

Thredbo Golf Course Subdivision Thredbo Village NSW

Stormwater Management Strategy

Report Prepared for: Kosciuszko Thredbo Pty Ltd

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1.0 INTRODUCTION

1.1. Background

Southeast Engineering and Environmental has been engaged to assist in the development of Stormwater Management Strategy and associated concept drawings for the proposed Golf Course Subdivision at Thredbo.

The strategy presented in this report seeks to address agency concerns and comments following the original Development Application (DA 21/13081) submission as well as comply with the Snowy Mountains Special Activation Precinct Master Plan (July 2022).

The strategy adopts Water Sensitive Urban Design (WSUD) principles that respond to the site constraints including a robust treatment train and outlets in accordance with *Guidelines for outlet structures on waterfront land* (DPIE 2022).

The Strategy has been assessed using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) to ensure there is confidence in the performance of the proposed system.

1.2. Scope and objective

This report addresses the requirements for stormwater management as described by:

- Section 2.11 Stormwater Management of the *NSW Alpine Regions Development Control Plan 2025*;
- and Section 11.4 Water Quality of the *Snowy Mountains Special Activation Precinct Master Plan* July 2022; and
- *Controlled activities – Guidelines for outlet structures on waterfront land*, DPIE 2022)

The objective is to outline, and where possible, quantify the potential stormwater impacts and issues associated with the proposed development. Information is presented in the form of modelled as well as designs of management strategies to meet current best practice relevant for the site.

1.3. Proposal

The proposed development includes:

- 18 new residential lots;
- New service roads and car parking;
- Golf Course redesign; and
- New services (stormwater, sewer, water, gas and power)

2.0 SITE DESCRIPTION

The Site is located at Lot 876, DP 1243112 within the Thredbo Golf Course at Crackenback Drive, Thredbo. The new foot path from the car park also crosses into the Community Centre Lot which is Lot 500/DP1118419. The Site is within Thredbo Alpine Resort, Kosciuszko National Park.

The Site currently comprises open space and the developed golf course with interspersed trees throughout, surrounded by forested areas and bordered by Thredbo River to the south.

Existing residential development in Thredbo lies to the north-east of the Site including the Crackenback subdivision and Thredbo Ski area..

The site is accessed from Crackenback Drive, near the Thredbo Community Centre. The location of the proposed development is shown in the Figure 2.1.



Figure 2.1 Site locality

The development Site generally grades from the north west to the south east toward the Thredbo River via several drainage depressions. The Site will need to manage runoff from the development area itself and also the catchment upslope of the development.

Refer to Figure 2.2 for proposed subdivision layout.

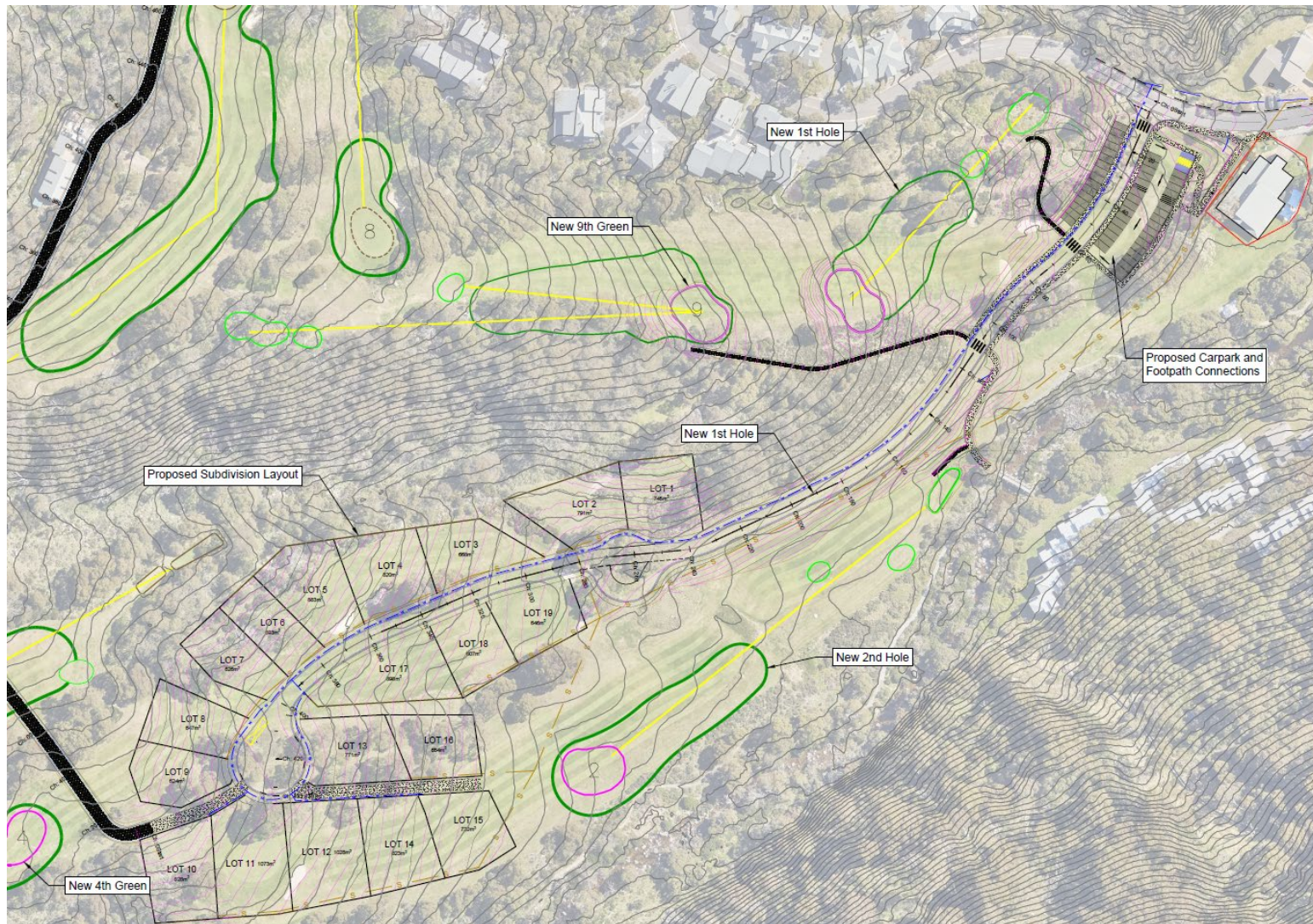


Figure 2.2 Proposed Development (CLM CIVIL)

3.0 PLANNING REQUIREMENTS

With regards to stormwater management the following planning requirements apply to the development.

3.1. Chapter 4 of State Environmental Planning Policy (Precincts - Regional) 2021 (SEPP).

Chapter 4 Kosciuszko Alpine Region of the SEPP aims to protect and enhance the Alpine Region by ensuring development is ecologically sustainable, including the conservation and restoration of ecological processes, natural systems and biodiversity.

Key requirements of Chapter 4 Kosciuszko Alpine Region include:

- consideration of the Snowy Mountains Special Activations Precinct Master Plan
- consultation with National Parks and Wildlife Service and consideration of submissions received
- development proposals to be referred to the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) for comment and be authorised under the [National Parks and Wildlife Act 1974](#)

3.2. Snowy Mountains Special Activation Precinct Master Plan July 2022

The Snowy Mountains Special Activation Precinct Master Plan Chapter 11.4 Water Quality includes the following performance criteria:

- a. Maintain or improve the ecological condition of waterbodies and their riparian zones in catchments over the long term.
- b. Development in the Alpine Precinct should implement on-site water management and water quality systems through:
 - i. the capture and re-use of water on-site.
 - ii. the treatment of water on-site with any water discharged back into catchments having a neutral or beneficial effect on water quality.
 - iii. incorporating water sensitive urban design principles into the development's-built form and landscaping, where possible.
- c. The quality of stormwater discharged into receiving catchments must be pre-development quality or better in relation to pH, total suspended solids, total phosphorus, total nitrogen and gross pollutants. The quality of water should aim to meet the following targets:
 - i. Total Suspended Solids: 85% reduction.
 - ii. Total Phosphorus: 60% reduction.
 - iii. Total Nitrogen: 45% reduction.
- d. The quality of water discharged into receiving catchments should maintain electrical conductivity levels. Water quality should aim to maintain an electrical conductivity below the 30 µS/cm ANZG 2018 Guideline value for upland rivers of South-East Australia.

- e. Monitor macroinvertebrates to ensure they are consistently within Band A of the NSW AUSRIVAS model.
- f. Erosion and sediment control should be managed during construction to ensure impacts to waterways are minimised in accordance with Managing Urban Stormwater Soils and Construction, also known as the Blue Book (current edition).
- g. Discharge of wastewater and/or contaminated stormwater to watercourses or waterways is not permitted unless otherwise specified in an environmental protection licence issued under the Protection of the Environment Operations Act 1997. Development must obtain the appropriate water licenses in accordance with the Water Act 1912 and the Water Management Act 2000 and consider the relevant Water Sharing Plan.

3.3. NSW Alpine Regions Development Control Plan (2025)

The NSW Alpine Regions Development Control Plan (DCP) 2025 came into effect on January 14, 2025, providing detailed guidelines for development in the Alpine Region, specifically within the Kosciuszko National Park.

As the DA was lodged prior to the adoption of the Alpine DCP it is not a matter for consideration. The future development of lots would be subject to the Alpine DCP."

