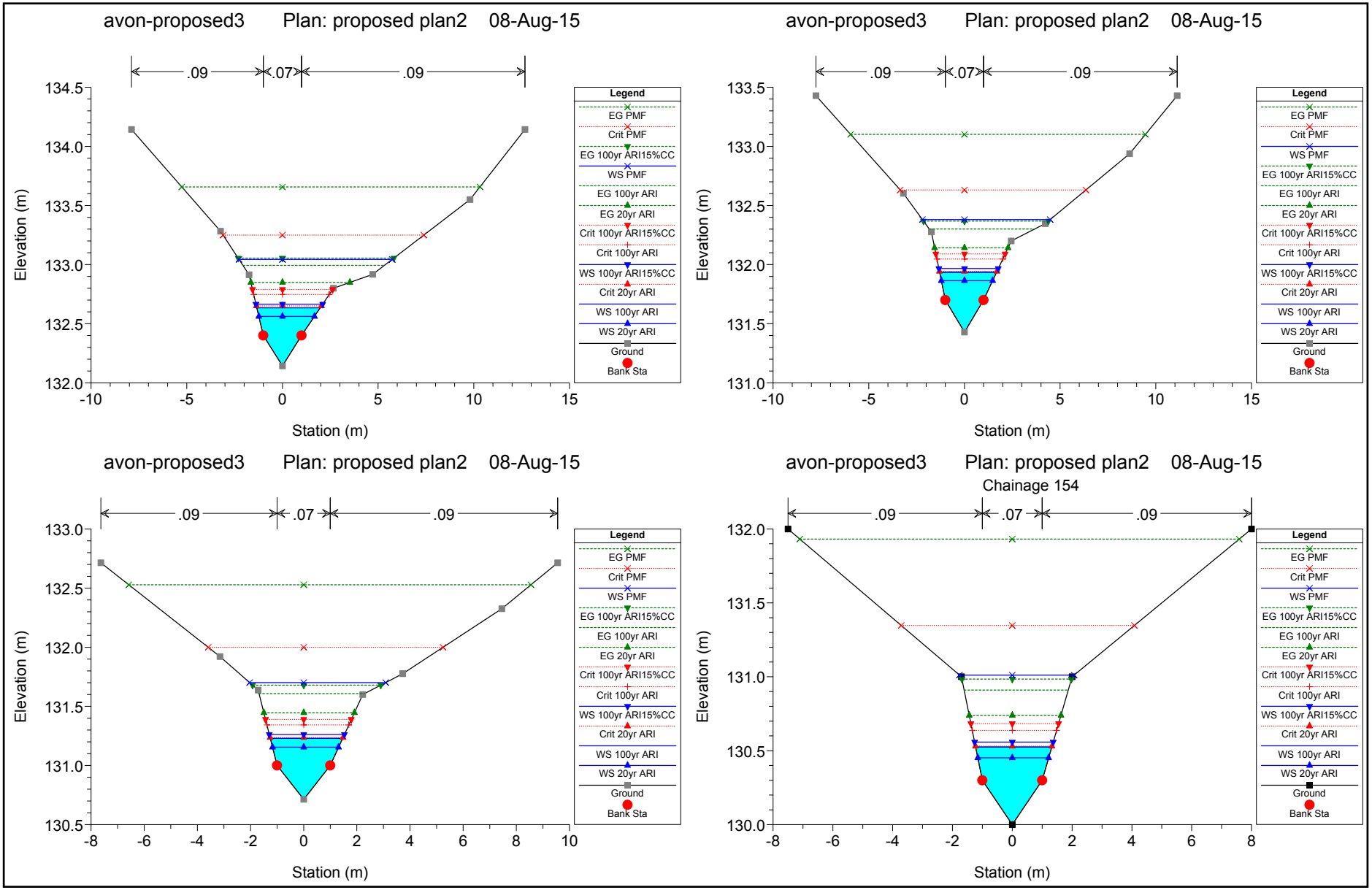
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
WS PMF
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
EG 100yr ARI15%CC
WS PMF
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta



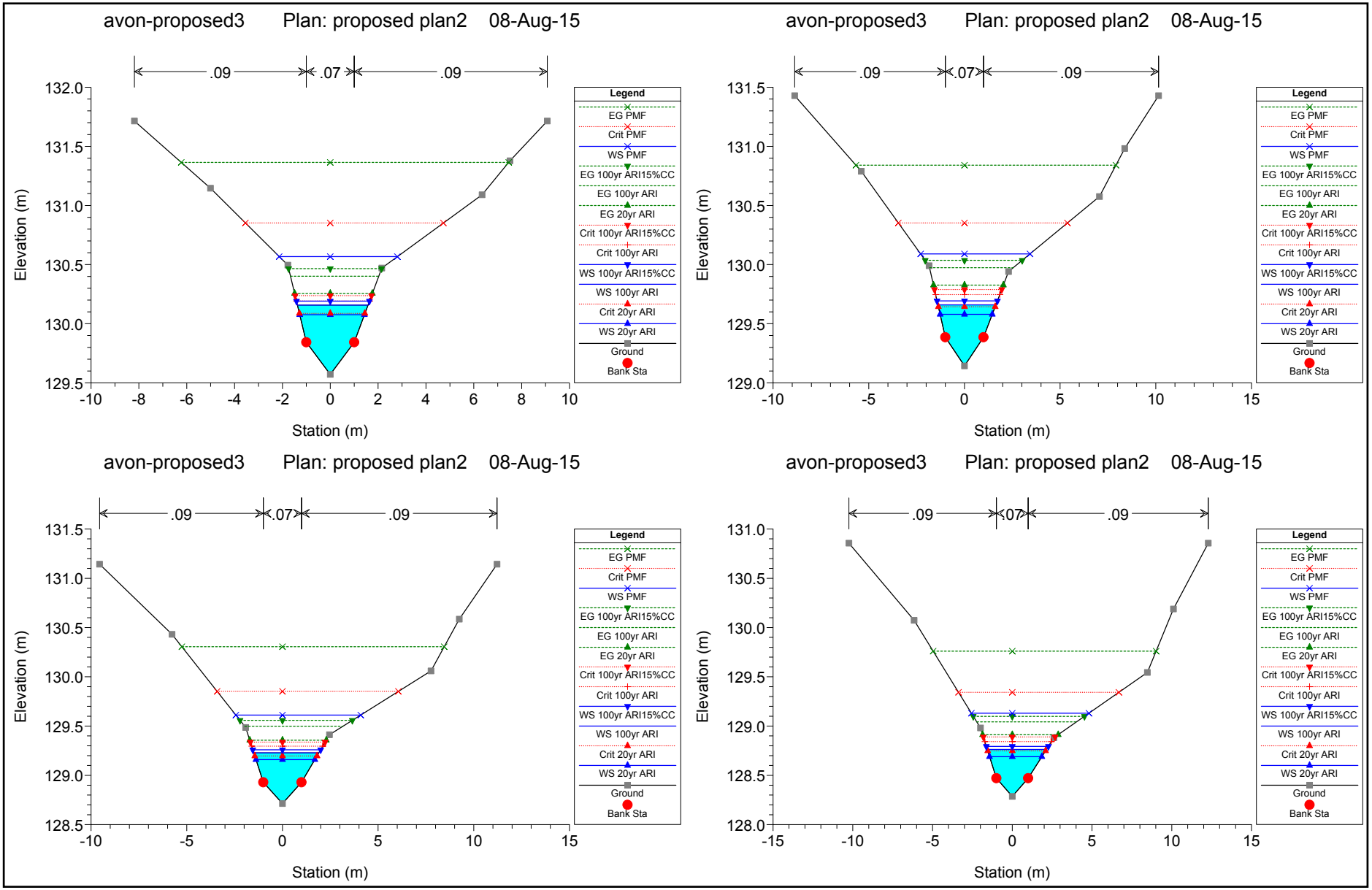
avon-proposed3 Plan: proposed plan2 08-Aug-15

