5.4.5 Water Cycle Management

5.4.5.1 Introduction

Storm Consulting were engaged to undertake a hydrological assessment of the proposed development and consider issues pertaining to water quality and quantity, and identify management strategies to implement in order to mitigate the impact of the development on the environment. The assessment undertaken by Storm Consulting culminated in the preparation of a Water Cycle Management Report which is reproduced as **Annexure 7**. In addition to the hydrological issues, the Water Cycle Management Report prepared by Storm Consulting considered flood risks and potential impacts of climate change through increased flood levels and rainfall intensity.

The proposal incorporates a number of measures to mitigate impacts on both the quantity of water leaving the site, as well as the quality of water that is discharged from the site including strategically located bio-filtration trenches within each identified catchment, and on-site storage of rainwater and infiltration within allotment boundaries.

This section of the EA discusses the Storm Consulting report and water cycle management.

5.4.5.2 Methodology

The Water Cycle Management assessment undertaken by Storm Consulting includes consideration of a range of matters including:

- Planning context including consideration of Shoalhaven LEP 1985 and Shoalhaven Council's DCP 100 – Subdivision Code;
- Water quality objectives including suspended solids, and nutrient loads, and Stormwater quality benchmarks provided within *"Stormwater Treatment Techniques – Environmental Targets"* prepared by the DECC;
- Climate change impacts, including increased rainfall and therefore run-off, and sea level rise;
- Water quantity objectives including runoff volumes, peak flows and runoff frequency.

Work undertaken by Storm Consulting included the following modelling:

- MUSIC which simulates urban stormwater systems operating at a range of temporal and spatial scales for catchments between 0.01 km^2 to 100 km^2 in size and modelling time steps ranging from 6 minutes to 24 hours to match the catchment scale.
- RAFTS models rainfall runoff and assist by determining the onsite detention requirements generated by the proposal.

Storm Consulting included an assessment of the site conditions including soil types, topography and slopes, established land use patterns, climatic conditions, drainage regime, and the extent of vegetation covering the site.

The assessment undertaken by Storm Consulting assessed the site, the nature of the proposal, undertook the modelling, recommended mitigation measures, and provided a final report. Work undertaken by Storm Consulting included an inspection of the site and surrounds.

Storm Consulting identified relevant constraints and opportunities for the development which included the following:

- Shallow soils and exposed bedrock;
- Site topography;
- Minor drainage line traversing the northern half of the property, along with smaller drainage depressions draining local runoff;
- Water quality benchmarks; and
- Water Sensitive Urban Design principles able to be implemented.

5.4.5.3 Findings

Construction Impacts

During construction, Storm Consulting recognise that there is a potential for higher levels of stormwater pollution to occur. This can be attributed to sight disturbances and vegetation removal necessary to construct the subdivision.

Storm Consulting have recommended mitigation of these impacts by way of preparing a detailed Soil and Water Management Plan in accordance with "Managing Urban Stormwater: Soils & *Construction, Version 4 (Landcom, 2004)"* commonly referred to as the "Blue Book". Such can assist in minimising the potential for soil erosion by appropriately staging the development to minimise the extent of land exposed at any one time and ensuring that appropriate soil erosion measures are employed and properly located.

Water Quality Modelling

Stormwater quality benchmarks required by the Department of Environment & Climate Change, (DECC) requires that stormwater discharges meet the following standards (**Table 9**):

Table 9

DECC Water Quality Benchmarks

Total Suspended Solids (TSS)	Reduce by 85%
Total Phosphorus (TP)	Reduce by 65%
Total Nitrogen (TN)	Reduce by 45%

In order to treat stormwater, the proposal incorporates a range of measures to reduce pollutant loads includes strategically placed bioretention areas, with appropriate diversions to ensure that water is redirected to pass through the systems prior to discharge from the site. The nature of the site, and in particular the topography of the land, according to Storm Consulting, precludes facilities such as wetlands and ponds which require large areas, whilst the shallow soils and waterlogged nature of some of the site has excluded the use of drainage swales.