The NSW Alpine Region DCP Chapter 2.11 Stormwater Management includes the following controls:

- C1. Development is to have a neutral or beneficial impact on surface and groundwater quality, including in watercourses and associated riparian vegetation and receiving waters.
- C2. All new underground stormwater pit and pipe drainage is designed to capture and convey the 5% annual exceedance probability (AEP) design event flow plus 20%.
- C3. All overland flow paths are designed to safely convey the 1% AEP flows plus 50% of underground pipe flows (based on the assumption that the underground pipe has a reduced capacity of 50% due to blockage of surface inlet pits).
- C4. All development that will affect existing stormwater infrastructure:
 - a. limit site discharge to predevelopment flows for the 10% AEP and below, and
 - b. provide a safe (where practical limit velocities to 2m/s) overland flow path for stormwater runoff for events greater than the 10% AEP up to and including the 1% AEP including consideration of climate change projections for rainfall intensity. This ensures that where pipes are blocked by frozen water there is a defined overland flow path to ensure water escapes and does not impact development.
- C5. Development allows for the treatment of stormwater runoff during summer months and the storage of snow push during winter months through:
 - a. edge treatments (rock or concrete lined channels and basins) to store snow push, reduce velocities of melted water and allow for sediment to be captured in channels or basins (designed to allow for removal of sediment by heavy machinery following winter months) before discharge into nearby watercourses;
 - b. vegetated buffer strips on roads to capture sediments in storm and snow runoff; or
 - c. site specific stormwater pollution devices to capture runoff from large, paved areas such as car parks.

4.0 AGENCY COMMENTS

4.1. *National Parks and Wildlife Service*

In response DA 21/13081, NPWS provided a request for further information with specific comments on stormwater and snowpush including:

- (i) Level of treatment proposed for stormwater, including stormwater quality targets;
- (ii) Location, capacity, servicing, maintenance and access requirements for stormwater treatment devices and retention basins;
- (iii) Volume calculations which justify the choice of device and basin measures proposed for the purposes of sub-paragraph (ii) above and which will allow the targets detailed for the purposes of sub-paragraph (i) above to be achieved;
- (iv) Management and treatment arrangements for the snowpush from the access road to address contaminants such as grit and hydrocarbons; and
- (v) Details of whether salt will be used in road management and how this will occur.

4.2. *NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW)*

In response DA 21/13081, the following request for further information specially relating to stormwater management from the Department of Planning and Environment, (now Department of Planning, Housing and Infrastructure (DPHI)), included:

DPHI:

An updated Stormwater Management Plan must be prepared by a suitably qualified practitioner to address Section 11.4 of the Snowy Special Activation Precinct Masterplan, and also including the following:

- A design for the development footprint with minimum stormwater quality targets for Gross Pollutants, Total Suspended Solids, Total Phosphorous and Total Nitrogen.
- Consideration of the environmental targets required within relevant guidelines, such as the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality 2000 or local objectives and Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
- Calculations must be provided (Model for Urban Stormwater Improvement Conceptualisation – MUSIC, or equivalent design report), detailing and justifying the inputs for the data used (design rainfall event, annual exceedance probability and the like).
- Method to control runoff and sheet flow dispersal over land (particularly from the retention devices),
- Details of the retention devices, including plans and specifications,
- Consideration of collection of stormwater and onsite water reuse.

Department of Planning and Environment – Water:

- Detailed stormwater outlet designs in accordance with the Guidelines for outlet structures on waterfront land.

5.0 STORMWATER MANAGEMENT

5.1. Stormwater Management Strategy Overview

A change in land use from largely pervious/natural to urban development has the following primary impacts:

- Increased flow volumes / potentially increased flowrates and associated impacts on existing downstream environment; and
- Changes to sediment and nutrient loads leaving the site and associated ecological impacts.

The proposed stormwater management strategy aims to manage runoff from the site by temporarily detaining frequent runoff events and maintaining as much a possible the natural runoff regime.

Due to the development location in the landscape the Site's stormwater system needs to manage runoff from developed areas (roads, lots) and also accommodate upslope runoff (from undeveloped areas) draining through the Site. One of the main principles in the proposed stormwater management strategy is to keep the "clean" upslope runoff separate to the runoff from developed areas. This approach allows stormwater treatment measures to be applied to developed area runoff only and maximise performance rather than diluting development runoff with external runoff.

A series of diversion drains, new pits and pipes will be installed to intercept and convey "clean" upslope runoff through the development to the Thredbo River via appropriate waterfront outlet that include scour protection and provide energy dissipation.

Runoff from developed areas (roads, lots) will be managed with the following:

- New stormwater network (designed to convey the 5% AEP);
- New service roads providing an overland flow path for large storm events (major system);
- An end of line gross pollutant trap to treat runoff from the proposed new carparking area;
- A series of end of line bioretention basins for water quality management and the protection of the receiving environment; and
- Stormwater outlets to the Thredbo River designed in accordance with *Guidelines for outlet structures on waterfront land*.

Refer Stormwater Management Plans Appendix A.

5.2. Stormwater Treatment Measures

5.2.1. Introduction

The effectiveness of proposed stormwater quality measures is estimated using the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). MUSIC uses a continuous period of rainfall, combined with a rainfall-runoff model and pollutant generation rates to estimate pollutant loads generated by landscapes. MUSIC has a range of treatment modalities that estimate pollutant collection as a factor of area, shape, retention time and treatment type.

5.2.2. Modelling Parameters

Climate information for the MUSIC model was sourced from Station 71063 (GUTHEGA). The reason this station was used is that it records provided continuous pluviograph rainfall gauge data. Pluviographic rainfall allows for much greater accuracy and validity when used in MUSIC's stochastically based models.

5.2.3. Treatment Approach

The stormwater treatment train components include the following measures:

Gross Pollutant Trap - An end of line GPT is proposed to treat the golf course carpark and a large portion of road runoff from the development. The system selected and modelled is an Atlan Ecoceptor Series 1500. This model of GPT targets coarse sediment, oils, grease and light liquids associated with carpark runoff. MUSIC nodes were obtained from the supplier.

Swale - Swales are grassed shallow trapezoidal channels with longitudinal fall designed to convey and provide stormwater treatment through infiltration and trapping a portion of sediment in the vegetation profile. A length of swale is proposed to treat a small sub-catchment in the western side of the Site. This swale will also provide a conveyance mechanism for a portion of upslope runoff outside the development.

Bioretention Basins - Bioretention systems are vegetated areas designed to allow water to pool temporarily before percolating through an engineered filter media. As water percolates through the bioretention soil media, sediment and nutrients become trapped within the upper layers. Water flow rate is controlled by the filter media which also provides a growing media for plants. Ground cover vegetation helps to break up sediment deposited in the top layer of the soil media and prevent erosion during storm events. Vegetation roots within the media act to maintain the porosity of the soil and promote nutrient uptake.

A number of bioretention basins are proposed to treat various sub-catchments across the development. The nominal surface area of each basin is sized on approximately 1% of the contributing catchment, with a typical 500mm deep filter media and 300mm of extended detention.

