



Thredbo Golf Course Development Stormwater Management Plan

Kosciuszko Thredbo Pty Ltd

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Template 2.8.1

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Abbreviations

Abbreviation	Description
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASRIS	Australian Soil Resource Information System
CEMP	Construction Environmental Management Plan
ESCP	Erosion and Sediment Control Plan
DA	Development Application
mAHD	metres relative Australian Height Datum
NPWS	National Parks and Wildlife Service
RC	Riparian corridor
SWMP	Stormwater Management Plan
VRZ	Vegetated riparian zone
WSUD	Water sensitive urban design

Executive Summary

Eco Logical Australia Pty Ltd was engaged by Kosciuszko Thredbo Pty Ltd to prepare a Stormwater Management Plan (SWMP) to support their Development Application relating to the subdivision and development of Thredbo Golf Course, located within Kosciuszko National Park.

This SWMP includes:

- A description of the existing environment, including topography, receiving environment conditions, catchment hydrology and water resources.
- Consideration of potential impacts of the development's concept design on hydrology (surface water quality and quantity) and waterfront land (riparian corridor and aquatic ecology).
- Recommendations for stormwater management and mitigation measures for construction and operation of the proposed development.
- Recommendations for the detailed design based on the assessment of concept designs.

Based on a review of the existing environment conditions and concept development designs, the potential impacts to surface water include increased sedimentation and decreased water quality within the study area, particularly downstream of the study area within Thredbo River.

Recommended stormwater management strategies include measures to separate clean and dirty surface water and procedures to minimise downstream contamination from discharges within the development site. Routine water quality monitoring during the construction phase is recommended for ongoing assessment of the effectiveness of mitigation measures.

Results of the Waterfront Land Assessment indicated that the proposed development design does not meet requirements of the NSW DPE Riparian Guidelines 2022 due to proximity to Thredbo River. Therefore, an Integrated Development Application and subsequent Controlled Activity Approvals are required for proposed development works on waterfront land. In addition, detailed designs of outlets are required as a condition of the Development Application approval.

1. Introduction

Eco Logical Australia Pty Ltd (ELA) was engaged by Kosciuszko Thredbo Pty Ltd (KT) to prepare a Stormwater Management Plan (SWMP) to support their Development Application relating to the subdivision and development of Thredbo Golf Course (the study area), located within Kosciuszko National Park.

The SWMP includes:

- A description of the existing environment, including topography, receiving environment conditions, catchment hydrology and water resources.
- Consideration of potential impacts of the development's concept design on water resources (surface water quality and quantity), and waterfront land (riparian corridor and aquatic ecology).
- Recommendations for stormwater management and mitigation measures (including water sensitive urban design (WSUD) approaches) for construction and operation of the subdivision development.
- Recommendations for the detailed design based on the assessment of concept designs.

It is noted that while this SWMP includes a summary of potential impacts to aquatic ecology posed by the development, a detailed impact assessment was undertaken separately to the scope of this SWMP and is presented in *Thredbo Golf Course Development: Aquatic and Riparian Impact Assessment* (ELA, 2023).

2. Site Location and Description

The study area is located at Lot 876, DP 1243112 within the Thredbo Golf Course at 2/4 Crackenback Drive, Thredbo. The study area lies within Thredbo Alpine Resort, Kosciuszko National Park, and is subject to Chapter 4 of the *State Environmental Planning Policy (Precincts – Regional) 2021*. The study area comprises open space developed golf course with interspersed trees throughout, surrounded by natural forested areas and bordered by Thredbo River to the south. Existing residential development in Thredbo lies to the north-east of the study area, with the Kosciuszko National Park to the west and south, primarily comprising natural forested areas, and the Mount Kosciuszko Ski Area to the north, comprising alpine forested areas and recreational open space.

For the purposes of this SWMP, the study area is defined as the area comprising and immediately surrounding the proposed development footprint, with consideration given to potential impacts caused by development downstream of the study area. The study area boundary, overall proposed development footprint and surface watercourses classified by Strahler stream order are indicated in Figure 1.