avon-proposed3 Plan: proposed plan2 08-Aug-15

avon-proposed3 Plan: proposed plan2 08-Aug-15

avon-proposed3 Plan: proposed plan2 08-Aug-15

Chainage 154

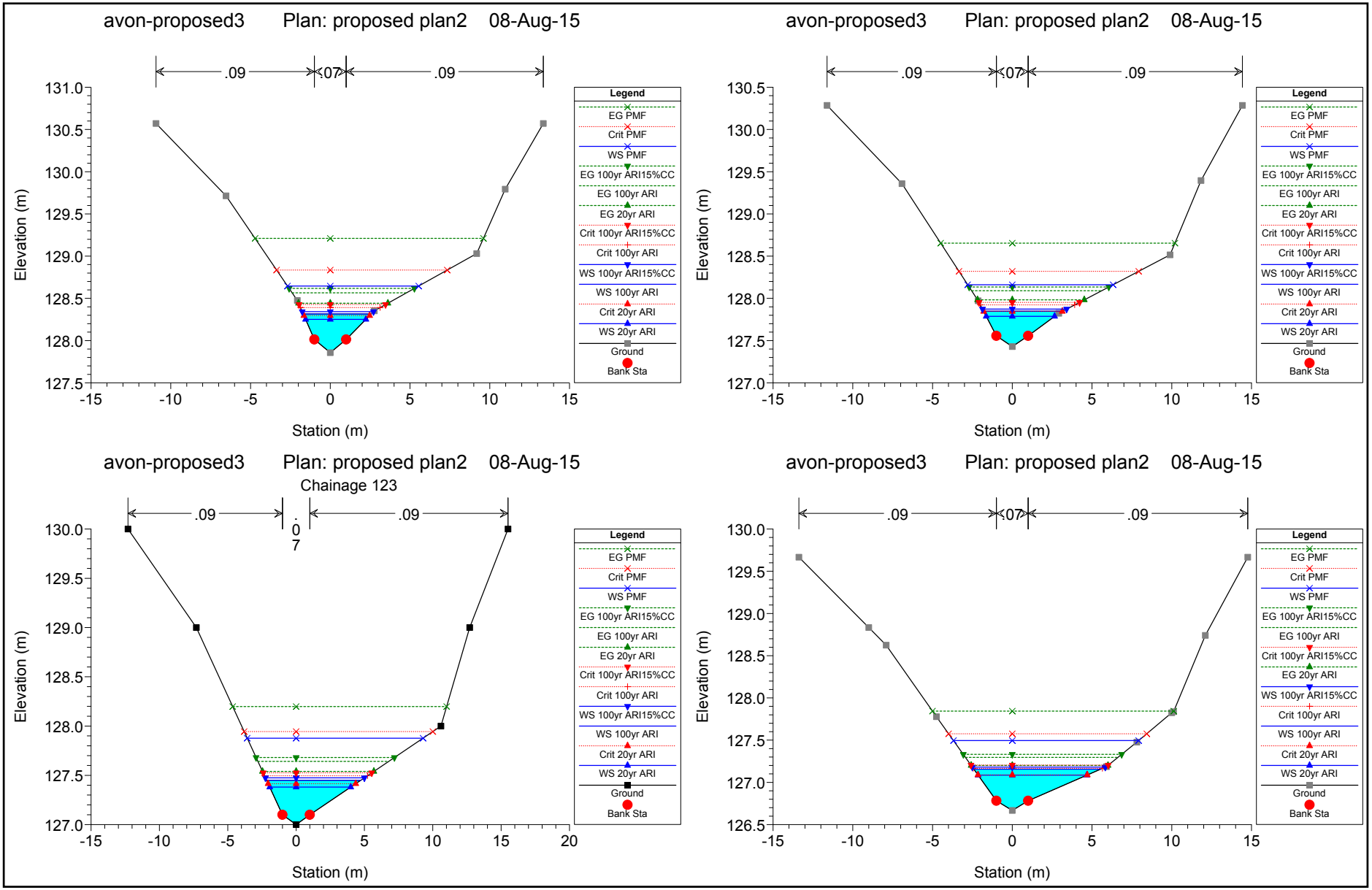


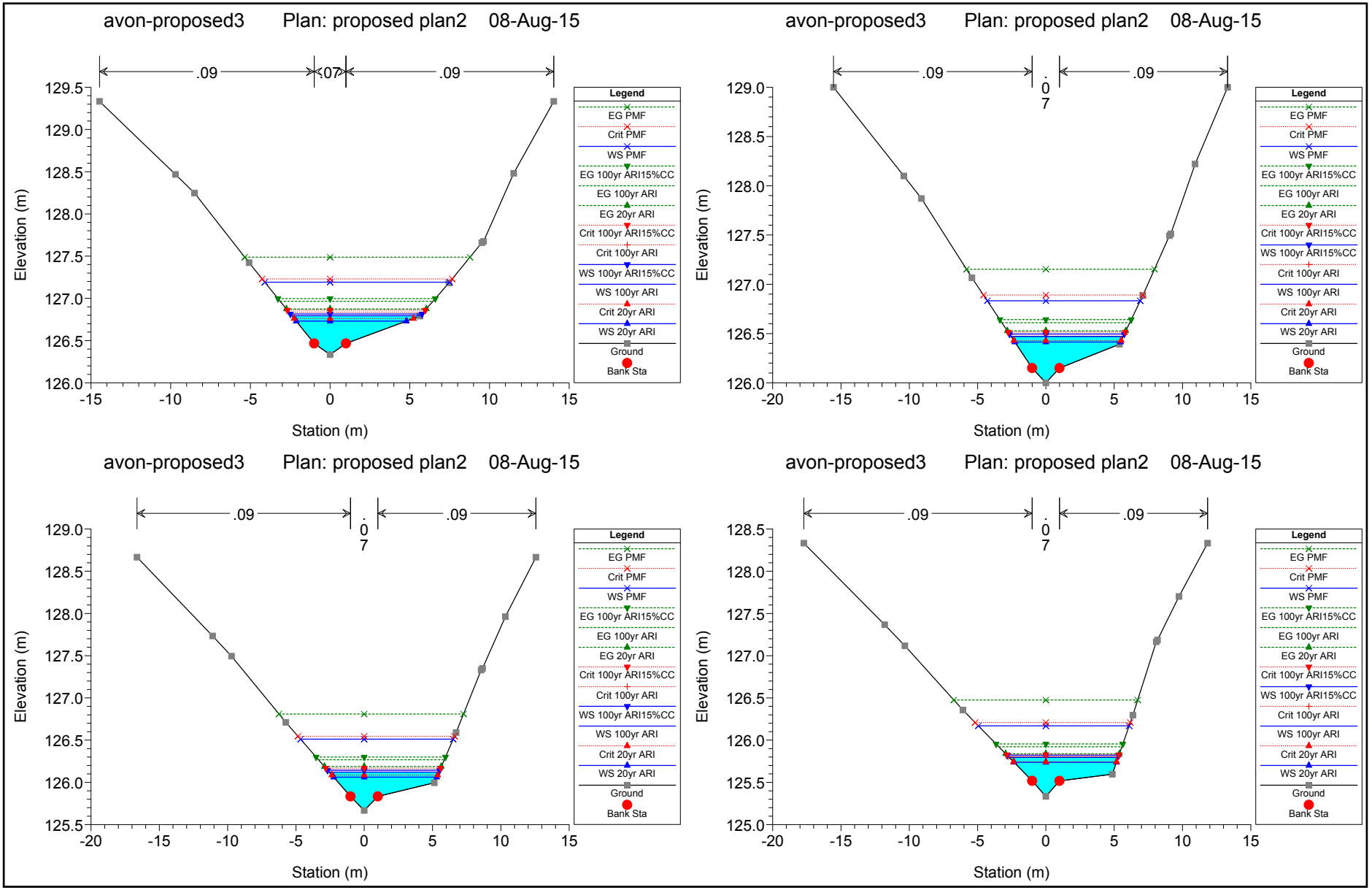
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
132.0
131.5
131.0
130.5
130.0
129.5
-10
-8
-6
-4
-2
0
2
4
6
8
10
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta

avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
131.5
131.0
130.5
130.0
129.5
129.0
-10
-5
0
5
10
15
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta

avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
131.5
131.0
130.5
130.0
129.5
129.0
128.5
-10
-5
0
5
10
15
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta

avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
131.0
130.5
130.0
129.5
129.0
128.5
128.0
-15
-10
-5
0
5
10
15
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta


avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 123
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
Crit 100yr ARI15%CC
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta


avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
WS 100yr ARI15%CC
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WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
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EG PMF
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WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
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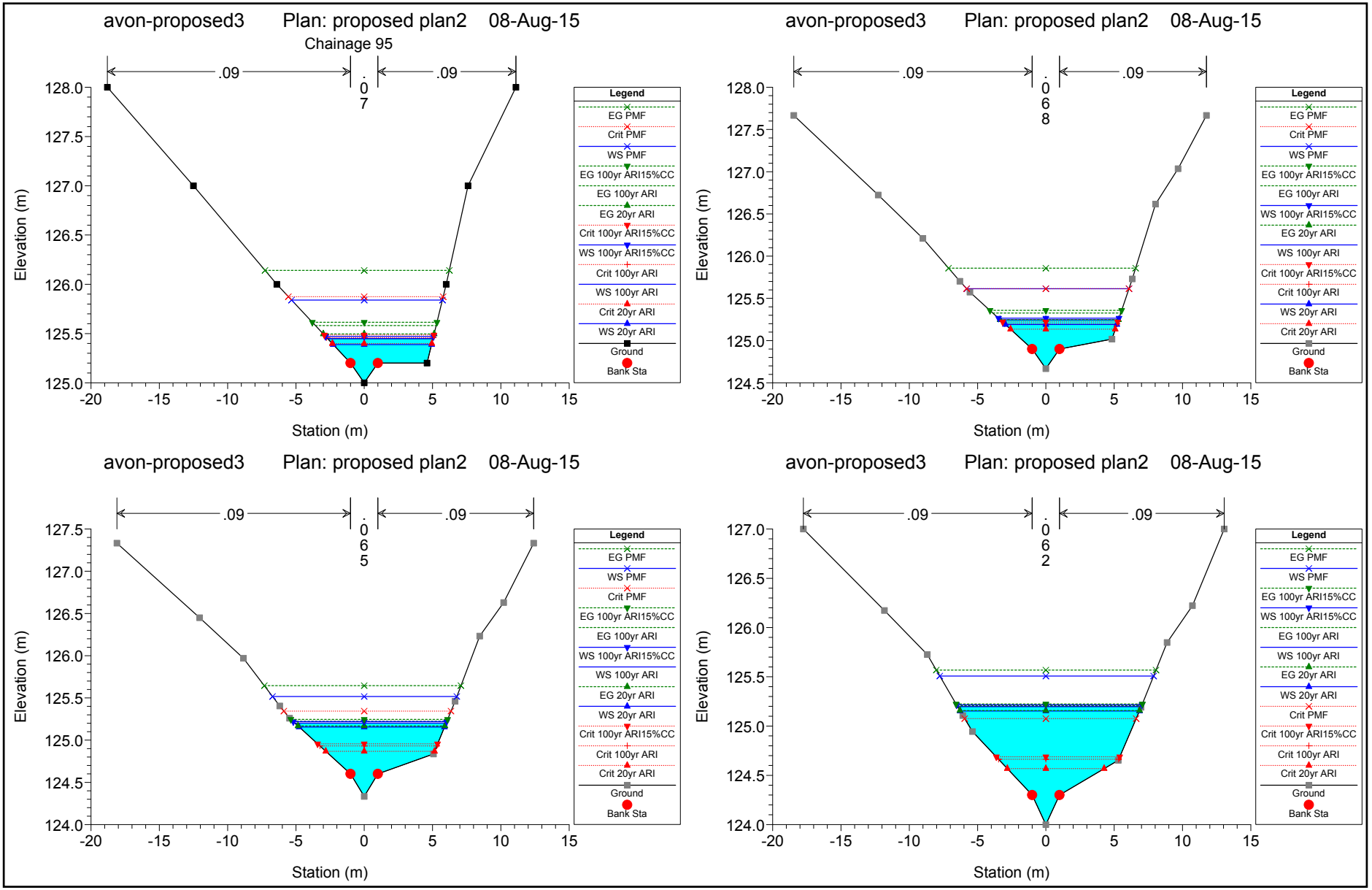
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta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Chainage 95
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Elevation (m)
Station (m)
Legend
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Crit PMF
WS PMF
EG 100yr ARI15%CC
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Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
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Legend
EG PMF
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WS PMF
EG 100yr ARI15%CC
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Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
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Legend
EG PMF
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Crit PMF
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Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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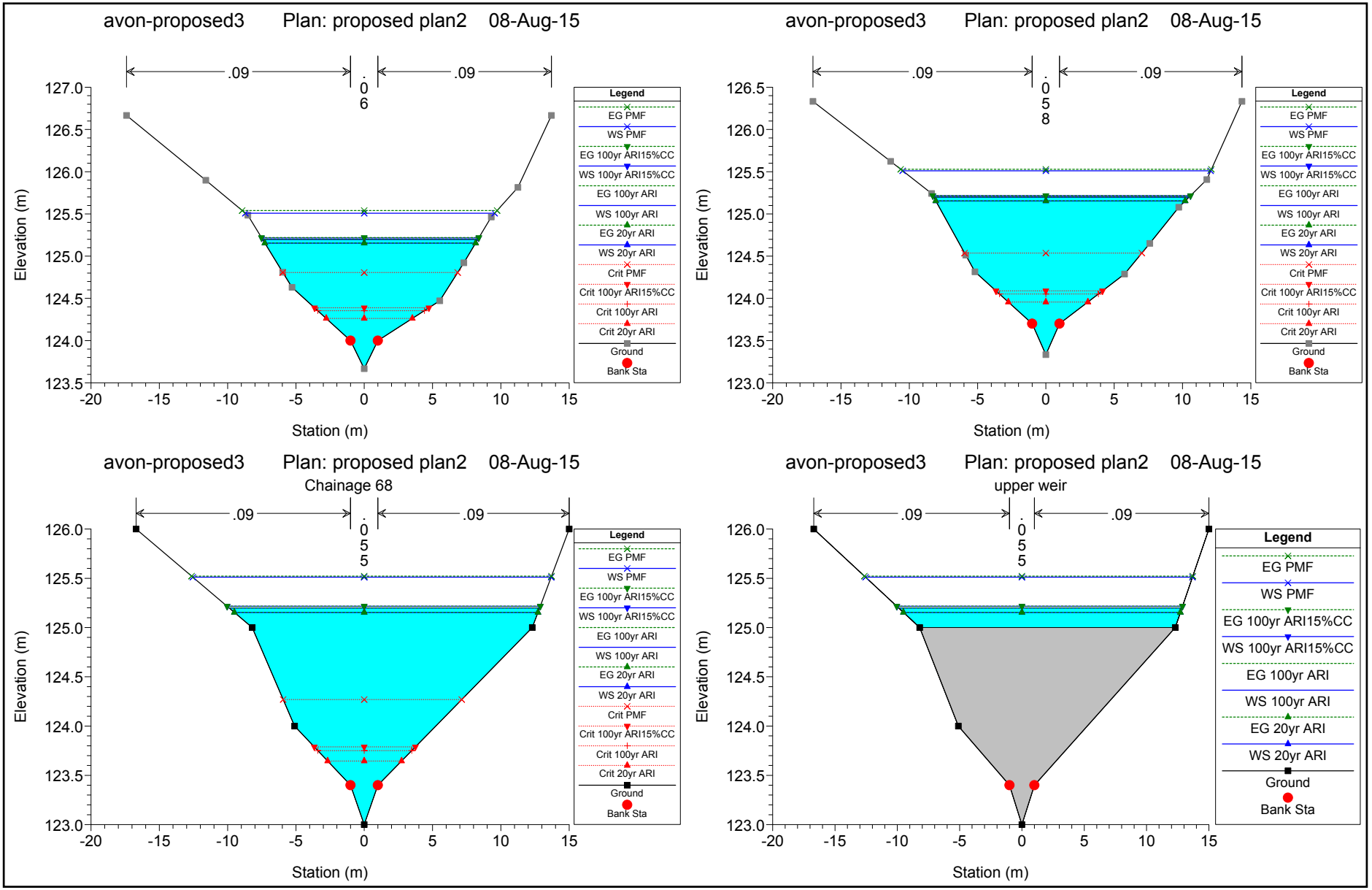
Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta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Elevation (m)
Station (m)
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EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 68
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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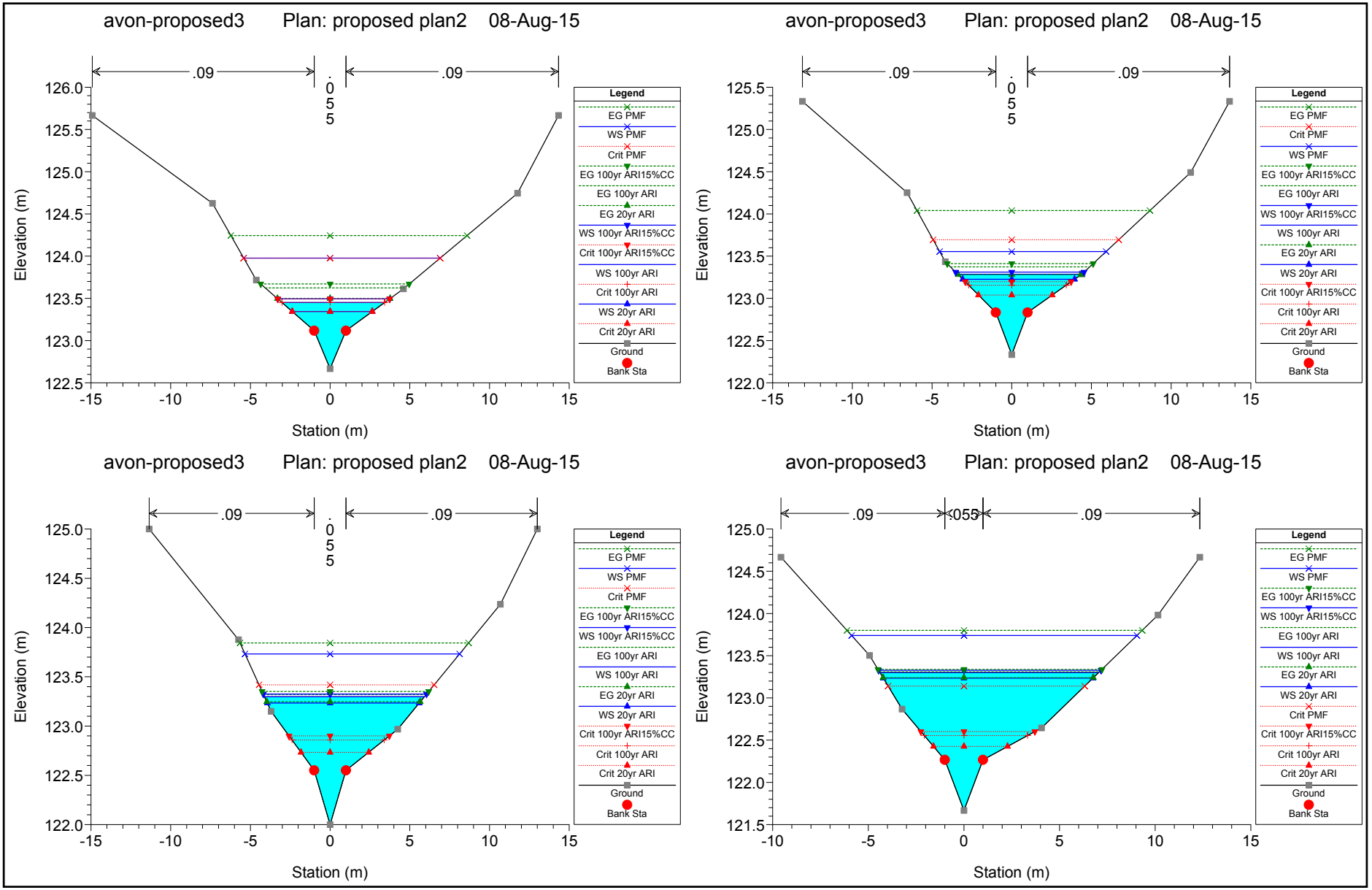
Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Ground
Bank Sta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Elevation (m)
Station (m)
Legend
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WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
WS 100yr ARI
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
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WS 20yr ARI
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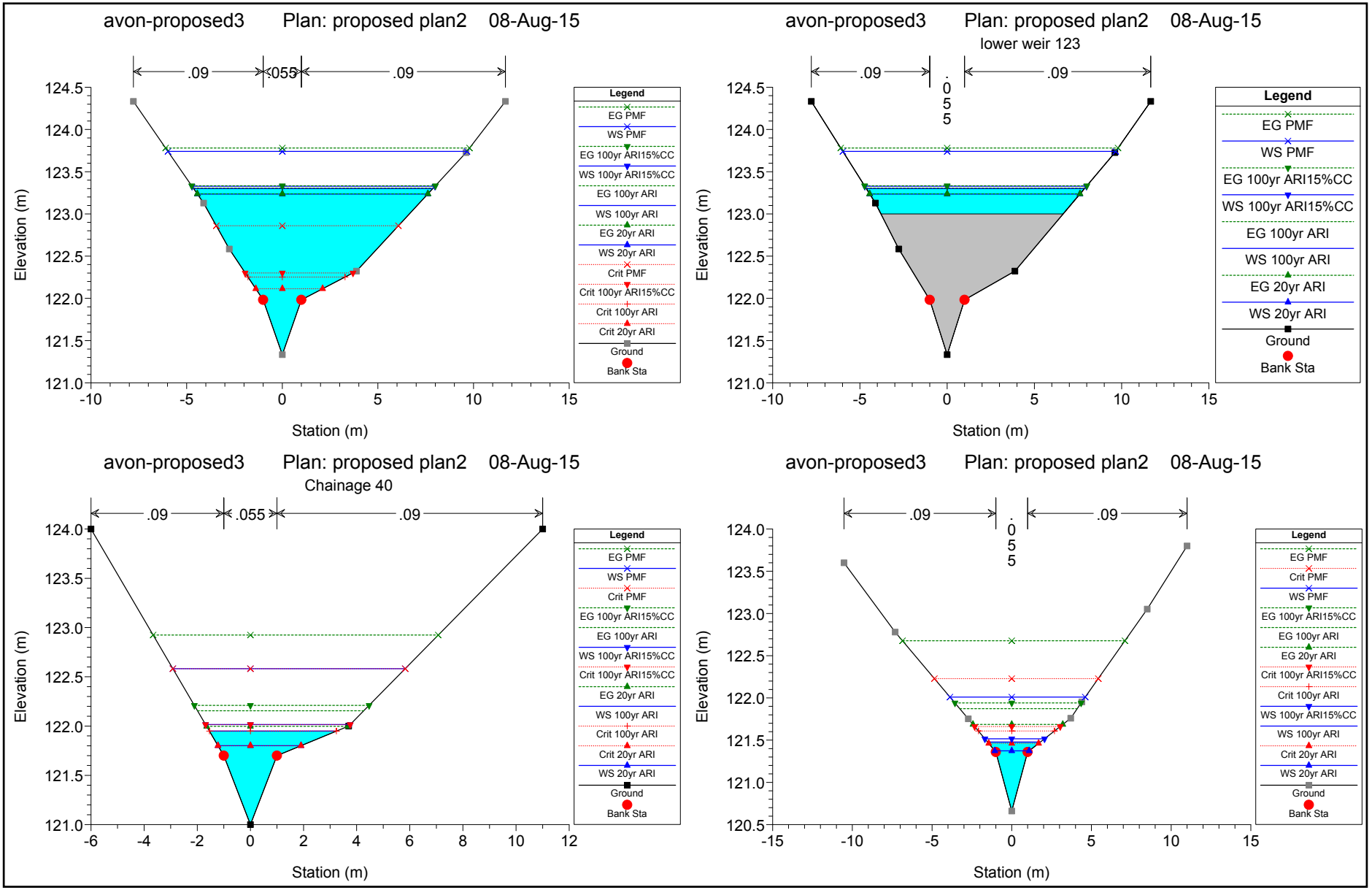
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Crit PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
lower weir 123
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 40
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.055
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
EG 20yr ARI
WS 100yr ARI
Crit 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.09
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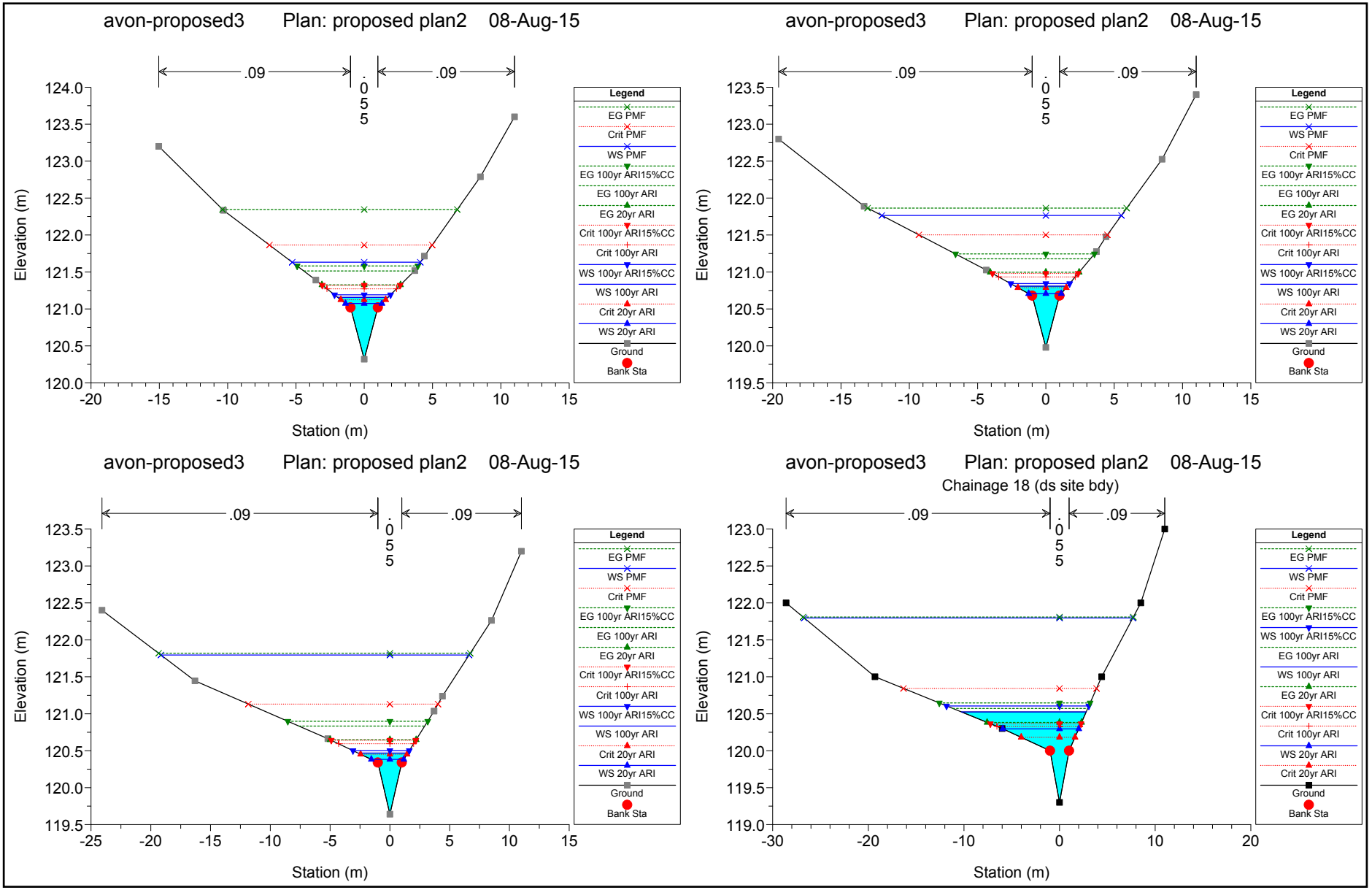
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta


avon-proposed3 Plan: proposed plan2 08-Aug-15
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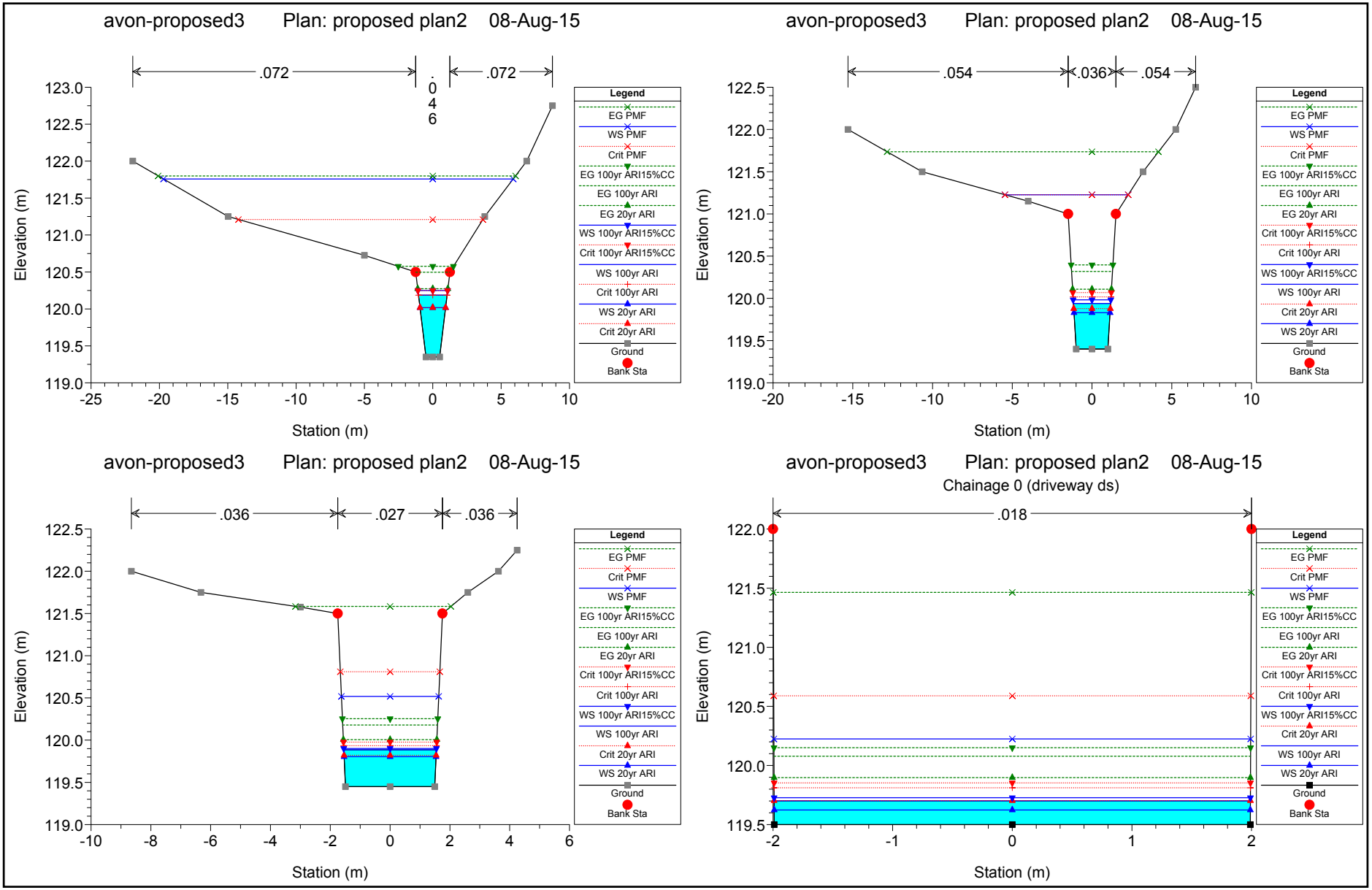
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
avon-proposed3 Plan: proposed plan2 08-Aug-15
avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 18 (ds site bdy)


avon-proposed3 Plan: proposed plan2 08-Aug-15
.072
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
WS 100yr ARI
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.054
.036
.054
Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
.036
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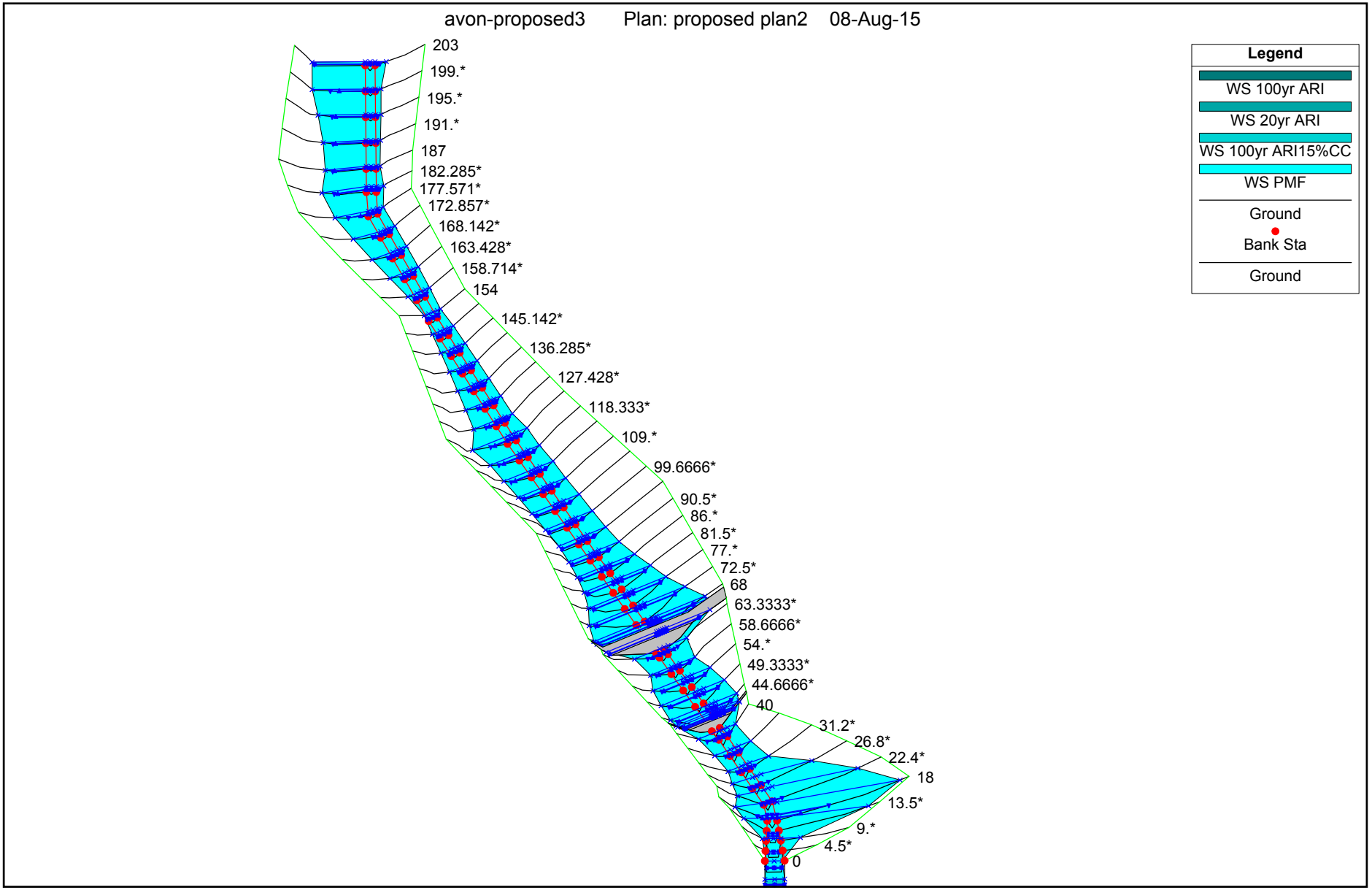
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-proposed3 Plan: proposed plan2 08-Aug-15
Chainage 0 (driveway ds)
.018
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta

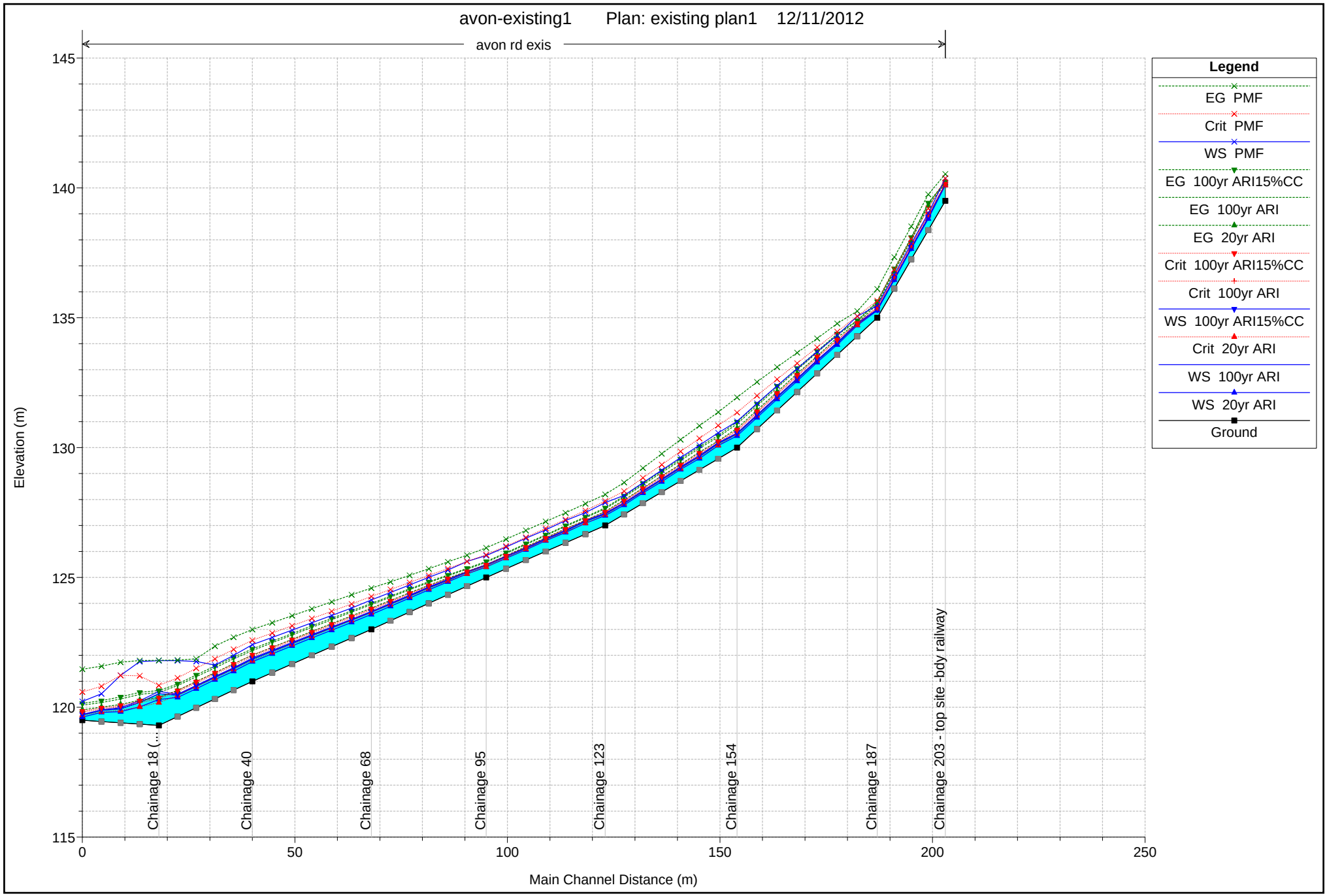

avon-proposed3 Plan: proposed plan2 08-Aug-15
203
199.*
195.*
191.*
187
182.285*
177.571*
172.857*
168.142*
163.428*
158.714*
154
145.142*
136.285*
127.428*
118.333*
109.*
99.6666*
90.5*
86.*
81.5*
77.*
72.5*
68
63.3333*
58.6666*
54.*
49.3333*
44.6666*
40
31.2*
26.8*
22.4*
18
13.5*
9.*
4.5*
0
Legend
WS 100yr ARI
WS 20yr ARI
WS 100yr ARI15%CC
WS PMF
Ground
Bank Sta
Ground

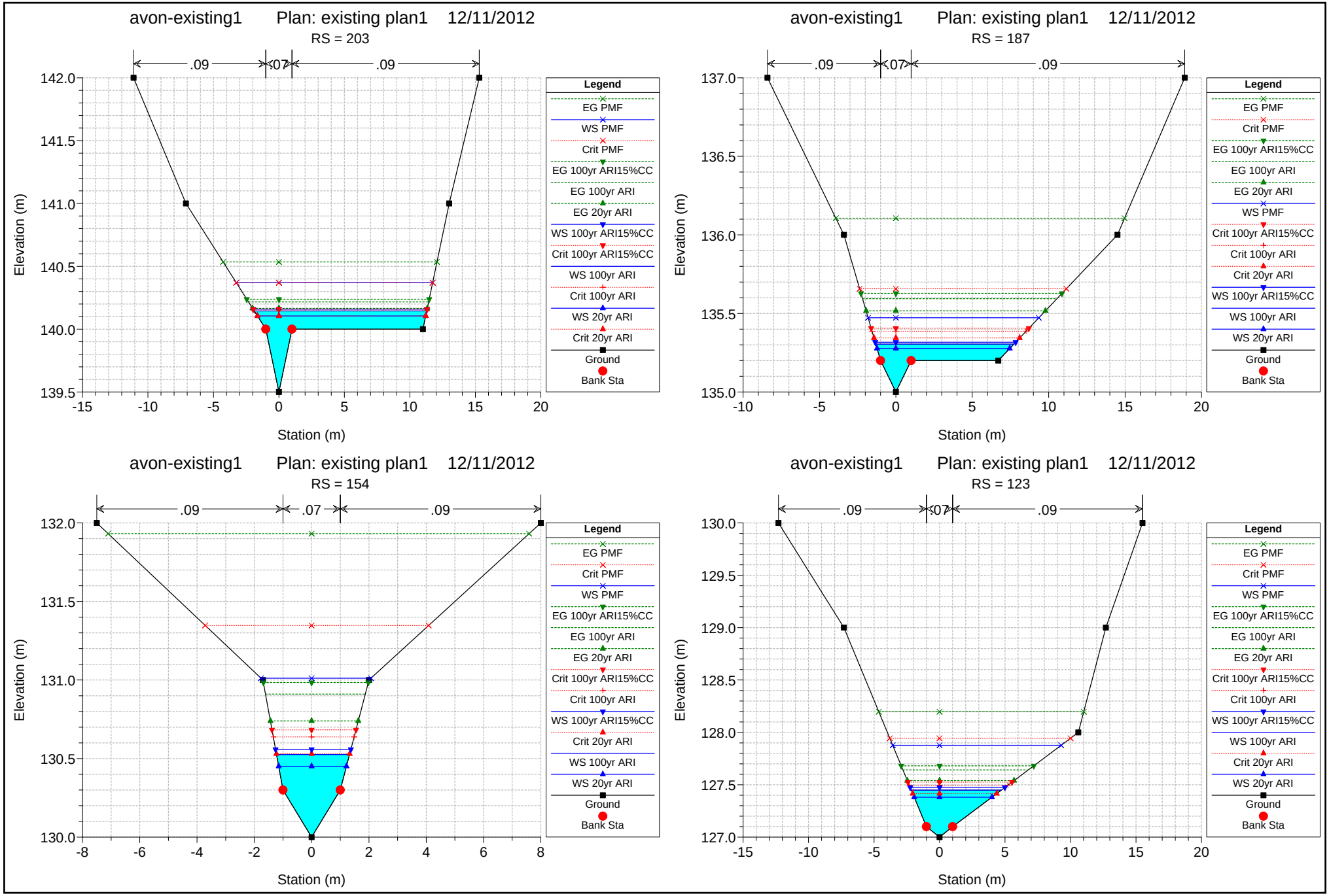
HEC-RAS Plan: p1 River: avon rd Reach: exis

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	203	100yr ARI	2.14	139.50	140.14	140.14	140.21660	0.04409	1.50	2.32	13.17	0.76
exis	203	20yr ARI	1.46	139.50	140.10	140.10	140.16570	0.03929	1.32	1.80	12.85	0.71
exis	203	100yr ARI15%CC	2.47	139.50	140.16	140.16	140.23840	0.04746	1.59	2.51	13.29	0.79
exis	203	PMF	8.77	139.50	140.37	140.37	140.53500	0.06280	2.41	5.48	14.99	0.98
exis	187	100yr ARI	2.14	135.00	135.30	135.39	135.59360	0.35586	2.92	1.08	9.04	2.06
exis	187	20yr ARI	1.46	135.00	135.28	135.34	135.51660	0.33902	2.59	0.83	8.68	1.96
exis	187	100yr ARI15%CC	2.47	135.00	135.32	135.41	135.62770	0.36145	3.06	1.18	9.19	2.10
exis	187	PMF	8.77	135.00	135.47	135.66	136.10600	0.39016	4.56	2.77	11.17	2.38
exis	154	100yr ARI	2.14	130.00	130.53	130.64	130.91040	0.14797	2.78	0.81	2.55	1.45
exis	154	20yr ARI	1.46	130.00	130.45	130.53	130.73950	0.14695	2.39	0.63	2.37	1.39
exis	154	100yr ARI15%CC	2.47	130.00	130.56	130.68	130.98460	0.14734	2.93	0.90	2.63	1.47
exis	154	PMF	8.77	130.00	131.01	131.35	131.93190	0.12729	4.48	2.34	3.84	1.54
exis	123	100yr ARI	2.66	127.00	127.45	127.50	127.64200	0.08577	2.26	1.65	6.88	1.14
exis	123	20yr ARI	1.80	127.00	127.38	127.42	127.53970	0.08549	1.99	1.21	5.93	1.11
exis	123	100yr ARI15%CC	3.04	127.00	127.47	127.53	127.68100	0.08623	2.36	1.83	7.23	1.16
exis	123	PMF	12.00	127.00	127.88	127.94	128.19790	0.06965	3.31	5.87	12.86	1.16
exis	95	100yr ARI	2.66	125.00	125.46	125.46	125.58070	0.06463	1.83	1.98	7.85	0.97
exis	95	20yr ARI	1.80	125.00	125.40	125.40	125.49560	0.06549	1.62	1.51	7.32	0.94
exis	95	100yr ARI15%CC	3.04	125.00	125.49	125.48	125.61430	0.06336	1.90	2.19	8.07	0.97
exis	95	PMF	12.00	125.00	125.84	125.87	126.14070	0.07126	3.08	5.53	11.04	1.14
exis	68	100yr ARI	2.66	123.00	123.66	123.75	123.95360	0.06230	2.56	1.37	5.57	1.21
exis	68	20yr ARI	1.80	123.00	123.57	123.65	123.81980	0.06496	2.28	0.94	4.37	1.19
exis	68	100yr ARI15%CC	3.04	123.00	123.69	123.79	124.00210	0.06134	2.66	1.56	6.02	1.21
exis	68	PMF	12.00	123.00	124.13	124.27	124.58930	0.05113	3.74	5.59	11.71	1.24
exis	40	100yr ARI	2.66	121.00	121.85	121.95	122.18310	0.06520	2.57	1.14	3.72	1.16
exis	40	20yr ARI	1.80	121.00	121.75	121.80	122.00530	0.06562	2.23	0.82	2.60	1.12
exis	40	100yr ARI15%CC	3.04	121.00	121.89	122.02	122.24710	0.06448	2.69	1.29	4.15	1.17
exis	40	PMF	12.00	121.00	122.41	122.58	122.99390	0.05588	3.92	4.51	7.76	1.21
exis	18	100yr ARI	3.18	119.30	120.52	120.33	120.57200	0.00648	1.17	4.56	13.04	0.40
exis	18	20yr ARI	2.14	119.30	120.30	120.18	120.38280	0.01399	1.41	2.17	7.94	0.56
exis	18	100yr ARI15%CC	3.61	119.30	120.61	120.36	120.64590	0.00513	1.11	5.71	14.87	0.36
exis	18	PMF	15.24	119.30	121.80	120.84	121.80870	0.00090	0.79	36.42	34.37	0.17