5.2.1. Model Configuration

The MUSIC model configuration is illustrated in Figure 5.1

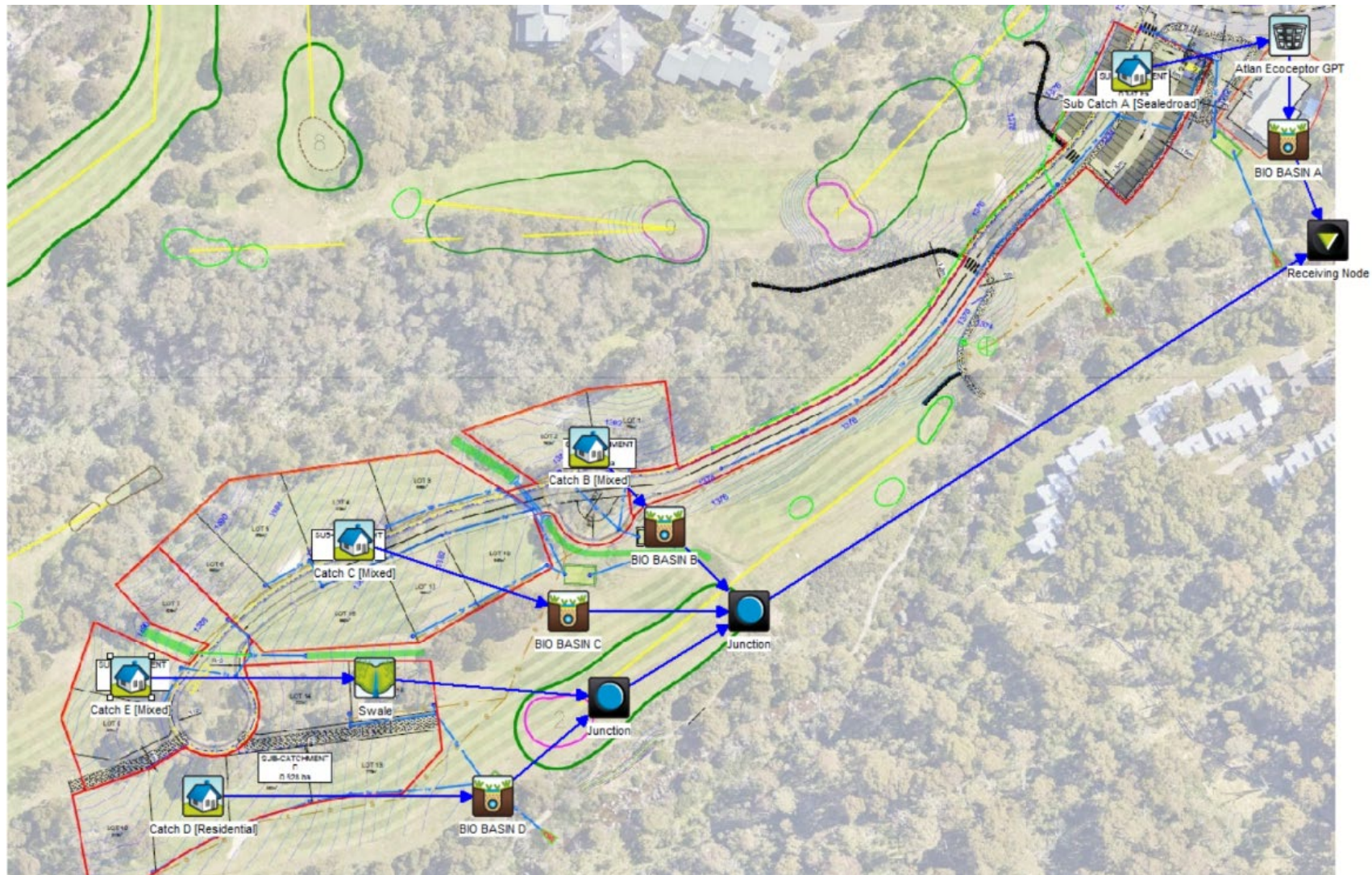


Figure 5.1 MUSIC model configuration

5.2.2. Treatment Targets

The Snowy Mountains SAP Master Plan water quality targets include the retention of a percentage of the annual pollutant load from a development based on comparison of pollutant loads from an equivalent untreated development with a development employing treatment. The quality of water should aim to meet the following targets:

- Total Suspended Solids: 85% reduction.
- Total Phosphorus: 60% reduction.
- Total Nitrogen: 45% reduction

5.2.3. Pollution Reduction for Development

The stormwater treatment targets appropriate for the site will be met by the treatment measures provided. The pollutant removal performance as predicted by MUSIC modelling exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. The results are summarised in Table 5:1.

Table 5:1 Pollutant removal predicted by MUSIC modelling for proposed stormwater quality treatment devices

POST-DEVELOPMENT	Pollutant load (kg/yr)	Residual Load (kg/yr)	% Reduction	Benchmark (minimum reduction)	Meets Criteria, (Y/N)
Suspended Solids	7390	755	89.8%	85%	Y
Total Phosphorus	13.7	3.62	73.5%	60%	Y
Total Nitrogen	88.0	43.0	51.1%	45%	Y

5.3. Stormwater Outlets on Waterfront Land

The number of proposed stormwater outlets to the Thredbo River has been minimised to reduce potential disturbance to the riparian zone. Where possible existing discharge points from the Site shall be utilised and where new outlets are required, they are to be constructed in accordance with *Controlled activities – Guidelines for outlet structures on waterfront land*, (DPIE 2022).

This will include rock stacked headwalls and rock scour protection. The exact location of each new outlet will require further site investigation and survey at detailed design. Where practicable existing Site rock will be incorporated as scour protection, again to minimise works in the riparian zone.

5.4. Snow Push Management

The proposed road profile generally includes a 6m wide pavement and 2m verge on either side for snow accumulation from snow push activity. Kerbs are generally concrete v drains to facilitate snow push machinery. Accumulated snow on the verge will eventually melt and be conveyed via v drains to treatment measures. Contaminants such as grit and hydrocarbons from carparking areas will be captured with the proposed GPT.

The flat open roads will not require salting, however limited amounts of salt may be required at times for sections of road that have a gradient, are in the shade or on the roundabout.

Once individual lots are developed, some property may require salt on pedestrian access points at times.

5.5. Operation and Maintenance

The GPT and bioretention systems would be managed by Kosciuszko Thredbo, the village operator.. Maintenance requirements are shown in Table 5:2.

Table 5:2: Maintenance requirements.

Item	Maintenance	
	Description	Frequency
Gross pollutant trap	Inspect and clean out sediment/ gross pollutants	2/ annum
Bioretention Basin	Inspect, water and ensure vegetation is established	1/ quarter (during establishment)
	Once established inspect annually Flush points annually	1/ annum (once established)

In addition, inspection of system elements will also be required after large rain events to check for blockages.

5.6. Construction Period Controls

A Soil and Water Management Plan (SWMP) will be developed for the construction of roads and lots. This SWMP shall be developed in accordance with the Managing Urban Stormwater, Soils and Construction (Blue Book).

This will include erosion and sediment controls that will be installed and maintained managed during construction period to ensure impacts to waterways are minimised.

Road construction and earthworks will need to include diversion of upslope runoff around disturbed areas. The construction period controls should also include use of bulked out bioretention basins as temporary sediment basins. Following 80% completion of construction (including bulk earthworks, roads and lot shaping) bioretention system would be formalised with filter media and vegetation as required.

5.7. Construction Sequencing

Construction of the subdivision requires consideration of runoff in a controlled manner as the various stages are rolled out. Construction sequencing and planning should be based around the best approaches to maintain stable flow paths during construction and the prevention of uncontrolled stormwater runoff from the construction site.

The SWMP will provide guidance on construction phasing to mitigate erosion and sedimentation impacts, and aims to limit the impact of concentrated flows.

In addition, the suggested construction sequencing includes the following:

1. Divert external catchment runoff around the stage being constructed through the provision of stable flow paths;
2. Construct sediment basin/s at low point of site (this may include bioretention basins in the bulked out phase);
3. Construct trunk drainage;
4. Once trunk drainage is complete divert flows from upstream into new trunk drainage;
5. Commence access road construction and bulk earthworks;
6. Following 80% completion of construction (including bulk earthworks, roads and lot shaping) bioretention system would be formalised with filter media and vegetation as required.
7. Finalise road construction and bulk earthworks.

6.0 SUMMARY AND CONCLUSION

6.1. Stormwater Management Strategy Overview

The proposed stormwater management strategy aims to manage runoff from the site by temporarily detaining frequent runoff events and maintaining as much as possible the natural runoff regime.

Due to the development location in the landscape the Site's stormwater system needs to manage runoff from developed areas (roads, lots) and also accommodate upslope runoff (from undeveloped areas) draining through the Site. One of the main principles in the proposed stormwater management strategy is to keep the "clean" upslope runoff separate to the runoff from developed areas. This approach allows stormwater treatment measures to be applied to developed area runoff only and maximise performance rather than diluting development runoff with external runoff.

A series of diversion drains, new pits and pipes will be installed to intercept and convey "clean" upslope runoff through the development to the Thredbo River via appropriate waterfront outlet that include scour protection and provide energy dissipation.

Runoff from developed areas (roads, lots) will be managed with the following:

- New stormwater network (designed to convey the 5% AEP);
- New service roads providing an overland flow path for large storm events (major system);
- An end of line gross pollutant trap to treat runoff from the proposed new carparking area;
- A series of end of line bioretention basins for water quality management and the protection of the receiving environment; and
- Stormwater outlets to the Snowy River designed in accordance with *Guidelines for outlet structures on waterfront land*.

Refer Stormwater Management Plans Appendix A.

The proposed strategy has been developed in accordance with the following:

- Section 4.10 Stormwater Management of the *NSW Alpine Regions Draft Development Control Plan 2023*;
- Section 11.4 Water Quality of the *Snowy Mountains Special Activation Precinct Master Plan* July 2022; and
- *Controlled activities – Guidelines for outlet structures on waterfront land*, DPIE 2022)

The proposed strategy also aims to address comments and concerns raised by NPWS and DCCEEW.

Planning requirements and the proposed development measures are outlined in Table 6:1.

Table 6:1: Assessment of proposed Stormwater Management Strategy against planning requirements.

Planning Requirement	Proposed measures/Comments	Assessment
Section 11.4 Water Quality of the Snowy Mountains Special Activation Precinct Master Plan July 2022 The Snowy Mountains Special Activation Precinct Master Plan Chapter 11.4 Water Quality includes the following performance criteria: a. Maintain or improve the ecological condition of waterbodies and their riparian zones in catchments over the long term. b. Development in the Alpine Precinct should implement on-site water management and water quality systems through: i. the capture and re-use of water on-site. ii. the treatment of water on-site with any water discharged back into catchments having a neutral or beneficial effect on water quality. iii. incorporating water sensitive urban design principles into the development's-built form and landscaping, where possible. c. The quality of stormwater discharged into receiving catchments must be pre-development quality or better in relation to pH, total suspended solids, total phosphorus, total nitrogen and gross pollutants. The quality of water should aim to meet the following targets: i. Total Suspended Solids: 85% reduction. ii. Total Phosphorus: 60% reduction. iii. Total Nitrogen: 45% reduction. d. The quality of water discharged into receiving catchments should maintain electrical conductivity levels. Water quality should aim to maintain an electrical conductivity below the 30 µS/cm ANZG 2018 Guideline value for upland rivers of South-East Australia. e. Monitor macroinvertebrates to ensure they are consistently within Band A of the NSW AUSRIVAS model.	Proposed stormwater strategy provides stormwater treatment to meet suspended solids and nutrient pollutant reduction targets. Outlets within the riparian zone to be constructed in accordance with <i>Guidelines for outlet structures on waterfront land</i>. To be conservative the use of rainwater tanks on lots has not been included in the MUSIC model however it is possible that they may be installed for roof water harvesting and reuse. WSUD principles have been adopted in the development of the stormwater management strategy. Proposed stormwater strategy exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. Proposed stormwater strategy provides stormwater treatment to meet suspended solids and nutrient pollutant reduction targets Water quality monitoring of Thredbo River has been undertaken by Canberra University and CRC Freshwater Ecology, since the 1990s.	Complies