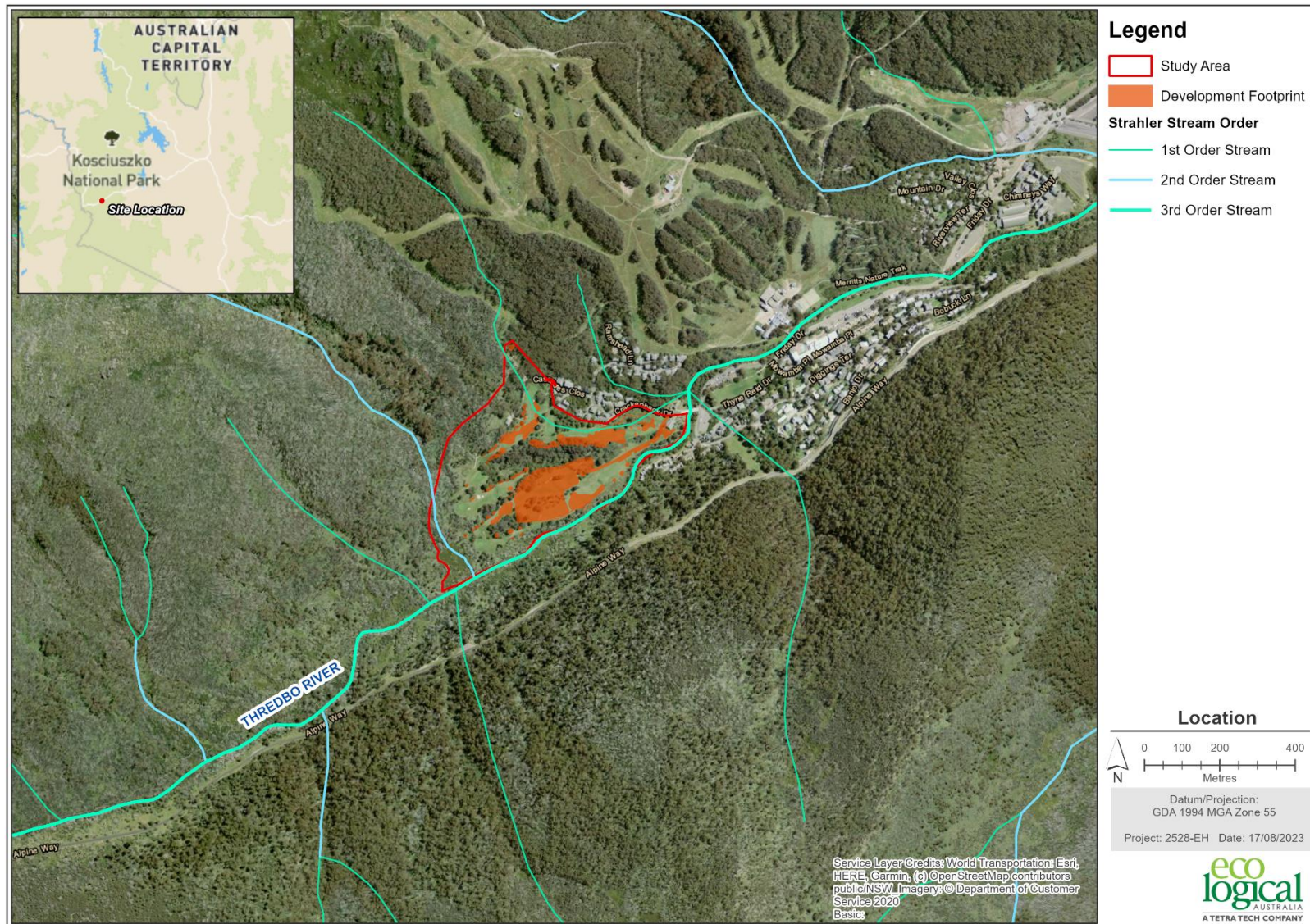


Figure 1: Location of the proposed development

3. Development Proposal

The total development footprint within the study area comprises 4.26 ha, including 1.47 ha containing 19 subdivided lots (average size 776 m²) with buildings (average footprint 261 m²), a 450m long by 6.1m wide access road via Crackenback Drive and 48 visitor carparks (Figure 2). Three stormwater retention devices (e.g. Puraceptor¹ units) are proposed to capture sediment and hydrocarbon pollutants prior to discharge to the Thredbo River. Drawings showing the proposed development and stormwater and drainage concept design are included in Appendix A. Lot details are outlined in Table 1.

Table 1: Lot and building footprint details

Lot number	Lot area (m ²)	Building footprint (m ²)
1	783	280
2	812	267
3	710	192
4	858	276
5	903	316
6	612	177
7	637	222
8	701	245
9	640	193
10	802	280
11	1061	371
12	1093	382
13	899	305
14	759	265
15	836	292
16	678	237
17	644	202
18	632	221
19	689	238
Total area	14749	4961

An overview of the proposed development footprint is presented in Figure 1. An overview of the proposed stormwater infrastructure design features relative to surface water drainages in the study area are indicated in Figure 3; detailed concept development designs showing proposed stormwater infrastructure are included in Appendix A.