According to modelling work undertaken by Storm Consulting, the proposal will result in the following pollutant loads and concentrations (**Table 10**):

Table 10

Pollutant Load (kg/annum) for development with and without treatment

	No Treatment	***With Treatment***	***% Load Reduction***	***Meets Criteria Y/N***
Suspended Solids (kg/y)	36000	5640	84.3%	N
Total Phosphorus (kg/y)	67.7	19.8	70.8%	Y
Total Nitrogen (kg/y)	558	212	62.1%	Y

Modelling undertaken by Storm Consulting reveals that the proposal will comply with the water quality benchmarks established by the DECC having regard to Total Phosphorous and Total Nitrogen, however is marginally (0.7%) below the required load reduction when it comes Total Suspended Solids (TSS). Having regard to TSS, Storm Consulting consider that although this is marginally below the benchmark removal requirements, this is satisfactory as it is a conservative assessment that has not included modelling of the positive effects of the proposed bioretention system which will have a practical benefit and will further increase TSS removal.

Water Quantity Modelling

According to the modelling undertaken by Storm Consulting utilising the MUSIC programme, stormwater runoff from the site will increase upon the development of the

subdivision. This can be attributed to the additional extent of sealed and hard stand areas resulting from the development and the current nature of the site which is undeveloped and vegetated with a variety of forest and pasture grasses. The impacts of this increase however will not adversely affect the downstream environment or infrastructure provided the measures for mitigation and management recommended by Storm Consulting are implemented and these are discussed in the following sections.

Having regard to total flows, utilising the MUSIC programme, Storm Consulting have assessed pre-development flows at 56.2 ML/yr, whilst post development, these are expected to increase to 110 ML/yr, whilst average flow rates from the site are modelled to be similar following the development. In addition, the assessment undertaken by Storm Consulting has shown that the installation of bioretention system across the site will enable an annual supplementary infiltration of 111 ML/yr to be achieved. According to Storm Consulting, this is equal to the supplementary recharge necessary to minimise impacts on the hydrologic regime to reduce impacts on ecological considerations including flora and fauna communities. This is further discussed in Section 5.6.5.3 of this EA.

The assessment of Storm Consulting has considered impacts on the Flat Rock Creek Catchment. In this regard, Storm Consulting has determined that the catchment of Flat Rock Creek is approximately 1,000 ha in area, whilst the proposed development area accounts for approximately 3% of this catchment, representing approximately 33 ha. As a consequence, Storm Consulting considers that the development will have a negligible impact on the hydrology of Flat Rock Creek, particularly as the development is at the lower end of the catchment.

Storm Consulting have also assessed the need for on site detention and retention in conjunction with the proposed development. With respect to this, Storm Consulting consider that as the site flows into a natural creek, the modest increase in flows that are modelled to result, will not adversely impact on any assets or infrastructure downstream. Storm Consulting also consider that the development will not increase flooding due to the nature of the floodplain which is wide and flat. As a result, Storm Consulting consider that retention or detention will have no benefits on the receiving catchment and is therefore not required.

Overland Flow Assessment

In addition to the overall quantity of water discharging from the site, Storm Consulting undertook an assessment of the overland flow to determine road widths and drainage design requirements where current discharges are concentrated. The areas of concern

relate to a drainage line traversing the northern half of the site, and smaller depressions which drain localised runoff, and which discharge at the south-eastern boundary.

The assessment undertaken by Storm Consulting included hydrological modelling using RAFTS to estimate peak flows, and their assessment accounts for conditions expected due to the impacts associated with climate change.

According to Storm Consulting the peak flow within the roadway at the lower end of the site is 6.72 m^3/s.