f. Erosion and sediment control should be managed during construction to ensure impacts to waterways are minimised in accordance with Managing Urban Stormwater Soils and Construction, also known as the Blue Book (current edition). g. Discharge of wastewater and/or contaminated stormwater to watercourses or waterways is not permitted unless other specified in an environmental protection licence issued under the Protection of the Environment Operations Act 1997. Development must obtain the appropriate water licenses in accordance with the Water Act 1912 and the Water Management Act 2000 and consider the relevant Water Sharing Plan.	The most recent ongoing water quality monitoring at locations both upstream and downstream of the study area is conducted as part of the NSW National Parks and Wildlife Service (NSW NPWS) Kosciuszko National Park water quality monitoring program. A detailed Soil and Water Management Plan (SWMP) will be developed for the construction of roads and lots. No discharge of wastewater or contaminated stormwater is proposed. The development will connect to existing wastewater trunk main with all wastewater being treated at STP. Proposed stormwater strategy provides stormwater treatment to meet suspended solids and nutrient pollutant reduction targets	
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Section 4.10 Stormwater Management of the NSW Alpine Regions Draft Development Control Plan 2023 C1. All new underground stormwater pit and pipe drainage design must be designed to capture and convey the 5% annual exceedance probability (AEP) design event flow plus 20%. C2. All overland flow paths must be designed to safely convey the 1% AEP flows plus 50% of underground pipe flows (based on the assumption that the underground pipe has a reduced capacity of 50% due to blockage of surface inlet pits). C3. All development that will affect existing stormwater infrastructure must: a. limit site discharge to predevelopment flows for the 10% AEP and below, and b. provide a safe (where practical limit velocities to 2m/s) overland flow path for stormwater runoff for events greater than the 10% AEP up to and including the 1% AEP including consideration of climate change projections for rainfall intensity. This ensures that where pipes are blocked by frozen water there is a defined overland flow path to ensure water escapes and does not impact development. C4. Development must manage stormwater at the source that allows for the treatment of stormwater runoff during summer months and the storage of snow push during winter months which may include: a. edge treatments (rock or concrete lined channels and basins) to store snow push, reduce velocities of melted water and allow for sediment to be captured in the channel or basin before discharge into nearby watercourses. Channels and basins to allow for removal of sediment by heavy machinery following the winter months, b. vegetated buffer strips on roads to capture sediments in storm and snow runoff, and c. site specific stormwater pollution devices to capture runoff from large, paved areas such as carparks. C5. Minimise road widths, where feasible and appropriate, to reduce salt application areas. C6. Ensure waterway crossings are designed to allow for the passage of fish. C7. Cover exposed stockpiles and use sediment traps or filters to keep sediment as close to the source as possible, with extra sediment filters used above environmentally sensitive areas such as creeks, streams, lakes and steep slopes.	Proposed stormwater shall be designed to capture and convey the 5% annual exceedance probability (AEP) design event flow plus 20%. Proposed road has one-way cross fall. For major events when capacity of road and kerb is exceeded runoff will simply sheet off the southern road batter in an evenly dispersed manner (Sheet flow) and disperse onto the golf course area below. Proposed road has one-way cross fall. For major events when capacity of road and kerb is exceeded runoff will simply sheet off the southern road batter in an evenly dispersed manner (Sheet flow) and disperse onto the golf course area below. The proposed road profile generally includes a 6m wide pavement and 2m verge on either side for snow accumulation from snow push activity. Kerbs are generally concrete v drains to facilitate snow push machinery. Accumulated snow on the verge will eventually melt and be conveyed via v drains to treatment measures. Contaminants such as grit and hydrocarbons from carparking areas will be captured with the proposed GPT. The proposed road profile has been minimised. No waterway crossings. A detailed Soil and Water Management Plan (SWMP) will be developed for the construction of roads and lots.	Complies
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C8. Water quality discharge should aim to meet the targets of: a. total Suspended Solids: 85% reduction, and b. total Phosphorus: 60% reduction. C9. Specific concentration targets should be met for all water quality discharges to ensure the Nitrate-oxidising Bacteria effect: a. total Nitrogen: limited to 0.1mg/L for 90% of time when there is flow, b. electrical conductivity levels to be maintained below the 30 μS/cm ANZG 2018 Guideline Value for upland rivers of south-east Australia, for 90% of time when there is flow, and c. erosion and sediment control should be managed during construction to ensure impacts to waterways are minimised. C10. Design of car parking and local road treatment is to: a. ensure appropriate storage and melting arrangements for sediment laden snow-push from clearing operations, b. be designed with robust materials such as concrete to reduce runoff/turbidity, c. consider investment in road paving and stormwater infrastructure to reduce run-off turbidity, and d. consider the use of storm-ceptors and other measures to prevent pollution from carparks and other paved areas.	Proposed stormwater strategy exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. A detailed Soil and Water Management Plan (SWMP) will be developed for the construction of roads and lots. Proposed stormwater treatment train from carpark includes GPT (to target coarse sediments, hydrocarbons/light liquids) and bioretention basin (to target suspended solids and nutrients).	
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The summary of the Request for additional information from the various agencies is outlined in FI matters to be addressed in this proposal include:

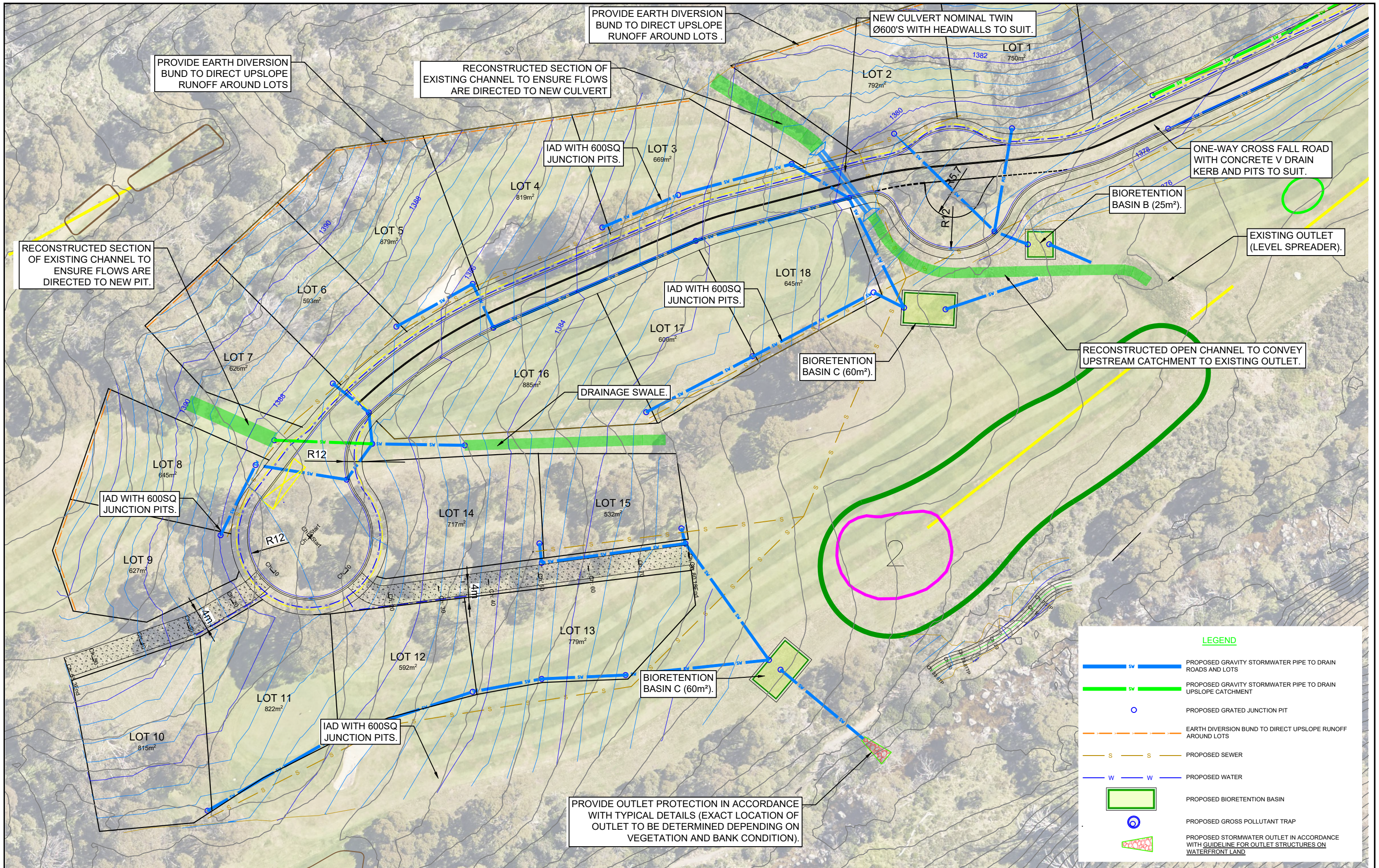
Table 5:2: Agency comments and responses

Agency	Comments	Response
DPE	<u>Stormwater</u> An updated Stormwater Management Plan must be prepared by a suitably qualified practitioner to address Section 11.4 of the Snowy Special Activation Precinct Masterplan, and also including the following: • A design for the development footprint with minimum stormwater quality targets for Gross Pollutants, Total Suspended Solids, Total Phosphorous and Total Nitrogen. • Consideration of the environmental targets required within relevant guidelines, such as the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines for Fresh and Marine Water Quality 2000 or local objectives and Australian and New Zealand Guidelines for Fresh and Marine Water Quality. • Calculations must be provided (Model for Urban Stormwater Improvement Conceptualisation – MUSIC, or equivalent design report), detailing and justifying the inputs for the data used (design rainfall event, annual exceedance probability and the like). • Method to control runoff and sheet flow dispersal over land (particularly from the retention devices),	Proposed stormwater strategy exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. The ANZECC guidelines are not specific regulatory criteria. <i>Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC, 2006)</i> which states (bold text from document): <i>The NSW WQOs are the environmental values and long-term goals for consideration when assessing and managing the likely impact of activities on waterways. They are not intended to be applied directly as regulatory criteria, limits or conditions but are one factor to be considered by industry, the community, planning authorities or regulators when making decisions affecting the future of a waterway</i> In this case, stormwater from the site will meet the relevant pollutant reduction targets. MUSIC model parameters and inputs provided. Proposed stormwater strategy exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. Proposed road has one-way cross fall. For major events when capacity of road and kerb is exceeded runoff will simply sheet off the southern road batter in an evenly dispersed manner (Sheet flow) and disperse onto the golf course area below.