¹ Puraceptor | Oil Water Separator | SPEL Stormwater

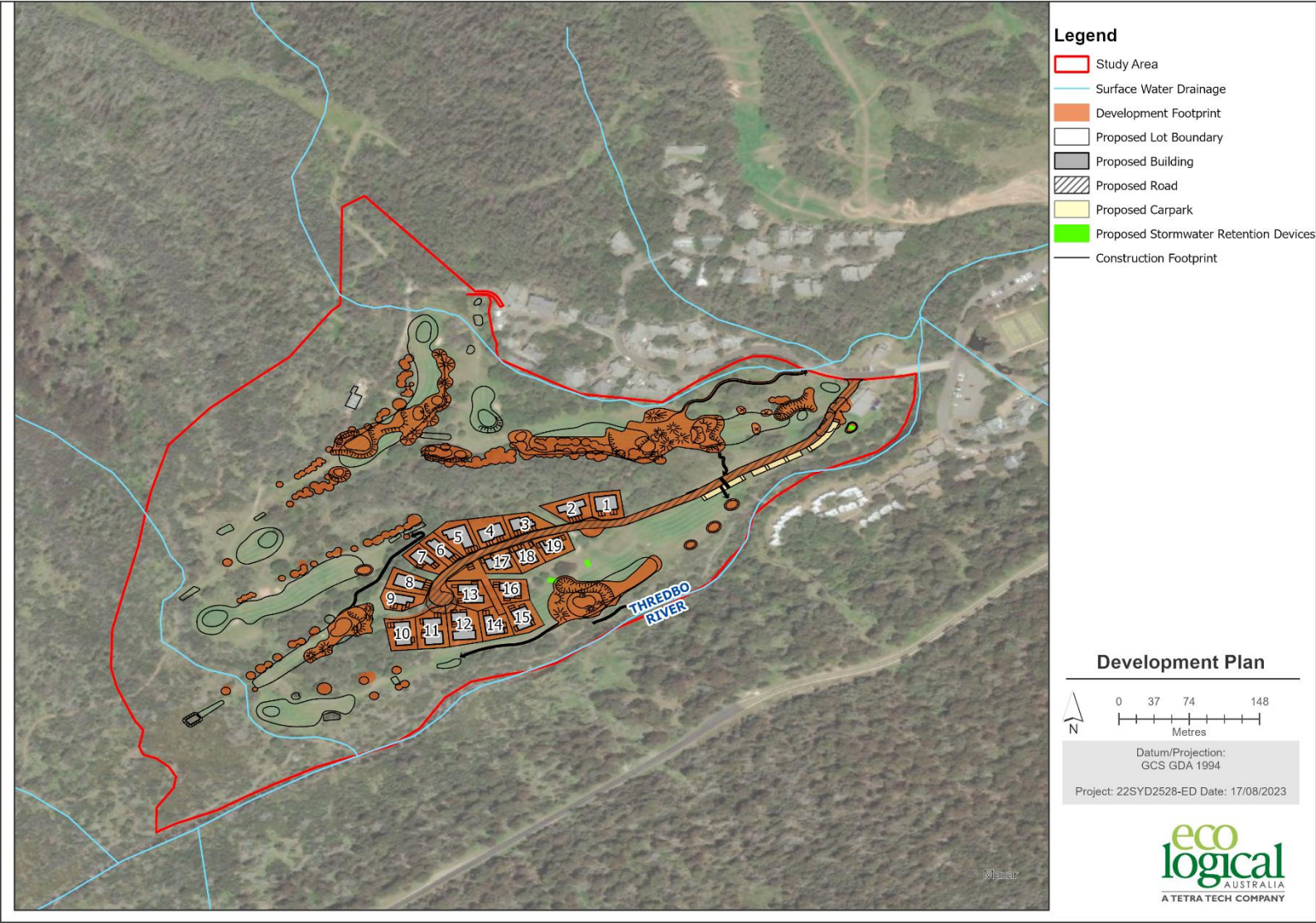


Figure 2: Proposed development area

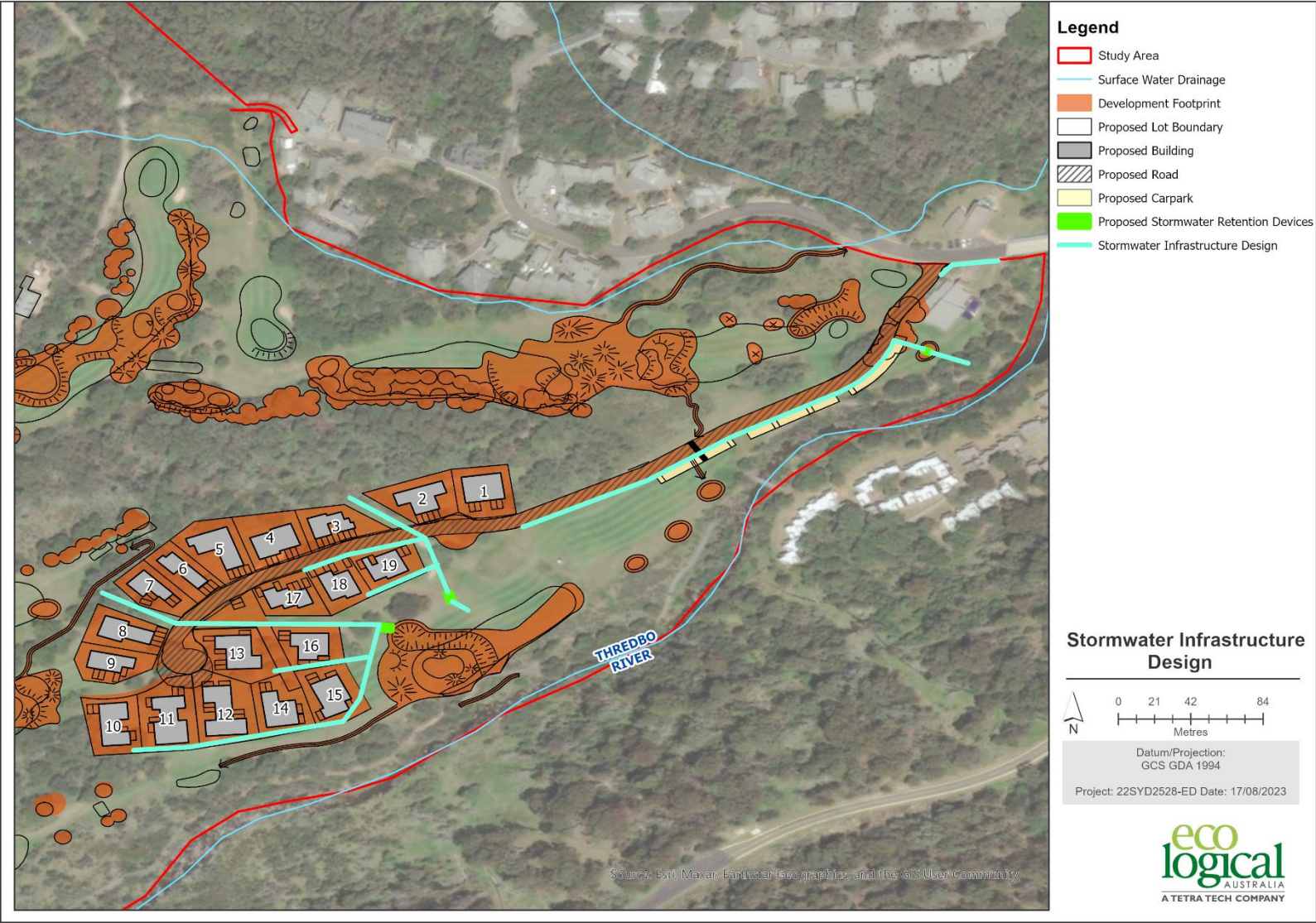


Figure 3: Proposed stormwater infrastructure design features

Development within the study area will comprise of the following components:

- Site earthworks.
- Building, access road and carpark construction.
- Construction and installation of stormwater drains and other ancillary services (electricity, sewer, gas, potable water and communications).
- Landscaping and rehabilitation work.

Controlled development activities will be managed in accordance with a site-specific Construction Environmental Management Plan (CEMP) to which this SWMP will be appended.

4. Existing Environment

4.1. Land Use

The study area is zoned C1 National Parks and Nature Reserves under Chapter 4 of the *State Environmental Planning Policy (Precincts – Regional) 2021*, and is located within an Area of Exceptional Recreational Significance (Management Unit) under the NSW Department of Planning, Industry and Environment *Kosciuszko National Park Plan of Management 2006*.

The study area comprises a 9-hole golf course which runs alongside Thredbo River and below the base of the ski slopes. The site provides defined fairways with tracts of both managed and undisturbed vegetation throughout.

Land uses adjoining the study area comprise tourist accommodation, buildings and sheds, roads and access tracks and recreational infrastructure.

4.2. Geology

Based on a review of the *Tallangatta, NSW 1:250,000 Geological Series Sheet SJ 55-3*, the regional geology underlying the study area primarily comprises granite of the Lower Devonian (MinView, 2023).

4.3. Soils