The assessment undertaken by Storm Consulting has resulted in a series of recommendations regarding drainage design as follows:

- Flow depths within the roadway must not exceed 200 mm with a maximum velocity depth multiple of 0.4;
- Approximately 2 m^3/s can be suitably conveyed within the roadway, and the remaining 4.72 m^3/s is to be conveyed as pipe flow;
- The piped flow at 4.72 m^3/s would result in a single 1200 mm diameter pipe.

In consideration of increased rainfall intensity to account for anticipated conditions under climate change impacts, Storm Consulting has recommended that a 30% increase be adopted consistent with the Floodplain Risk Management Guideline for the Practical Consideration of climate change. This will see peak flows increase to 8.74 m^3/s, which would necessitate duplicating the 1200 mm pipe, or alternatively a widened road pavement in order to provide greater capacity to convey stormwater. Such can be calculated for input into detailed design at construction stage.

According to the assessment undertaken by Storm Consulting, the development can satisfactorily accommodate the overland flow of stormwater, including additional peak flows anticipated due to the potential impacts of climate change.

Ecological Issues

The assessment of Storm Consulting has been considerate of ecological matters pertinent to the development concerning impacts on habitat and receiving environments. In particular, Storm Consulting have considered the hydrological impact on *Triplarina nowraensis* and Flat Rock Creek, and have consulted with SLR Global Environmental Solutions who undertook ecological evaluations detailed in Section 5.6, in preparing their assessment.

In relation to *Triplarina nowraensis,* this species was detected by SLR in the wetter portions of the site, generally in the eastern and northern portions of the site,

predominantly in those areas to be zoned for conservation purposes and not subject to development proposed by this Major Project. According to SLR, this species is well adapted to a wet environment and as such, it is necessary to protect existing wet areas, and ensure that discharges are arranged such that low points continue to receive stormwater.

Having regard to water quality, Storm Consulting have advised that the proposal will meet the recognised nitrogen and phosphorous reduction loads of 45% and 65% respectively such that adverse impacts are unlikely. Storm Consulting have advised that roads should be designed to direct drainage to biofiltration systems prior to stormwater being discharged within the current catchments to existing low points in order to maintain flows.

In relation to Flat Rock Creek, Storm Consulting consider that impacts are unlikely as the catchment of Flat Rock Creek is some 1000 ha, and the development site at 33 ha, representing only 3% of such catchment, and on that basis, impacts are unlikely. It should be noted that although the site itself, in part, drains towards Flat Rock Creek, the water quality treatment devices to be installed, coupled with the substantial vegetated buffer between the site and Flat Rock Creek, should further minimise impacts.

The favourable assessment of Storm Consulting is also supported by SLR (**Annexure 3**).

Given consideration to the above during the detailed design of drainage at the construction stage, impacts are unlikely.

Climate Change Impacts

Storm Consulting has considered the impacts of climate change in their assessment having regard to sea level rise and increased rainfall intensity.

With respect to increased rainfall intensity, Storm Consulting advises that the Floodplain Risk Management Guideline for the Practical Consideration of Climate Change suggests that in the absence of any detailed information, a worst case sensitivity analysis involving a 30% increase in intensity should be assessed. The assessment of Storm Consulting has assumed the 30 % increase. The assessment undertaken by Storm Consulting recommends that a duplicate 1200 mm pipe would be required to convey this additional flow.

Having regard to sea level rise, Storm Consulting has indicated that the maximum predicted sea level rise by 2100 is 0.9 m. Contour surveys on the plan prepared by Allen Price and Associates (**Annexure 1**) indicate the subject site and location of lots as having a minimum height of RL 46 m where residential development is to be undertaken Strom Consulting considers that the increase flooding of the Shoalhaven River and Flat

Rock Creek, coupled with predicted sea level rise will not have an impact on the proposed subdivision.