	- Details of the retention devices, including plans and specifications, - Consideration of collection of stormwater and onsite water reuse.	Details of stormwater treatment measures outlined in Stormwater Management Plans. Outlets within the riparian zone to be constructed in accordance with <i>Guidelines for outlet structures on waterfront land</i>. To be conservative the use of rainwater tanks on lots has not been included in the MUSIC model however it is likely that they will be installed for roof water harvesting and reuse.
DPE-water	Detailed stormwater outlet designs in accordance with the Guidelines for outlet structures on waterfront land for any outlets on waterfront land.	Outlets within the riparian zone to be constructed in accordance with <i>Guidelines for outlet structures on waterfront land</i>. Typical details and sizing calculations provided in Stormwater Management Plans. The exact location of outlets to be determined depending on vegetation and bank condition.
NPWS	<u>Stormwater and snowpush</u> We consider that the following is required to fully assess any potential stormwater impacts of the development on terrestrial and aquatic biodiversity: (i) Level of treatment proposed for stormwater, including stormwater quality targets; (ii) Location, capacity, servicing, maintenance and access requirements for stormwater treatment devices and retention basins; (iii) Volume calculations which justify the choice of device and basin measures proposed for the purposes of sub-paragraph (ii) above and which will allow the targets detailed for the purposes of sub-paragraph (i) above to be achieved; (iv) Management and treatment arrangements for the snowpush from the access road to address contaminants such as grit and hydrocarbons; and (v) Details of whether salt will be used in road management and how this will occur.	Proposed stormwater strategy exceeded the targets of 85%/60%/45% for TSS/TP/TN respectively. Treatment measure type, location and extent show in Stormwater Management Plans. Refer Section 5.5 for maintenance requirements MUSIC model has been used to size treatment measure to achieve pollutant reduction targets. The proposed road profile generally includes a 6m wide pavement and 2m verge on either side for snow accumulation from snow push activity.

		Kerbs are generally concrete v drains to facilitate snow push machinery. Accumulated snow on the verge will eventually melt and be conveyed via v drains to treatment measures. Contaminants such as grit and hydrocarbons from carparking areas will be captured with the proposed GPT.
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APPENDIX A – STORMWATER MANAGEMENT PLAN



Rev	Date	Description
K	8/9/25	Revised Lot Layout
J	7/02/25	Amended as per Kosciuszko Thredbo Comments 31/1/25
I	22/01/25	Amended as per Kosciuszko Thredbo Comments
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G	30/07/24	Amended as per DPE Requirements (80% Issue)
F	04/07/24	Amended as per DPE Requirements (50% Issue)

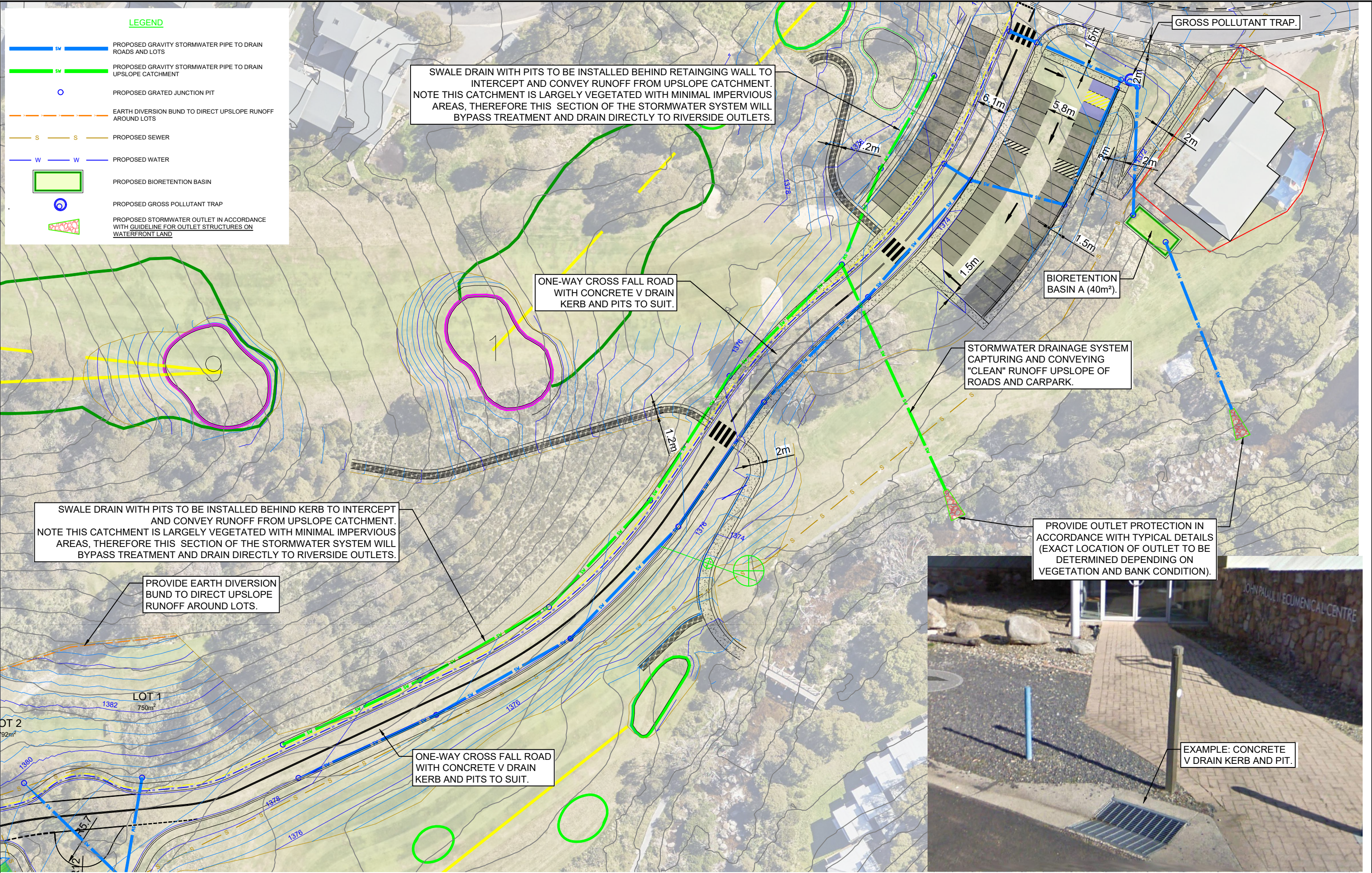
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Thredbo Village NSW



Client: Kosciuszko Thredbo Pty Ltd

Stormwater Management
General Arrangement (1 of 2)