Soils at the study area are characterised as the Great Soil Group (GSG), Brown Earth (BRE). Soil survey results (survey 1005367) within 500 m south of the study area are characterised as Tenosol with a loamy texture, a soil profile depth of > 50 cm to 75 cm and topsoil pH between 6 and 6.5 (NSW Planning, 2023). Tenosols have a weakly developed soil profile which is typically very sandy and without obvious horizons. They generally have poor structure and low water-holding capacity. Groundwater contamination can be a potential problem due to the high permeability of these soils.

A review of the Australian Soil Resource Information System (ASRIS, accessed 17 March 2023) indicated an extremely low probability of acid sulfate soils at the study area and surrounds.

4.4. Vegetation

The study area surface is primarily covered and stabilised with grassed fairways with some interspersed eucalyptus tree cover becoming denser in the northern portion of the study area.

4.5. Topography and Drainage

The study area is located at approximately 1400 metres Australian Height Datum (mAHD) and gently slopes towards the Thredbo River from north-west to south-east. Ground surface levels range from RL 1433 mAHD in the northern portion of the study area to 1367 AHD in the south-eastern portion of the study area (-36.5062, 148.3011).

The general slope of the study area is approximately 4% increasing to a maximum of 20% in the northern portion of the study area. Stormwater runoff from the golf course currently drains to the Thredbo River, which borders the study area to the south, via overland surface runoff and groundwater infiltration pathways. The topography, slope and typical overland surface runoff pattern are presented in Figure 4.