HEC-RAS Plan: p1 River: avon rd Reach: exis (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
exis	0	100yr ARI	2.18	119.50	119.70	119.81	120.07870	0.02317	2.72	0.80	3.98	1.94
exis	0	20yr ARI	1.14	119.50	119.62	119.70	119.89750	0.03072	2.32	0.49	3.98	2.11
exis	0	100yr ARI15%CC	2.61	119.50	119.73	119.85	120.15070	0.02240	2.88	0.91	3.98	1.93
exis	0	PMF	14.24	119.50	120.22	120.59	121.46420	0.01830	4.93	2.89	3.99	1.85


avon-existing1 Plan: existing plan1 12/11/2012
avon rd exis
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground
Elevation (m)
145
140
135
130
125
120
115
0
50
100
150
200
250
Main Channel Distance (m)
Chainage 18 (...
Chainage 40
Chainage 68
Chainage 95
Chainage 123
Chainage 154
Chainage 187
Chainage 203 - top site -bdy railway


avon-existing1 Plan: existing plan1 12/11/2012
RS = 203
.09
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Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
WS 100yr ARI
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 187
.09
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Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS PMF
Crit 100yr ARI15%CC
Crit 100yr ARI
Crit 20yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 154
.09
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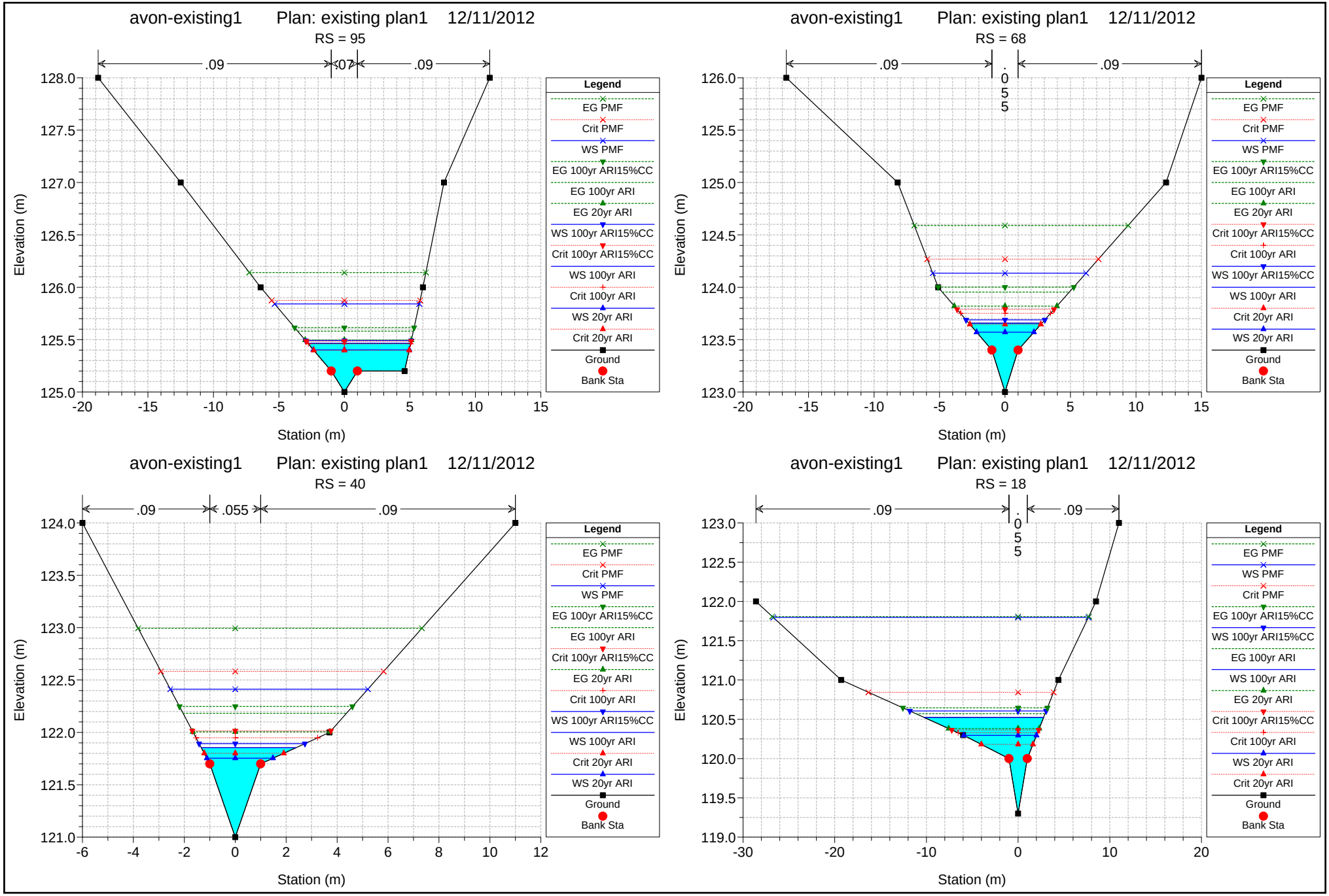
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 123
.09
.07
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta


avon-existing1 Plan: existing plan1 12/11/2012
RS = 95
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.07
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Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
WS 100yr ARI15%CC
Crit 100yr ARI15%CC
WS 100yr ARI
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 68
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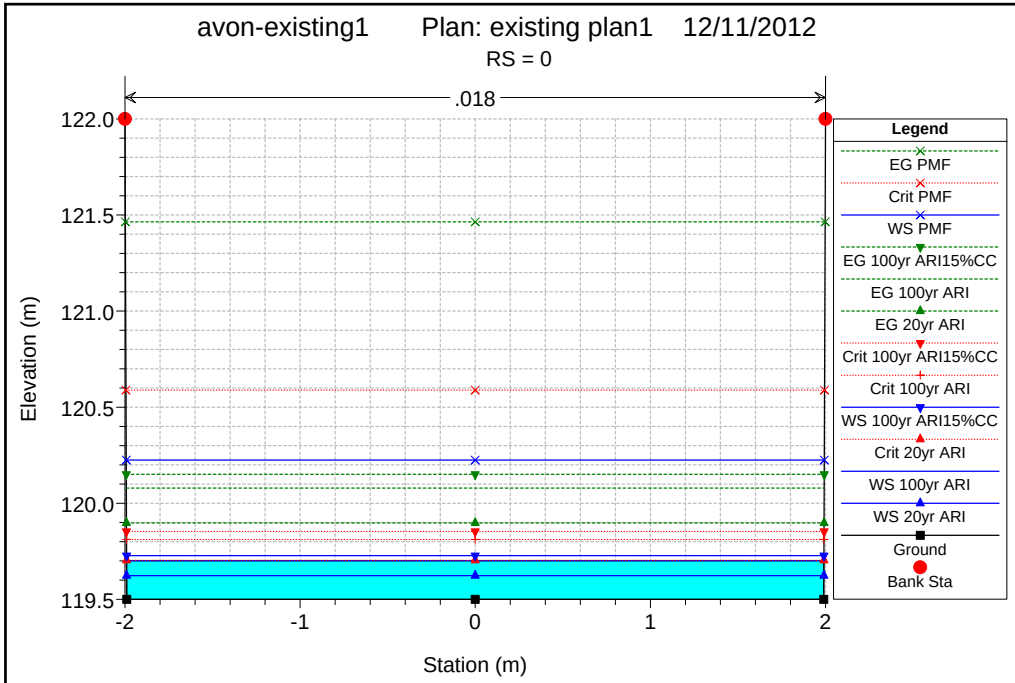
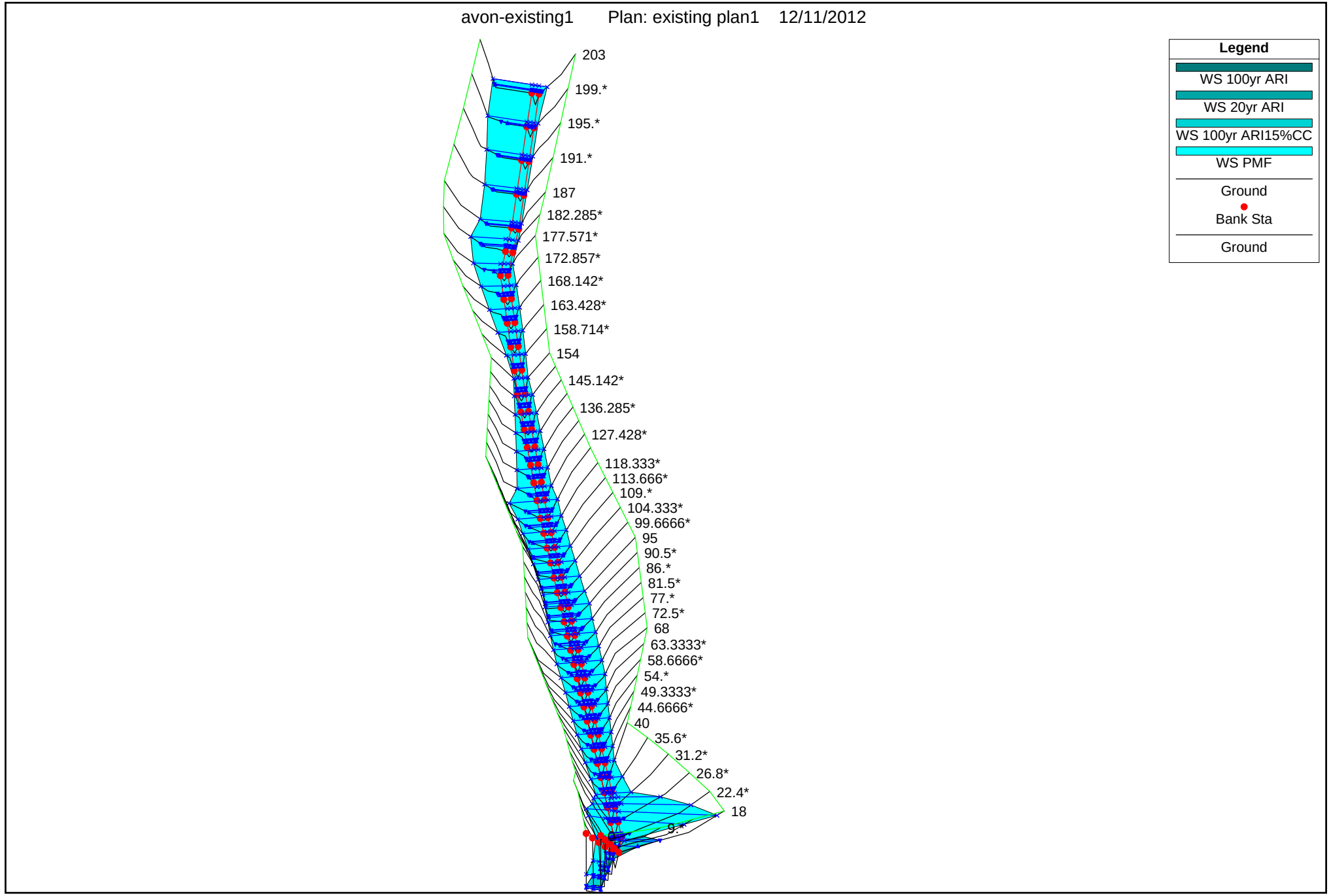
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 40
.09
.055
.09
Elevation (m)
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
Crit 100yr ARI15%CC
EG 20yr ARI
Crit 100yr ARI
WS 100yr ARI15%CC
WS 100yr ARI
Crit 20yr ARI
WS 20yr ARI
Ground
Bank Sta
avon-existing1 Plan: existing plan1 12/11/2012
RS = 18
.09
.055
.09
Elevation (m)
Station (m)
Legend
EG PMF
WS PMF
Crit PMF
EG 100yr ARI15%CC
WS 100yr ARI15%CC
EG 100yr ARI
WS 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 20yr ARI
Crit 20yr ARI
Ground
Bank Sta