Status	For Development Approval		
Datum	GDA94 / AHD	Scale	1:1000
Sheet	40 of 45	Revision	K
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Rev	Date	Description
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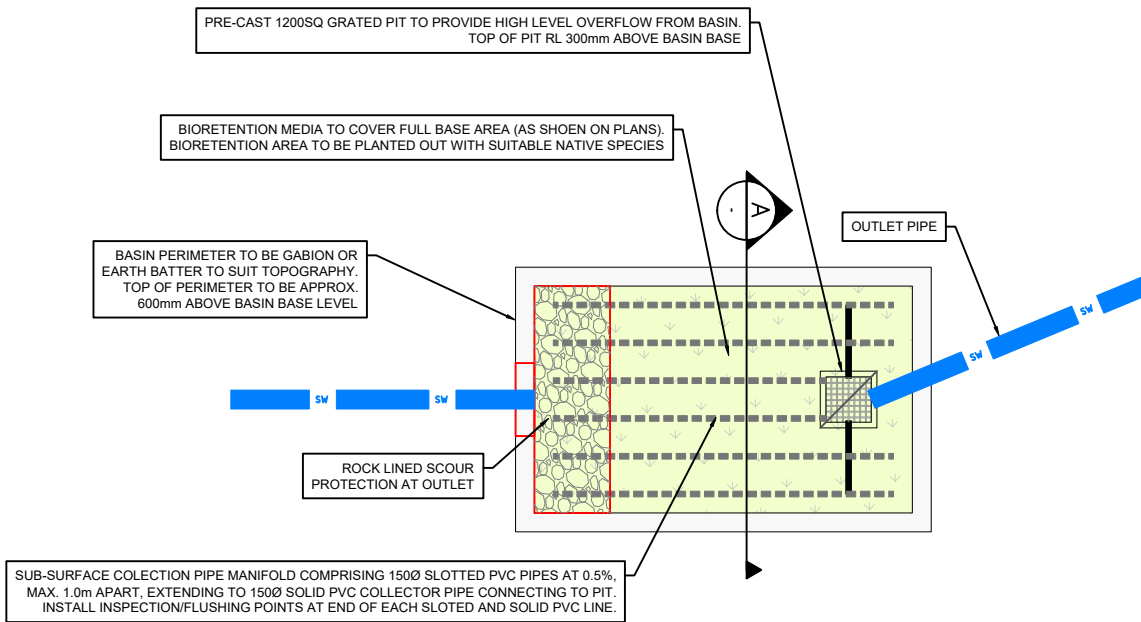
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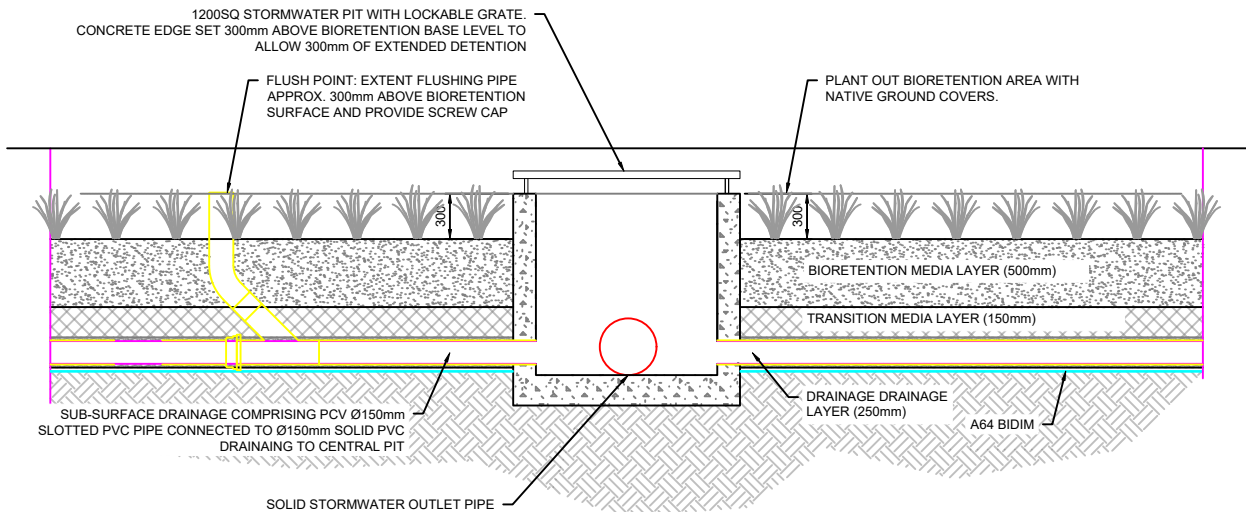
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Stormwater Management General Arrangement (1 of 2)		Date: GDA94 / AHD	Scale: 1:1000
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BIORETENTION BASIN (TYP.)

NOT TO SCALE



BIORETENTION BASIN (TYPICAL CROSS SECTION.)

NOT TO SCALE

CONSTRUCTION SEQUENCING

- CONSTRUCTION SEQUENCING INCLUDES THE FOLLOWING:
- DIVERT EXTERNAL CATCHMENT RUNOFF AROUND THE STAGE BEING CONSTRUCTED THROUGH THE PROVISION OF STABLE FLOW PATHS;
 - CONSTRUCT SEDIMENT BASIN/S AT LOW POINTS OF SITE (THIS MAY INCLUDE THE BIORETENTION BASIN FOOTPRINTS IN THE BULKED OUT PHASE);
 - CONSTRUCT TRUNK DRAINAGE;
 - ONCE TRUNK DRAINAGE IS COMPLETE DIVERT FLOWS FROM UPSTREAM INTO NEW TRUNK DRAINAGE;
 - COMMENCE ACCESS ROAD CONSTRUCTION AND BULK EARTHWORKS;
 - FOLLOWING 80% COMPLETION OF CONSTRUCTION (INCLUDING BULK EARTHWORKS, ROADS AND LOT SHAPING) BIORETENTION SYSTEM CAN BE FORMALISED WITH FILTER MEDIA AND VEGETATION AS REQUIRED.
 - FINALISE ROAD CONSTRUCTION AND BULK EARTHWORKS AND MAKE GOOD.

BIORETENTION SYSTEM

THE PROPOSED BIORETENTION SYSTEM FORMS A FUNDAMENTAL PART OF THE TREATMENT TRAIN THAT IMPROVES THE WATER QUALITY OF STORMWATER RUNOFF FROM THE SITE. THE BIORETENTION SYSTEM – CONSISTS OF VEGETATION, A SOIL FILTRATION MEDIA AND SUB-SURFACE DRAINAGE SYSTEM . THERE WILL BE A SMALL DEPTH OF PONDING AT THE SURFACE FOR A NUMBER OF HOURS FOLLOWING RAINFALL HOWEVER THE BIORETENTION SYSTEM WILL APPEAR DRY MOST OF THE TIME.

THE DESIGN OF THE BIORETENTION SYSTEM INCLUDES THE FOLLOWING:

- MINIMUM SURFACE AREA AS SHOWN
- EXTENDED DETENTION = 300mm
- FILTER MEDIUM DEPTH = 0.5m
- TRANSITION LAYER DEPTH = 0.15m
- DRAINAGE LAYER DEPTH = 0.25m

BIORETENTION-DRAINAGE PIPE SPECIFICATION

SLOTTED DRAINAGE PIPES (NO FILTER SOCK AND NOT AG LINE) ARE TO BE Ø150mm SLOTTED PVC-U PIPES WITH MINIMUM INLET AREA TO LENGTH RATIO OF 1000sqmm/m OF PIPE

SLOTTED DRAINAGE PIPES ARE TO HAVE A MAXIMUM SPACING OF 1.5 METRE. SLOTTED DRAINAGE PIPES ARE TO BE FITTED WITH STANDARD UNDER-DRAINAGE INSPECTION/CLEANOUT FITTINGS (REFER FLUSHING POINTS BELOW) AT THE END OF PIPES AND AT JUNCTIONS TO ALLOW FOR THE REMOVAL OF ACCUMULATED FINES WITHIN THE SYSTEM.

CONNECT SLOTTED DRAINAGE PIPES TO THE APPROPRIATE Ø150mm SOLID PVC-U COLLECTION LINE AND DRAIN TO PIT AS SHOWN.

JOINTING: PROVIDE TEES, COUPLINGS OR ADAPTORS AT JUNCTIONS TO AS 2439.1. ALL SLOTTED DRAINAGE PIPES ARE TO BE EMBEDDED IN THE MEDIA AS SHOWN ON DRAWINGS. ALL JUNCTIONS AND CONNECTIONS ARE TO BE SEALED TO PREVENT SOIL MATERIAL ENTERING THE PIPE NETWORK.

FLUSHING POINTS: FLUSHING POINTS ARE TO BE PROVIDED AS SHOWN ON THE DRAWINGS. THE FLUSHING POINTS ARE TO BE CONSTRUCTED OF SOLID Ø100mm PVC-U PIPE. THE 90 DEGREE BEND IS TO BE CONSTRUCTED OF TWO 45 DEGREE BENDS SEPARATED BY A MINIMUM OF 300MM OF SOLID PVC-U.

PROVIDE PVC-U SCREW CAP FOR EACH FLUSH POINT. TOP OF FLUSH POINT TO FINISH MIN. 300mm ABOVE BIORETENTION FINISHED SURFACE LEVEL

BIORETENTION-PLANTING SPECIFICATION

PLANT OUT BIORETENTION AREA WITH NATIVE GROUND COVERS.

BIORETENTION-FILTER MATERIAL SPECIFICATION

FILTER MEDIA HYDRAULIC PROPERTIES
THE FILTER MATERIAL SHALL PREFERABLY BE A "WASHED SAND" OF SILICEOUS OR CALCAREOUS ORIGIN, ONE THAT HAS BEEN MINED AND PROCESSED. NATURAL SOILS OR TOPSOILS ARE NOT USUALLY SUITABLE. SOILS SHALL HAVE THE FOLLOWING MECHANICAL AND PHYSICAL PROPERTIES:

- SATURATED HYDRAULIC CONDUCTIVITY IN THE RANGE OF 100 - 200mm/H. THIS CRITICAL ELEMENT IS TO BE DEMONSTRATED THROUGH LAB TESTING (ASTM-F1815-06).
- PARTICLE SIZE DISTRIBUTION/COMPOSITION REQUIREMENTS:

DESCRIPTION	PROPORTION	GRADING
CLAY AND SILT	<3%	<0.05mm
VERY FINE SAND	5-30%	0.05-0.15mm
FINE SAND	10-30%	0.15-0.25mm
MEDIUM TO COARSE SAND	40-60%	0.25-1.0mm
COARSE SAND	7-10%	1.0-2.0mm
FINE GRAVEL	<3%	2.0-3.4mm

- PH - 6.2-6.8 BEFORE DELIVERY - ADD DOLOMITE AS REQUIRED
- ELECTRICAL CONDUCTIVITY (EC) < 12ds/m

NOTE: FILTER MEDIA SHALL ALSO CONTAIN A SMALL AMOUNT OF ORGANIC MATERIAL (NOT EXCEEDING 5%) TO SUPPORT VEGETATION GROWTH. THE SOURCE OF THE ORGANIC MATERIAL SHALL BE PROVIDED TO COUNCIL FOT APPROVAL AND MUST BE FROM A CLEAN SOURCE, NOT COMPOST.