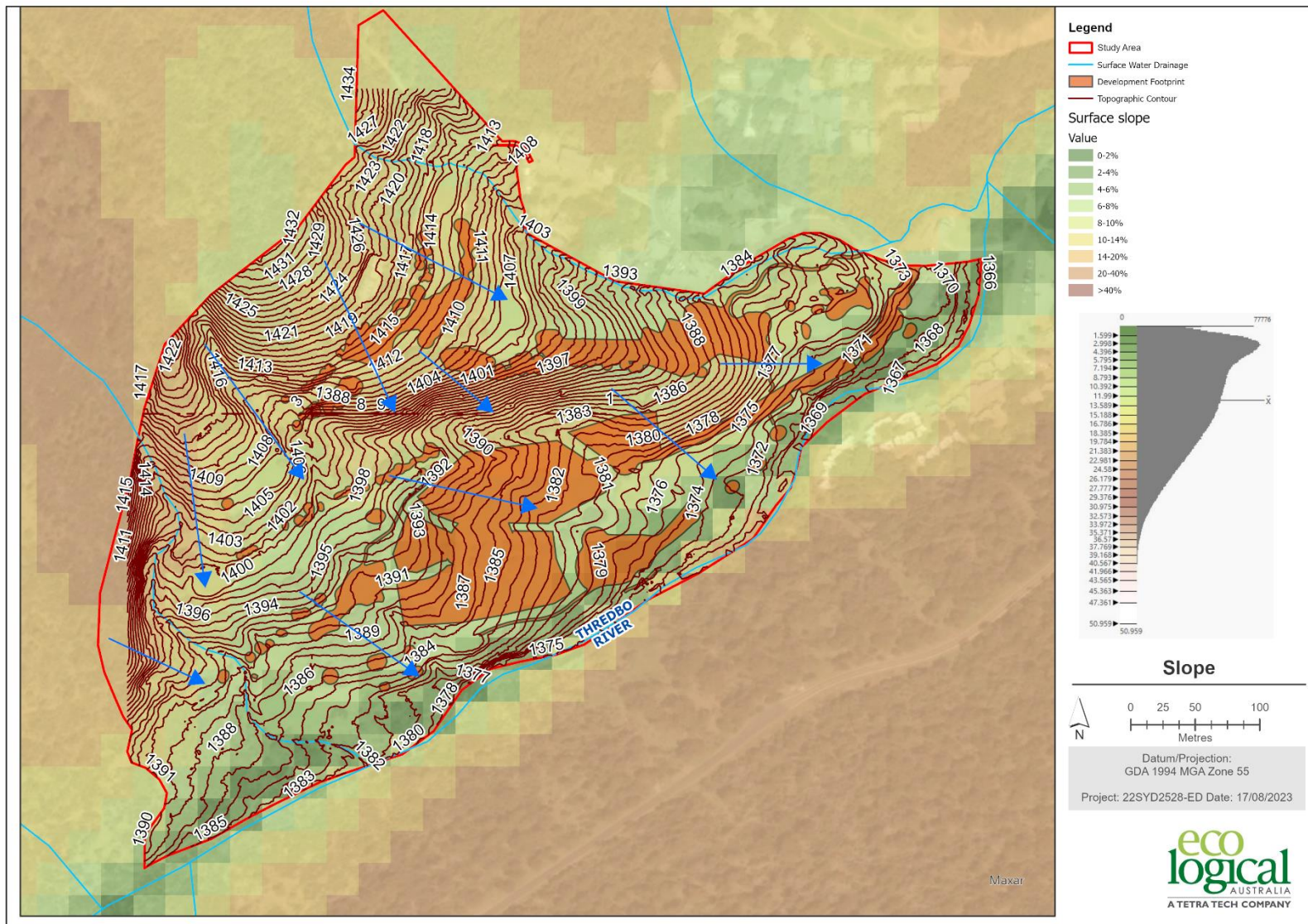


Figure 4: Topography, slope and surface water runoff pattern

4.6. Climate and Precipitation

Based on data retrieved from Thredbo Village (station 071041), the average temperature at the study area typically ranges between -3.5°C and 21.5°C. Average rainfall is 1816.4 mm/year, with an average number of rain days of 132 days per year. Typically, the wettest month (mean rainfall) is September and the driest is February (Bureau of Meteorology, 2023).

4.7. Hydrology and Water Resources

The study area is located within the Thredbo River sub-catchment of the Snowy River catchment (24,900 km²). The southern border of the study area is bounded by Thredbo River for approximately 70 m with flow to the north-east. Thredbo River is a third order stream under Strahler stream classification (see Figure 1).

One second order unnamed tributary runs through the western portion of the study area from the north and discharges into Thredbo River at the south-western study area boundary. One first order unnamed tributary runs through the eastern portion of the study area from the north and discharges to the Thredbo River near the south-eastern study area boundary.

Two additional second order unnamed tributaries and two first order unnamed tributaries are located upstream of the study area within the study area, and two first order unnamed tributaries are located downstream of the study area within the study area, all of which discharge into Thredbo River.

4.7.1. Water Quantity

There is only one nearby gauge approximately 30 km downstream of the study area on Thredbo River at Paddy's Corner (222541). Considering the similar hydrologic characteristics of Thredbo River at the study area relative to the location of available gauge data, the water levels in Thredbo River at the study area are likely consistent with the plot of water level data (Bureau of Meteorology, 2023) presented in Figure 5.

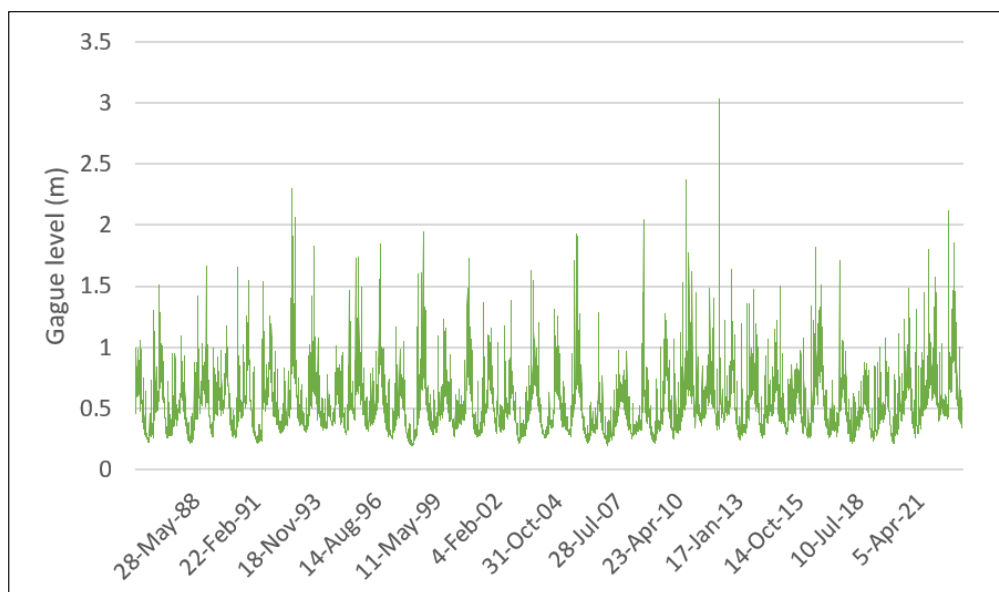


Figure 5: Thredbo River at Paddy's Corner (222541) gauged water levels

4.7.2. Water Quality

Water quality monitoring of Thredbo River has been undertaken by Canberra University and CRC Freshwater Ecology, funded by KT, since the 1990s. However, the historical water quality monitoring datasets were not publicly available for review.