avon-existing1 Plan: existing plan1 12/11/2012
RS = 0
.018
122.0
121.5
121.0
120.5
120.0
119.5
Elevation (m)
-2
-1
0
1
2
Station (m)
Legend
EG PMF
Crit PMF
WS PMF
EG 100yr ARI15%CC
EG 100yr ARI
EG 20yr ARI
Crit 100yr ARI15%CC
Crit 100yr ARI
WS 100yr ARI15%CC
Crit 20yr ARI
WS 100yr ARI
WS 20yr ARI
Ground
Bank Sta

avon-existing1 Plan: existing plan1 12/11/2012



APPENDIX H (*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 22 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, detention 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.*);

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- 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*);
-Summer Hill Flour Mill Concept Plan Application Stormwater Management Plan and Flood Study (*250 dwelling high density residential subdivision*);
- Mt Penang Stormwater Management Strategy;
- Ashlar Golf Course Redevelopment – Flood and WSUD Strategy for 100 dwelling 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 subdivisio*n);
- Rouse Hill Regional Centre – Detailed design and performance analysis of bio retention systems, raingardens and constructed wetland;

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Resume

- Hezlett Road, North Kellyville – Generic lot based raingarden design, road bio-retention swale design and detention offset analysis;
- Voyager Point (*DHA*) – Detailed Design of Detention/Bio-Retention Basins for 200 lot residential subdivision;

► ***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;
- Narrabeen Creek, Pittwater – Detailed design of creek rehabilitation and embankment stabilisation measures from Graf Ave to Ponderosa Parade;
- Little Bay Central Drainage Corridor – Controlled Activity Approval and detailed design of Central Corridor Drainage Features (*ie wetlands, bio-retention basins, weirs, elevated walkways, bridges, pool/riffle creekline*);
- Sector 8 Warriewood – Controlled Activity Approval for residential development adjoining Fern Creek;
- Nolan's Reserve Footbridge - Abutment Armour and bridge repair design;
- Middle Creek Footbridge Armour design (*Narrabeen Lakes for Warringah Council*);

► ***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;

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- 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*);
- Barina Downs Road, Detention Basin Design (*large regional detention facility*);
- Robertson Road, Scotland Island – Detailed Stormwater Drainage Design;
- Jenkins Road, Dundas - Detention System Design;
- Lot 2 Muir Road, Chullora – Drainage and Detention System Design for Large Industrial Development;

▶ ***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*);

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- 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 2D TUFLOW Flood Assessment, Darling Harbour;
- Lynwood Ave, Dee Why Flood Assessment;
- Ashlar Golf Course Development - 2D TUFLOW Flood Study;
- Ashlar Golf Course Development – HEC RAS Flood Modelling Breakfast Creek and Western Channel;

▶ ***Dam Hazard Assessment***

- Kellyville Ridge Dam, Second Ponds Creek, Dam Hazard Assessment;
- UWS Campbelltown Dam Hazard Assessment;
- Hume Golf Course, Albury Dam Hazard Assessment;
- CSIRO, Greystanes Dam Hazard Assessment;
- Honeysuckle Creek Dam DSC Surveillance Report (*Killara Golf Course*);

▶ ***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.
- 2 Year Surface Water and Bed Sediment Monitoring Program, Ashlar Residential Development, Blacktown

▶ ***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*);
- Garie Beach Culvert Amplification (*RTA and NPWS*);
- Bridge Amplification Design, Narroy Road, Narrabeen;

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

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▶ ***General Civil Engineering***

- BER Sydney South, provision of general civil engineering design for Abigroup for a number of Schools in Sydney South;
- McCarr's Creek Road/Pittwater Road Inventory and Condition Assessment;
- Design of steel pedestrian bridge, elevated walkway, stairs and reinforced concrete weirs for residential subdivision at Little Bay;
- Design of playground equipment footings, BBQ shelter footings/slab and small reinforced concrete retaining walls for playground at Sector 8, Warriewood Valley;
- Seawall design 26 Prince Alfred Parade, Newport;
- Reinforced Earth retaining wall design for Sydney Water/Landcom, Potts Hill;

▶ ***Expert Advice / L&E Court***

- 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 witness (*water quality on industrial site*) for L&E Court Case - Phiney Place, Ingleburn (*representing private developer*);
- Expert witness (*drainage, S88K easement)*) for L&E Court Case – Park Street, Mona Vale (*representing adjoining land owner*);
- Expert witness (*drainage/absorption system/easement*) for L&E Court Case – 120 Hopetoun Avenue, Vaucluse (*representing owner/developer*);
- Expert witness (*drainage/riparian corridor*) for L&E Court Case – 23B Macpherson Street, Warriewood (*representing private developer*);
- Expert witness (*riparian matters/controlled activity application/culvert creek cro*ssing) for Supreme Court Case – Wambo Coal Mine, Warkworth (*representing mine operator*);
- Expert Witness – Anglican Church, Commercial Rd, Rouse Hill – Drainage Matters;
- Expert Witness – Warringah Council, Development at Bantry Bay Rd, Forestville – Stormwater Management/Water Quality and Detention;
- Expert Witness – Abax Contracting, Development at Fern Creek Road Warriewood – Stormwater Drainage, Water Quality, Detention and Flooding;

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Michael J Shaw
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Principal
Civil Certification

Resume

- ***Certification***

- Subdivision PCA for Central Open Space Works, Cobaki (*Tweed Council LGA*) - Part 3A Major Project ;
- Subdivision PCA Lachlan's Line, Macquarie Park (*NSW Urban Growth/Ryde Council LGA*) - Part 3A Major Project;
- Construction Certificate Issue and compliance inspections for Bulk Earthworks and Civil Infrastructure (*Roads & Drainage*), Precincts 1&2 (450 lots) and 6 Cobaki (450 lots) (*Tweed Council LGA*);
- Civil compliance inspections and Part4A certificates for Putney Hill Development, Ryde (100 lots)– Part 3A Major Project (*Ryde Council LGA*);
- Civil compliance Inspections and certificates for Kiah Development (*Stage 4*), Willoughby (50 lots);
- Civil compliance inspections and Part4A certificates for DHA Riverfront Development, Ermington (500 lots)– Part 3A Major Project (DHA/*Parramatta Council LGA*);
- Civil compliance inspections and Part4A certificates for Clemton Park Development (*Australand*) – Part 3A Major Project (*Canterbury Council LGA*);
- Bunya Collector Road CC – Private certification assessment for Landcom;
- Construction Certificate issue (*Private Certification*) for small subdivision at Mount Street, Constitution Hill;
- Construction Certificate issue (*Private Certification*) for small subdivision works at 28 Crescent Rd, Mona Vale;
- Construction Certificate issue (*Private Certification*) for small subdivision works at Brush Rd, Eastwood;
- Part4A Compliance Certificate (Road and Drainage Works) for Retirement Village at Evans Road, Rooty Hill;
- Penrith Lakes Weir 3 CC assessment and compliance inspections for NSW Planning;
- Construction Certificate Drainage Works – Little Street, Lane Cove;

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, C7, C12, C15, C16 (*BPB 0816)*
- Member of BPB Disciplinary Committee (*2015*)

APPENDIX I (*Sediment Basin Sizing*)

SWMP Commentary, Standard Calculation

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: Avon Rd Pymble

Site location: Ku-ring-gai LGA

Precinct:

Description of site: Assumes Type D soils of low to moderate erosion hazard

Site area	Site						Remarks
	A	B					
Total catchment area (ha)	1.5						The site is a self contained catcment
Disturbed catchment area (ha)	1.5						The entire site area is disturbed

Soil analysis

Soil landscape	Ku-ring-gai						DIPNR mapping (if relevant)
Soil Texture Group	Type D						Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	4						See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	80						See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	25						See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	13.2						See IFD chart for the site
Rainfall erosivity (R-factor)	6500						Automatic calculation from above data

Comments:

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-}\%ile,\ x\text{-}day} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
A	0.45	25	1.5	168.75	84	253.125
B	0.45					

APPENDIX J (*Architectural Dwgs with OSD*)

HOUSE LOT 3

HOUSE LOT 4

House 3

Living room

RL +144.80
112 sqm

Deck
27 sqm

Toilet

Dining

Laundry

Pantry

Kitchen

Planter box
RL +144.40

Footprint demolished
8 Beechworth Road

RL + 147

Proposed fence 1.8m high

Detention tank
5m3

Rain water tank
5kl

3.3

4 m

LEC PROPOSED FOOTPRINT
House 4

master
bedroom

office

livingroom

RL +144.70
157 sqm

bathroom

toilet

pantry

kitchen

dining room

RL + 144

RL + 145

RL + 143

RL + 142

RL + 141

RL + 140

RL + 143

Stormwater drainage
as per documentation

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

7.3 m

RL + 145

RL + 144

RL + 143

RL + 142

RL + 141

145.00

144.00

143.00

142.00

141.00

Beechworth Road 10B

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Do not scale from drawings. All dimensions to be checked on site before commencement of work. All discrepancies to be brought to the attention of the Architect. Larger scale drawings and written dimensions take preference. This drawing is copyright and the property of the author, and must not be retained, copied or used without the express authority of MARCHESE + PARTNERS INTERNATIONAL PTY. LTD.