TRANSITION LAYER

A TRANSITION LAYER IS REQUIRED WHEN THE DRAINAGE LAYER IS FINE GRAVEL. IT IS RECOMMENDED WHEN THE DRAINAGE LAYER IS COARSE SAND. THE TRANSITION LAYER SHOULD BE A SAND/COARSE SAND MATERIAL CONFORMING TO THE GRADING BELOW AND IS GENERALLY APPLIED IN A 100-200mm LAYER.

SIEVE SIZE AS (mm)	% PASSING
0.075	0-3
0.15	0-4
0.3	0-16
0.6	12-40
1.18	40-65
2.36	70-100
4.75	90-100
9.5	100

DRAINAGE LAYER

THE DRAINAGE LAYER IS NORMALLY BETWEEN 200-250mm THICK. SUITABLE MATERIALS INCLUDE A HARD DURABLE AGGREGATE, EG. BASALT, MAY BE IMPORTED WITH MAXIMUM DIAMETER OF 10MM OR FINE GRAVEL IN THE RANGE 4mm - 7mm.

SIEVE SIZE	% RETAINED
>10mm	0
6.0-10.0mm	>70%
2.0-6.0mm	<20%
<2.0mm	0

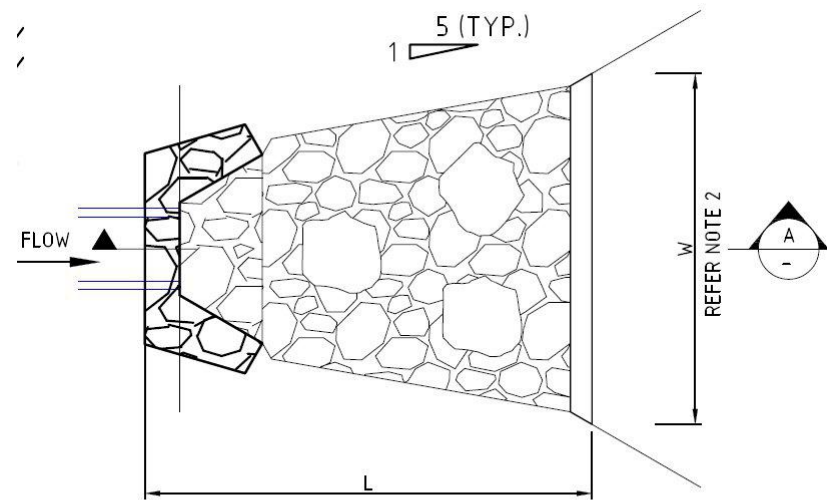
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Client: Kosciuszko Thredbo Pty Ltd	Status: For Development Approval
Stormwater - Typical Details (1 of 2)	Datum: GDA94 / AHD Scale: 1:1000 Size: A3 Drawing Number: U-183 Sheet: 42 of 45 Revision: K

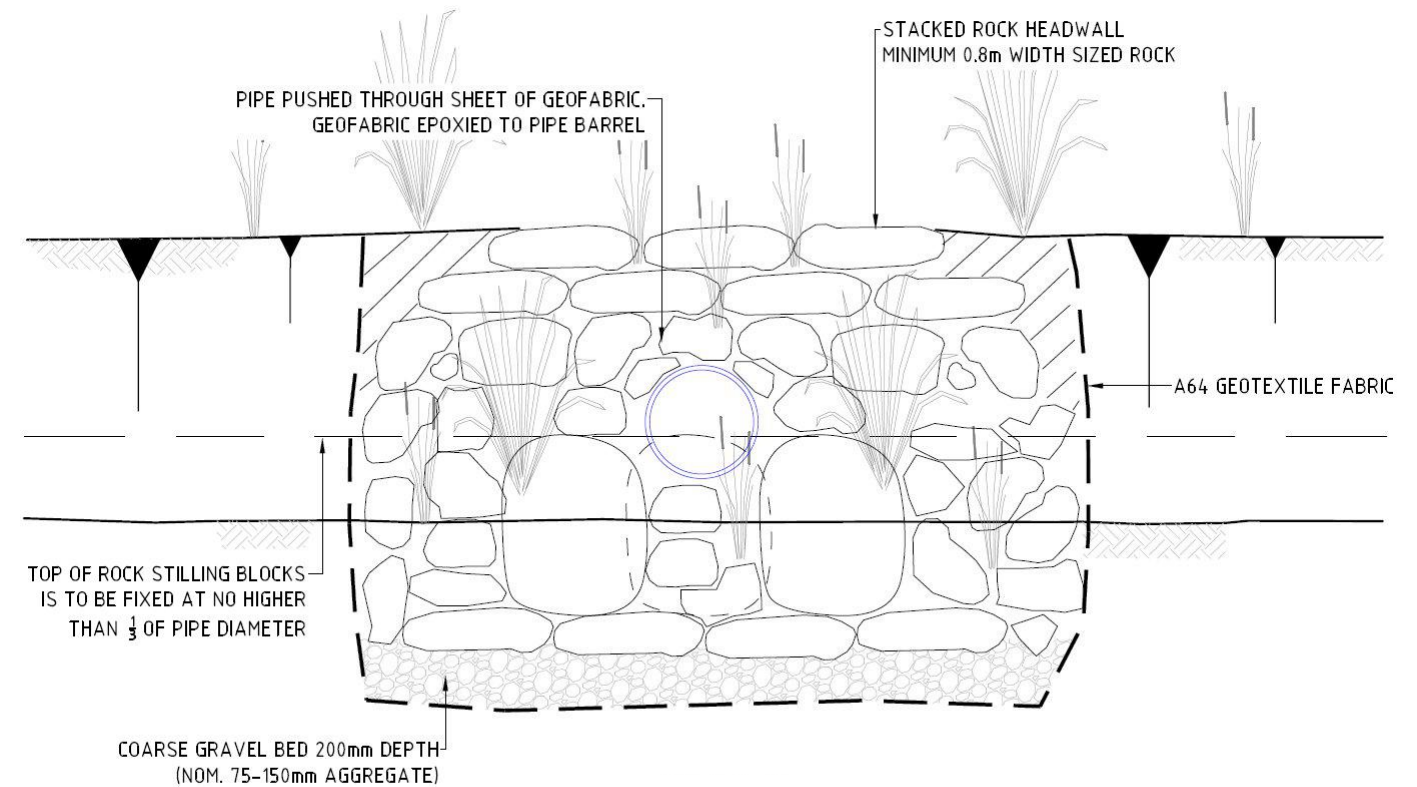


NOTES:

1. READ 'L' FROM CHART 1. LEFT.
2. $W = 3$ TIMES PIPE DIAMETER 'D'.
3. THE MEDIAN ROCK SIZE D_{50} AND LENGTH (L) OF ROCK SCOUR PROTECTION DOWNSTREAM OF STORMWATER OUTLETS IS TO BE DETERMINED USING CHART 1. MIN. $D_{50} = 200\text{mm}$
4. ROCK IS TO BE GRADED IN ACCORDANCE WITH THE ROCK SIZE DISTRIBUTION TABLE AS SHOWN BELOW
5. IN THE EVENT THE WIDTH OF THE OUTLET CHANNEL IS LESS THAN THE DESIGN WIDTH OF THE ROCK APRON, THE ROCK SCOUR PROTECTION SHALL EXTEND UP TO THE BANK TO EITHER THE HEIGHT OF THE OBVERT OF PIPE OR CULVERT OR TO THE DESIGN TAILWATER LEVEL.

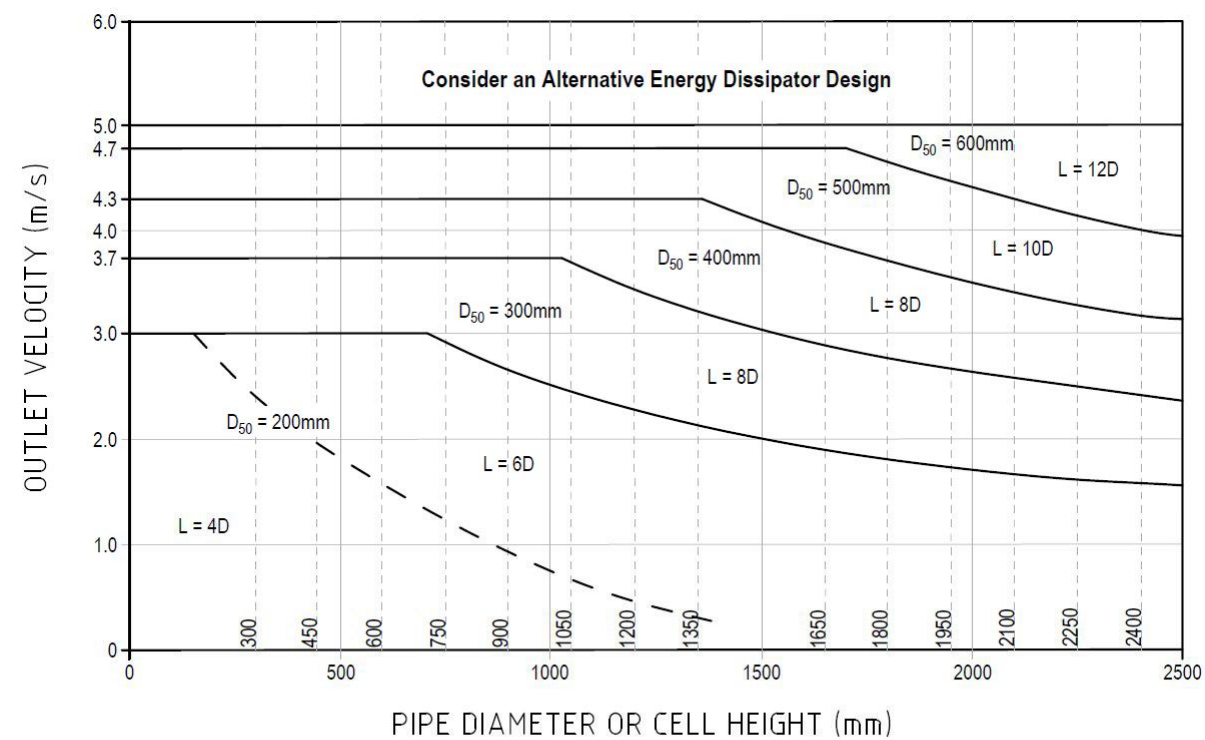
TYPICAL STORMWATER OUTLET LAYOUT IN ACCORDANCE WITH
GUIDELINE FOR OUTLET STRUCTURES ON WATERFRONT LAND