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.

Quarterly field measurements include turbidity, pH, electrical conductivity and temperature. Water samples are collected on a biannual basis and analysed for nutrients and heavy metals. In addition, biological health is monitored through collection and analysis of macroinvertebrate samples in accordance with the Australian River Assessment System (AusRivas) framework. The most recent available water quality data (February 2022) indicated water quality parameters are generally within Australian and New Zealand Environment and Conservation Council (ANZECC) water quality guideline levels at monitoring locations both upstream (site 011) and downstream (site 012) of the study area. Total nitrogen was the only exception, with 0.12 mg/L (upstream location) and 0.14 mg/L (downstream location) slightly exceeding the guideline level of 0.10 mg/L (Institute for Applied Ecology, 2022), as shown in . The typical range for total phosphorus concentrations are indicated in Figure 7.

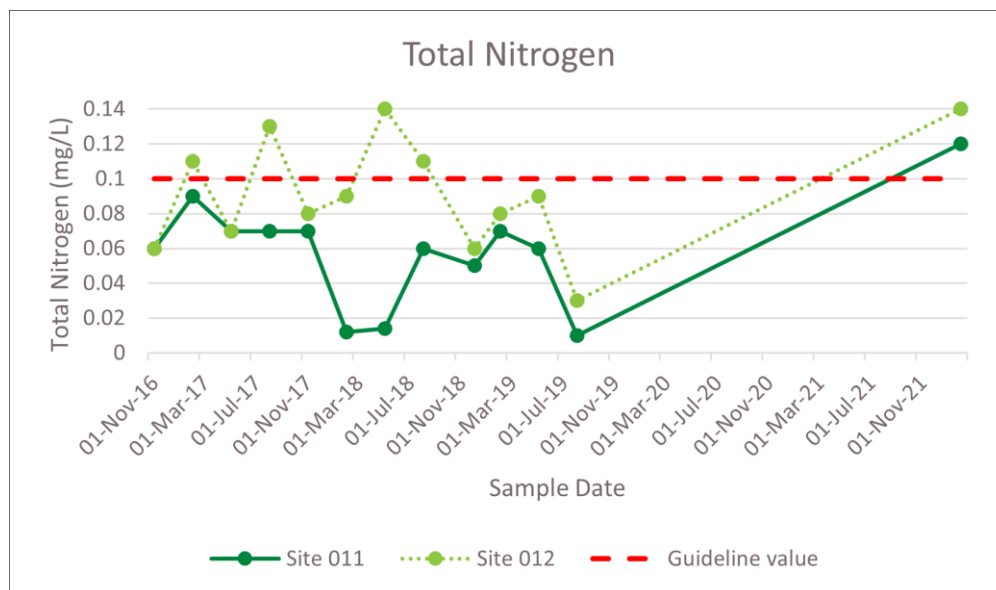


Figure 6: Total Nitrogen upstream and downstream of study area 2016 – 2022

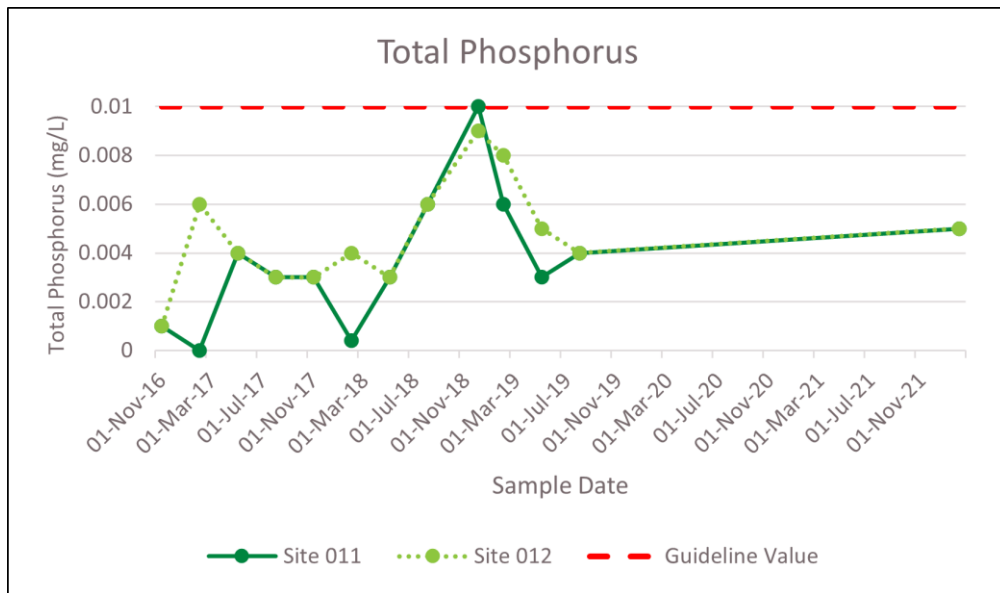


Figure 7: Total Phosphorus upstream and downstream of study area 2016 – 2022

4.8. Potential Receptors

Potential receptors of impacts resulting from the proposed development include:

- Surface water of Thredbo River and unnamed tributaries within the study area.
- Waterfront land including aquatic and riparian species populations and/or ecological communities within the study area.