REVISION	DATE	DESCRIPTION	BY
P	27.11.27	APPROVED BY LEC	PS
Q	27.02.15	FOR SECTION 34 CONFERENCE	PS
S	04.05.15	SUBMISSION TO LEC	PS
S4	17.07.15	SUBMISSION TO LEC	PS

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Sydney · Brisbane · Melbourne · Canberra · Guangzhou
ACN 098 552 151 ABN 20 098 552 151

MN
TN

CLIENT

Ausbao

pwc

PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE

HOUSE LOT 4
LEVEL 00 147.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		
JOB 12009	DRAWING MP 44.03		REVISION S4

LOT 1

LOT 2

6 Beechworth Road

LEC PROPOSED FOOTPRINT
LOT 3

LEC PROPOSED FOOTPRINT
LOT 4

HOUSE LOT 2

Stormwater drainage
as per documentation

Detention tank
5m3

Rain water tank
5kl

Planterbox
RL +145.40

Living room

RL +144.80
112 sqm

Deck
27 sqm

Toilet

Dining

Laundry

Pantry

Kitchen

Planterbox
RL +145.40

6.6 m

4.9 m

Proposed fence 1.8m high

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

RL + 146

RL + 145

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

RL + 139

RL + 138

HOUSE LOT 3

Footprint demolished
8 Beechworth Road

RL + 147

Proposed fence 1.8m high

Detention tank
5m3

Rain water tank
5kl

3.3 m

4 m

office

master
bedroom

livingroom

RL +144.70
157 sqm

bathroom

toilet

pantry

kitchen

dining room

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

Stormwater drainage
as per documentation

10m Managed buffer to
Conservation Area AP

Proposed fence 1.8m high

10m Managed buffer to
Conservation Area AP

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

RL + 145

RL + 144

RL + 143

RL + 142

RL + 141

RL + 140

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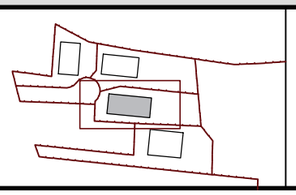

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Sydney · Brisbane · Melbourne · Canberra · Guangzhou
ACN 098 552 151 ABN 20 098 552 151

MN
TN

CLIENT

Ausbao

pwc

PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE

HOUSE LOT 3
LEVEL 00 RL 144.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		
JOB 12009	DRAWING MP 43.04		REVISION S4

HOUSE LOT 1

LEC PROPOSED FOOTPRINT
LOT 2

Detention tank
5m3

Rain water tank
5kl

3.6 m

planterbox
RL + 148.30

planterbox
RL + 148.30

Living room

deck
27 sqm

games room

RL+145.80
132 sqm

toilet

Dining

laundry

Pantry

Kitchen

planterbox
RL + 148.30

5.6 m

HOUSE LOT 2

Stormwater drainage
as per documentation

RL + 146

RL + 145

RL + 144

RL + 143

RL + 142

Proposed fence 1.8m high

Proposed fence 1.8m high

4.6 m

LEC PROPOSED FOOTPRINT
LOT 3

Proposed fence 1.8m hig

10m Managed buffer
Conservation Area

10m
Con

IMPORTANT NOTES:

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REVISION	DATE	DESCRIPTION	BY
P	27.11.27	APPROVED BY LEC	PS
Q	27.02.15	FOR SECTION 34 CONFERENCE	PS
S	04.05.15	SUBMISSION TO LEC	PS
S4	17.07.15	SUBMISSION TO LEC	PS

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PROJECT
PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE
HOUSE LOT 2
LEVEL 00 RL 145.80

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 42.04	S4

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PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE

HOUSE LOT 1
LEVEL 00 RL154.50

SCALE	DATE	DRAWN	CHECKED
1:100 @ A1 1:200 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 41.03	S4

Beechworth Road

Avon Road

boundary

footprint of house 1

footprint of house 2

footprint of house 3

footprint of house 4

NO. 2

NO. 6

NO. 10B

NO, 10A

NO. 12

NO. 1

NO.11

NO.15

1 Avon Road

footprint of building 4 above
fire sprinkler and hydrant pump

Rainwater tank: 20 m³

Detention tank: 170.3 m³

building for bicycles

exhaust fan room

expansion joint

approved basement outline

main switch room (3000x3000)

NBN/Comms room (3000x3000)

66 car parking spaces of which 6 access/shared car parking spaces

storage

footprint of building 1 above

3.3.02
3BED
105sqm

3.3.01
2BED
98sqm

3.3.05
1BED
60sqm
adaptable

3.3.04
2BED
79sqm

3.3.03
2BED
84sqm

Water Meter, Gas, NBCW Cabinets

Comm's Pump Room :: Domestic Water Pumps
Supply Fans

approved basement outline

BUILDING 3
RL 131.90

RL 131.90

mirror

15% @ 17m

16% @ 24m

9.5m

25m

31.5m

55m

Car Spaces Allocation

- Visitor car spaces
- Building 1 car spaces
- Building 3 car spaces
- Building 4 car spaces

Note:

- The landscape shown on the drawing is indicative only. For landscape design please refer to landscape architect drawings and documentation.

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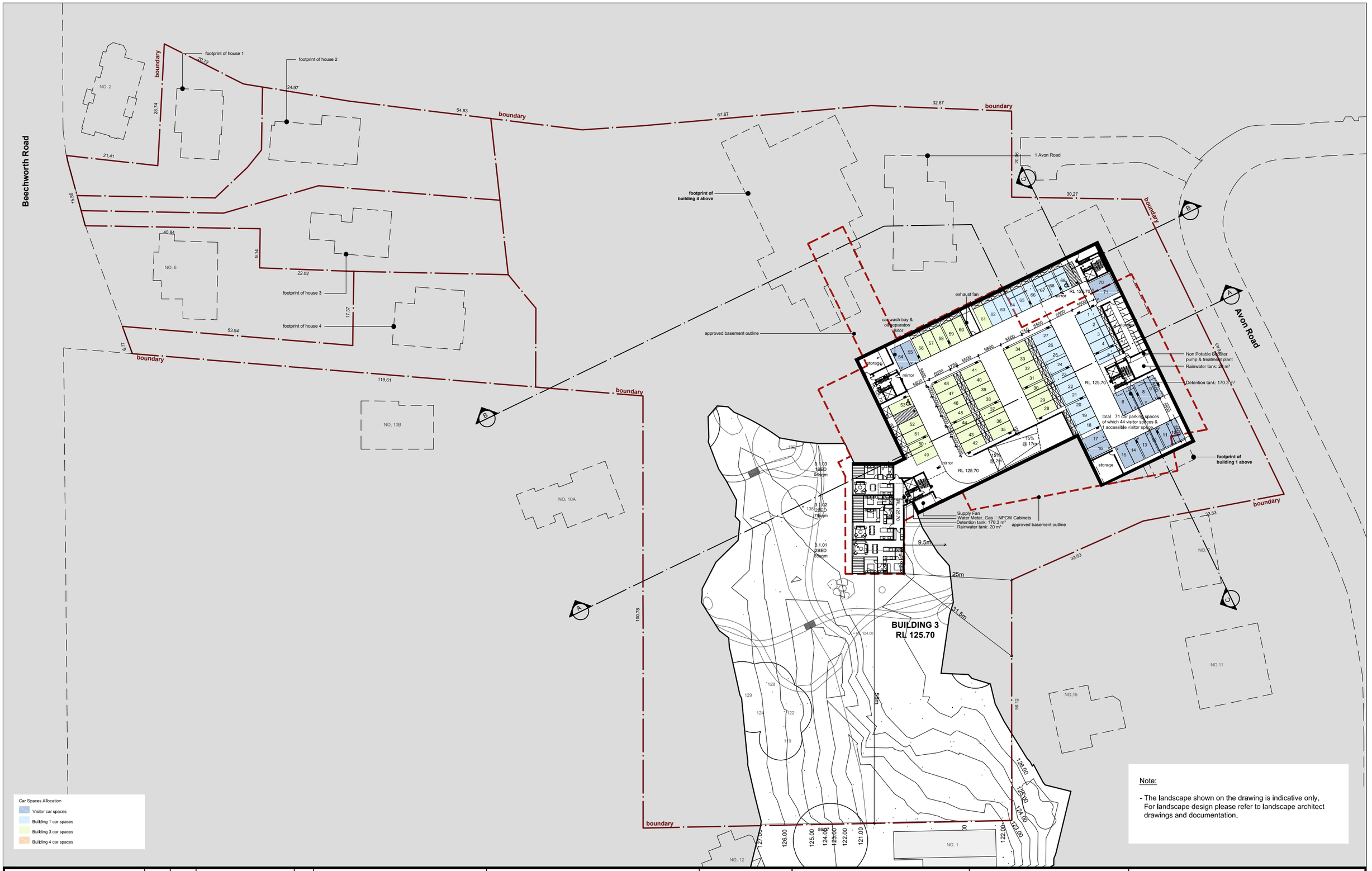
PROJECT

PROPOSED RESIDENTIAL DEVELOPMENT
AVON ROAD, PYMBLE

DRAWING TITLE

FLOOR PLAN LEVEL RL+132

SCALE	DATE	DRAWN	CHECKED
1:400 @ A1 1:800 @ A3	01.11.2012		
JOB 12009	DRAWING MP 22.05		REVISION S4



Car Spaces Allocation

- Visitor car spaces
- Building 1 car spaces
- Building 3 car spaces
- Building 4 car spaces

Note:

- The landscape shown on the drawing is indicative only. For landscape design please refer to landscape architect drawings and documentation.

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PROJECT: PROPOSED RESIDENTIAL DEVELOPMENT AVON ROAD, PYMBLE

DRAWING TITLE: FLOOR PLAN LEVEL RL+126

SCALE	DATE	DRAWN	CHECKED
1:400 @ A1 1:800 @ A3	01.11.2012		

JOB	DRAWING	REVISION
12009	MP 22.03	S4