Impact of Filling

The proposal will require the filling of land in order to enable the reshaping of land to accommodate the proposed road system. Storm Consulting have considered the impact of filling by undertaking a preliminary investigation of peak flows and overland flow path sizing which has demonstrated that the passage of flood flows within pipes and the roadway reserve is feasible. Due to the siting of the property at the top of an escarpment away from the Shoalhaven River and its floodplain, according to Storm Consulting the proposal will have no impact on the flood regime.

Sediment Controls

Accompanying the proposal as **Annexure 1** is a Typical Sediment and Erosion Control Plan prepared by Allen Price and Associates which shows the provision of typical sediment control measures to be implemented in the construction of Stage 1 of the proposed subdivision. The plan includes details of topsoil mounds, diversion drains, stabilised access arrangements, straw bale sediment filters, sediment fencing and filter treatment of inlets. The typical details outlined for Stage 1 can be utilised in subsequent stages of the proposed subdivision.

It is expected that more detailed plans would be prepared following approval of this project for implementation during the physical works and, in the following stages in order to control erosion and maintain water quality.

5.4.5.4 Conclusion

According to Storm Consulting, water quality impacts are minimised due to the best practice stormwater treatment systems to be implemented in the construction of the proposed subdivision, with the development generally meeting the recognised EPA guidelines. Such treatment will mitigate impacts on the threatened *Triplarina nowraensis,* Flat Rock Creek, and the receiving environment generally. Storm Consulting concludes with the following recommendations:

- *Implement treatment systems and stormwater management measures outlined in this report and drawings. We would also suggest the addition of controls at the lot level, such as rain gardens and impervious area controls to further improve post development impacts.*
- *Further design of stormwater drainage should be cognisant of the shallow bedrock on site.*

- *Undertake a detailed assessment of peak flows and main overland flow paths through the development site.*

Such works are supported by this EA and can be undertaken during the detailed design and construction of the project.

5.5 CULTURAL HERITAGE

This Section of the EA deals with cultural heritage matters, considering both indigenous and non-indigenous heritage, and considers the impacts of the proposed subdivision the subject of this EA.

This section of the EA in part, is based on the Aboriginal Heritage Assessment prepared by South East Archaeology (SEA) which deals specifically with indigenous heritage matters.

5.5.1 Non Indigenous Heritage

5.5.1.1 Introduction

The subject site is predominantly undeveloped, being cleared and used for agricultural purposes, mostly restricted to grazing. The site contains no significant structures, with buildings being restricted to ancillary dwellings and rural sheds.

There are no heritage items of non-indigenous significance on or in the near vicinity of the site, and therefore Cowman Stoddart Pty Ltd prepared a preliminary heritage assessment of the site and surrounds to determine whether there was a demonstrable need for the preparation of a more thorough heritage assessment or heritage impact statement. It is noted however that SEA also undertook a similar desk top assessment for the purposes of their Aboriginal Heritage Assessment (**Annexure 8**).

5.5.1.2 Methodology

Cowman Stoddart Pty Ltd has prepared a preliminary desk-top assessment of the non-indigenous heritage items located within the vicinity of the site and surrounds. The desktop review included a review of the NSW State Heritage Inventory/Register, Shoalhaven LEP, Illawarra REP No. 1, and the Commonwealth Australian Heritage on-line databases.

5.5.1.3 Results

The review found that the subject site is not identified in Shoalhaven LEP 1985 as containing an item of environmental heritage. Furthermore, the site is not identified in the Illawarra Regional Environmental Plan, the NSW State Heritage Register or the Commonwealth Australian Heritage database.

Beyond the subject site, the closest property that is identified by Shoalhaven LEP as containing an item of environmental heritage is associated with the Flat Rock Creek dam. In this regard, Lots 6 and 12 DP 805611 fronting Filter Road at West Nowra contains an inter-war reinforced concrete building and storage dam. An extract from SCC GIS is reproduced as **Figure 15** and shows the siting of this property in relation to the subject site. The identified heritage item is separated from the subject site by a distance of some 500 metres with this area containing substantial forested lands. The consequences being that the property does not have any connection to the heritage item. On this basis, it is not considered to be within the vicinity of the subject site.