A review of potential impacts to potential surface water receptors that may result from the proposed controlled development activities is presented in Section 5.1.

An assessment of potential impacts to aquatic and riparian species within the study area was undertaken separately to this SWMP and is detailed in the *Thredbo Golf Course Development: Aquatic and Riparian Impact Assessment* (ELA, 2023). A summary of conclusions relevant to this SWMP is provided in Section 5.2.

5. Impact Assessment

5.1. Hydrology Assessment

A desktop hydrology assessment was undertaken as part of this SWMP and included:

- A review of the existing catchment hydrology at the site (Figure 1).
- Characterisation of the surface water environment including quantity and quality (Section 4.7).
- Identification of potential hydrologic/surface water receptors (Section 4.8).

Review of the preliminary stormwater design (Appendix A) indicates that conveyance of surface water in unnamed tributaries within the site will continue to discharge to Thredbo River with minimal loss or change to flow conditions. Stormwater flow paths mimic natural conditions where feasible and direct all stormwater to the natural waterways. Based on assessment, the potential impacts to water quantity within the study area are considered minimal.

Potential impacts to water quality from the proposed development, however, may include increased sedimentation and decreased water quality within the site and study area, particularly downstream of the site within Thredbo River due to an increase in exposed areas; increased traffic (vehicular and pedestrian) and increased waste generation. Based on this assessment, the potential impacts to water quality are considered probable and need to be considered under appropriate mitigation strategies.

Potential water impacts must therefore be managed through implementation of mitigation measures as specified in Section 0 of this SWMP.

5.2. Waterfront Land Assessment

A Waterfront Land Assessment was undertaken separately to this SWMP in the *Thredbo Golf Course Development: Aquatic and Riparian Impact Assessment* (ELA, 2023) and consisted of:

- An aquatic ecology assessment to determine potential impacts of the developments on threatened species and ecological communities listed under the *Fisheries Management Act 1994* (FM Act).
- A riparian assessment, as per the *Water Management Act 2000* (WM Act), to assess impacts and offsets to the vegetated riparian zone (VRZ) triggered for work on waterfront land.

Potential impacts to riparian land, aquatic species populations and/or ecological communities within the study area are generally considered low risk based on results of the Waterfront Land Assessment. In summary, the Assessment indicated that the proposed development:

- Is not likely to have a significant impact on any threatened fish species or aquatic communities listed under the FM Act or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Does not trigger the need for a Species Impact Statement, nor referral to a Commonwealth body in relation to fish.
- Does not require dredging, reclamation, obstruction of fish passage or permits under Part 7 of the FM Act (outlets would be covered under a CAA).
- Is not likely to degrade watercourse condition by proposed VRZ encroachments, due to existing cleared use.

- Does require the implementation of mitigation measures as outlined in the SWMP to prevent adverse effects to Thredbo River's water quality.
- Does require an Integrated Development Application for assessment by NSW Department of Planning and Environment (DPE)-Water for works on waterfront land.
- Does require detailed designs of outlets to meet DPE standards.

The requirement for preparation of an Integrated Development Application as determined under the Waterfront Land Assessment does not fall under the auspices of this SWMP and should be addressed separately.

The requirement for detailed stormwater outlet designs does fall within the scope of this SWMP and must be included in subsequent revision, following detailed design, to satisfy DPE conditions of approval.

6. Management and Mitigation Measures

Management and mitigation measures to be implemented during the construction and operation phases of the development are outlined below, including measures for separating clean and dirty surface water areas and procedures for managing significant precipitation events to avoid and minimise downstream contamination from discharges within the development site.

6.1. Erosion and Sediment Control

Separate to this SWMP, an Erosion and Sediment Control Plan (ESCP) must be developed as part of the Construction Environmental Management Plan (CEMP) to detail how sedimentation will be managed throughout the construction and operation of the development. The objective of the ESCP will be to reduce pollution and sedimentation discharges to the Thredbo River. While the Snowy River Development Control Plan does not apply to Alpine resort areas, it is recommended that controls detailed in Section 3 of the Snowy River Development Control Plan are considered in the development of an ESCP. These controls include:

- Measures to ensure that land is stabilised, and erosion is controlled during construction to protect water quality in streams and lakes downstream of the development site.
- Stormwater systems are designed to optimise the interception, detention, and removal of waterborne pollutants prior to discharge to receiving waters.
- Maintaining vegetated riparian buffers to waterways.
- Stormwater diversions do not create an adverse effect on adjoining properties.
- Disturbed areas are re-stabilised and re-vegetated as soon as practicable.
- Landscaping is undertaken using native species suitable to the locality and with consideration of bushfire requirements.

The following sections provide information to identify controls and procedures specific to stormwater management that shall also be incorporated into the ESCP. Erosion and sediment controls must be appropriate to ensure sediment discharges to the Thredbo River are avoided and minimised throughout the construction phase.