NOT TO SCALE



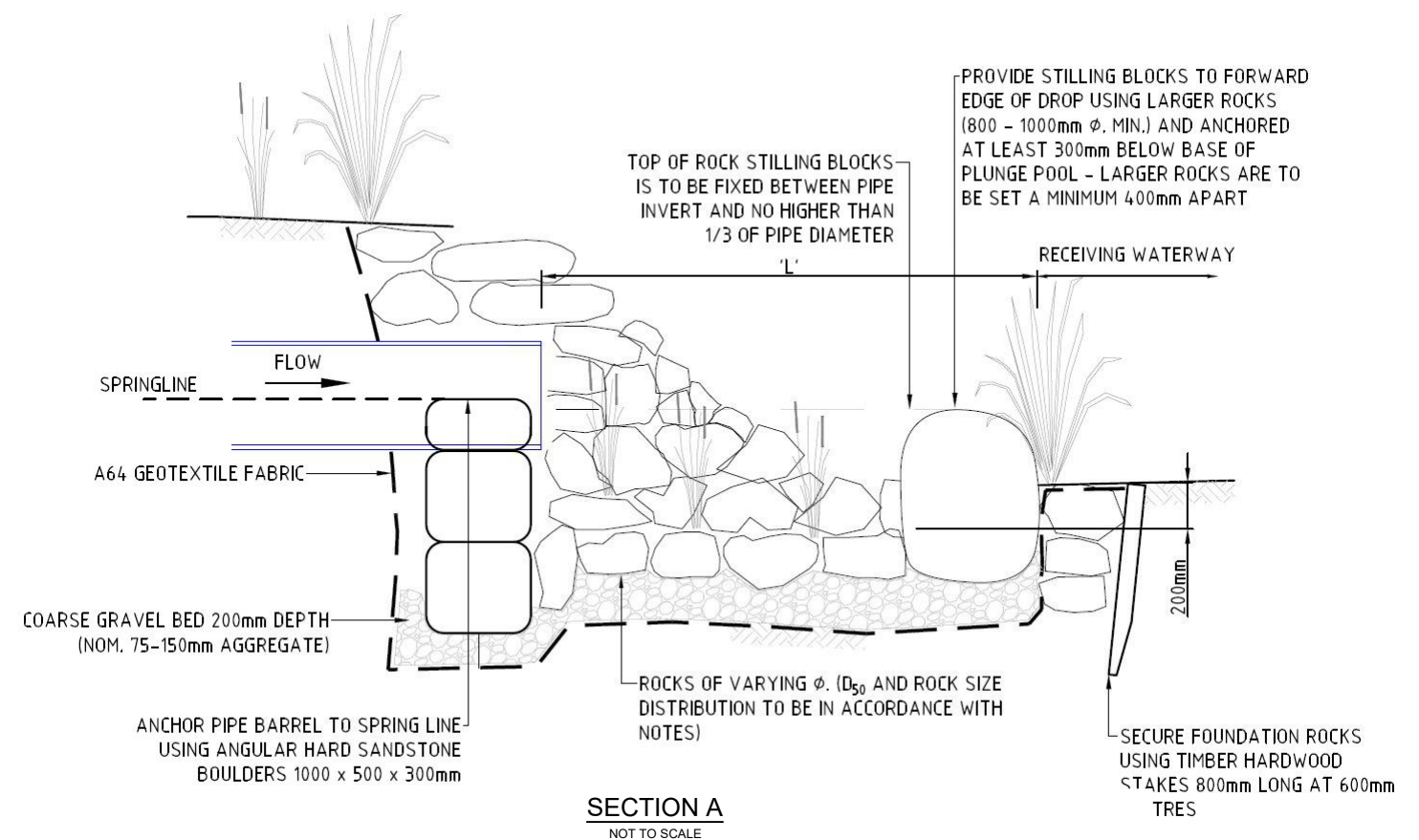
TYPICAL ROCK STACK HEADWALL AROUND STORMWATER OUTLET PIPE

NOT TO SCALE



SIZING OF STORMWATER OUTLET SCOUR PROTECTION

NOT TO SCALE



SECTION A

NOT TO SCALE

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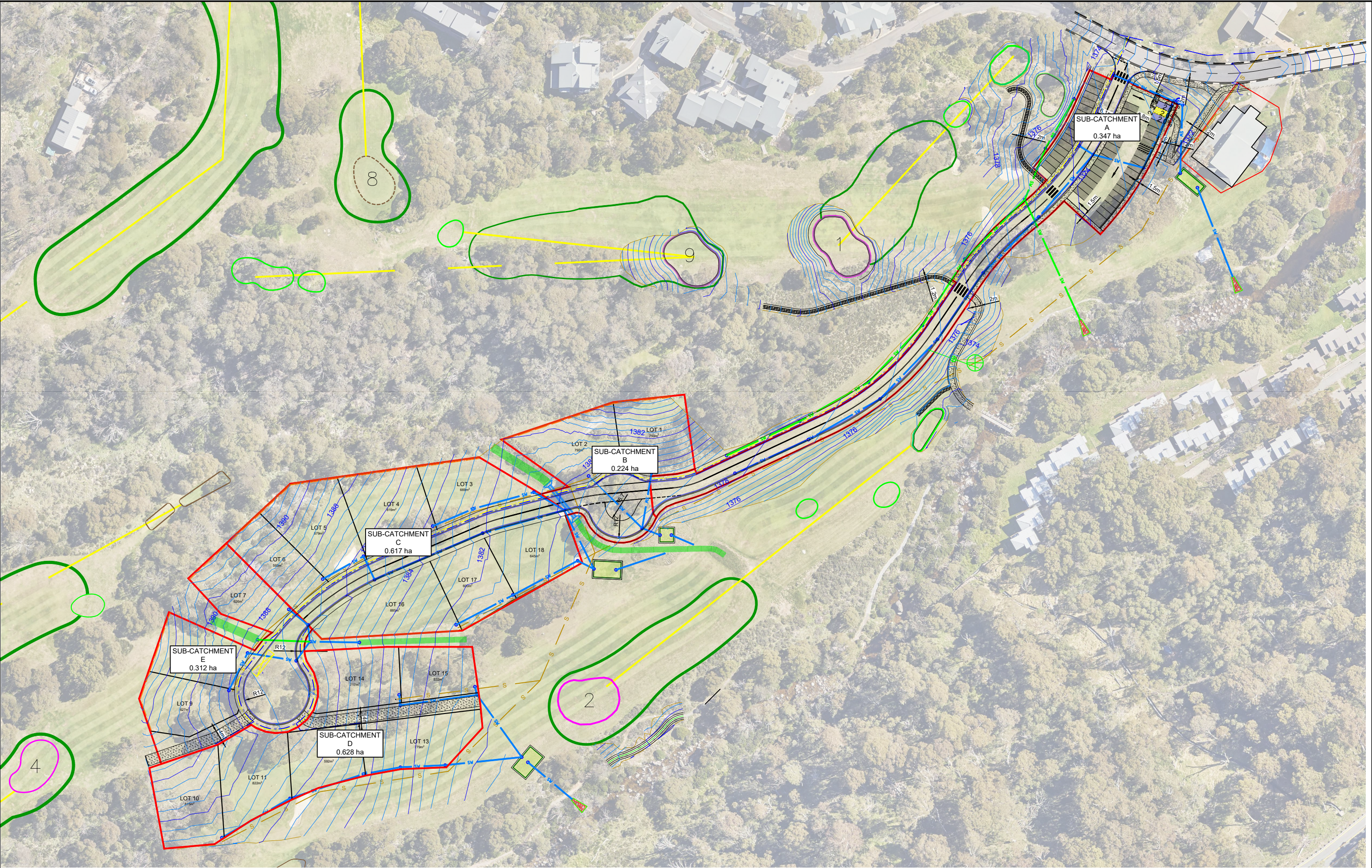
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Client: Kosciuszko Thredbo Pty Ltd

Stormwater - Typical Details
(2 of 2)

Status	For Development Approval
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Size	A3
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Stormwater Management Catchment Plan		Datum: GDA94 / AHD	Scale: 1:1000
Drawing Number: U-183		Sheet: 44 of 45	Revision: K