6.2. Construction Phase Stormwater Management

The following minimum requirements shall be met pre- and during the construction phase:

- Prior to commencement of site earthworks, clean water diversion banks will be installed upstream of earthworks areas to divert water and avoid sediment discharges through surface runoff.
- Areas for plant, material and stockpile storage shall be designated as per requirements of the site-specific CEMP.
- The controlled development activities must be confined to necessary construction areas as per the proposed development design footprint.
- If necessary, construction of temporary sediment basins will be completed prior to commencement of earthworks.
- Water quality monitoring must be undertaken in accordance with Section 6.2.1.

- Stormwater, erosion and sediment control measures must be inspected weekly and corrective action taken immediately if damage or ineffectiveness is observed.
- All site personnel will be briefed to ensure implementation of the management measures outlined in this SWMP and the ESCP.

6.2.1. Water Quality Monitoring

Pre- and during construction monitoring must be undertaken and meet the following requirements:

- A water quality monitoring site within Thredbo River located immediately downstream of the development site shall be nominated and sampled prior to commencement of controlled development activities.
- Three surface water samples shall be collected from the nominated site monthly for a period of at least 3 months prior to commencement of controlled activities. Each sample will be analysed for salinity (EC), pH, total dissolved solids, turbidity, major ions (cations and anions), nutrients (total nitrogen, total phosphorous) and metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc). The average (geometric mean) and median value of the results from the three samples for each analyte shall be recorded as the sampling event result. If the difference between the average and median results is greater than one standard deviation for any analyte, resampling must be undertaken. The average and standard deviation of these samples shall represent a baseline against which samples collected during construction will be assessed.
- During construction, four surface water samples shall be collected from the nominated site on a monthly basis, or following rainfall events that generate overland flow, whichever number is greater. Three samples will be analysed for salinity (EC), pH, total dissolved solids, turbidity and nutrients (total nitrogen, total phosphorous). If any analyte records higher than the average plus 2 standard deviations from the baseline (pre-construction) sample group, the fourth sample will be analysed for major ions (cations and anions) and metals (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc) and compared to the baseline data. If exceedance is recorded for two consecutive sampling events the source of the exceedance should be investigated and additional on-site mitigation measures implemented.
- Water quality data including dates and volumes of rainfall; times and dates of sampling and analytical results must be kept in an on-site register. The register is to be maintained for the duration of the construction phase and made available for inspection by an environmental site representative upon request.
- All environmentally relevant incidents with potential to affect water quality downstream of the development site must be recorded in an on-site register and made available for inspection by an environmental site representative upon request. Remediation and or mitigation measures implemented subsequent to these incidents should be recorded in the register. Sampling of surface waters should be undertaken following the incident and following remediation to demonstrate minimal impacts.

6.3. Operational Phase Stormwater Management

When construction is completed, stormwater will be managed through the proposed stormwater infrastructure system, discharging via three stormwater retention devices to the Thredbo River. Water quality monitoring requirements will cease upon practical completion and will revert to management through the NSW NPWS Kosciuszko National Park water quality monitoring program.

6.4. Water Sensitive Urban Design

Water sensitive urban design (WSUD) elements have been considered in the concept stormwater design development. The aim of WSUD is to maximise the retention of stormwater pollutants within the development and minimise impacts on the receiving environment, in this case the Thredbo River.

The proposed development incorporates the following elements of WSUD:

- Ensure water quality is not impacted through implementation of stormwater management controls during the construction phase.
- Integration of stormwater treatment into the natural landscape through overall preservation of watercourses and riparian corridors within the development site.
- Reduction of surface runoff caused by the development through minimising impervious areas.
- Treatment of stormwater prior to discharge into Thredbo River via three proposed water retention devices.

7. Stormwater and Drainage Concept Design Review

The stormwater and drainage concept designs are presented in Appendix A Concept Development Design. The proposed stormwater and drainage system aims to preserve as much natural runoff and stormwater treatment through groundwater infiltration as possible.

Stormwater drainage infrastructure is proposed to manage runoff surrounding impervious areas including the subdivided lots, buildings and access road. The drainage infrastructure will be connected to three stormwater retention devices to treat stormwater prior to discharge to Thredbo River. The location of the three proposed stormwater retention devices is considered adequate and appropriate considering the minimal potential for contamination of stormwater that could impact ecosystems of Thredbo River, as determined in Section 6.

8. Conclusions and Recommendations

Based on a review of the existing environment conditions and concept development designs, potential impacts to surface water during construction of the development include increased sedimentation and decreased water quality within the site and study area, particularly downstream of the site within Thredbo River. No significant impacts to surface water quantity are expected.

The risk of potential impacts to water quality are considered manageable through implementation of required mitigation strategies specified in this SWMP. These measures include separation of clean and dirty surface water areas and procedures for managing runoff from significant precipitation events to avoid and minimise downstream contamination from discharges within the development site. Routine water quality monitoring is recommended for ongoing assessment of the effectiveness of mitigation measures.

Results of a Waterfront Land Assessment indicated that the proposed development design does not meet requirements of the NSW DPE Riparian Guidelines 2022 due to proximity to Thredbo River. Therefore, an Integrated Development Application and subsequent Controlled Activity Approvals are required for proposed development works on waterfront land. In addition, detailed designs of outlets are required to meet DPE standards as a condition of the Development Application approval.

It is recommended to proceed to detailed design for the proposed development considering the outcomes of this SWMP.

9. References

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Appendix A Concept Development Design