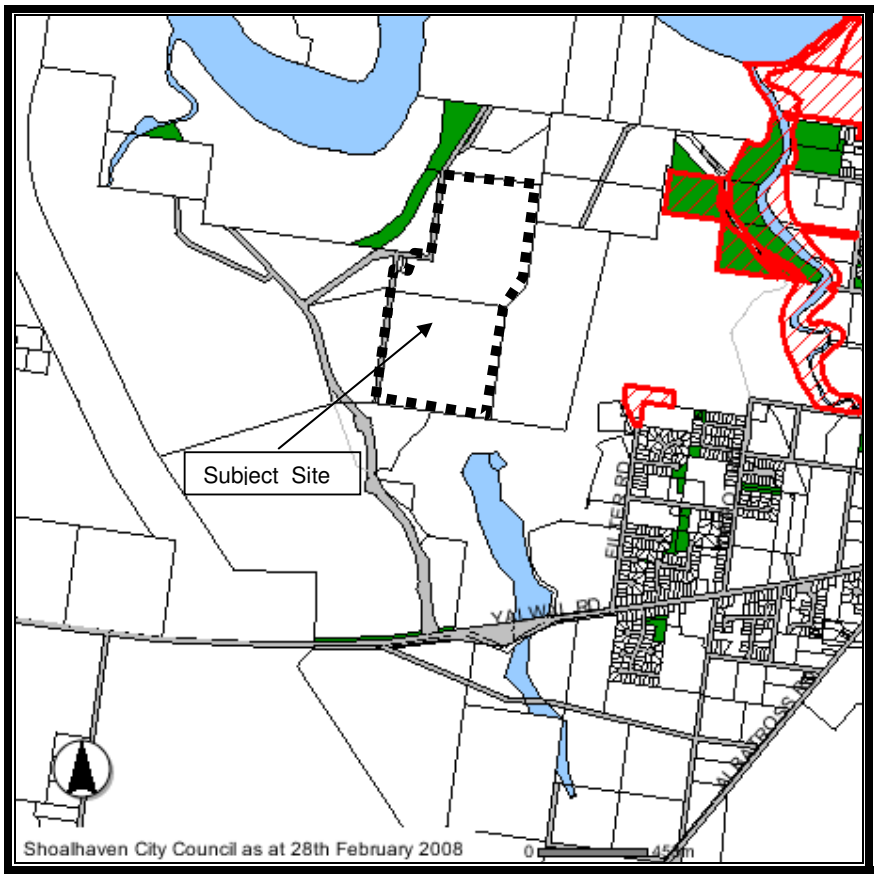

Figure 15: Identified Items of Environmental Heritage.

5.5.1.4 Anticipated Impact

Given that none of the identified heritage items are located on, or in the vicinity of the site, it is anticipated that the proposed subdivision of the property, and future development for residential purposes, will not have a direct impact on any of the identified items of environmental heritage at West Nowra.

The subject site is remote from the identified heritage item as it has frontage to a different road, is sited a minimum of 500 m from the subject site with this area being vegetated with native forest such that it is visually separated from it. The subject site is not visible from the identified heritage item.

5.5.1.5 Findings of South East Archaeology

According to the report of SEA (**Annexure 8**), their preliminary assessment identified that the study area did not contain any non-indigenous heritage items listed on any heritage register or planning instrument, and nor have any relics as defined under the Heritage Act 1977 been identified during detailed field investigations. Consequently, SEA considers that non indigenous heritage matters do not require further consideration and supports the findings of this EA.

5.5.1.6 Conclusion

The preliminary heritage assessment undertaken found that the subject site is not identified as containing an identified item of environmental heritage of either local, regional, state or federal significance.

Investigation of identified heritage items in the West Nowra area determined that none have a visual link or connection to the subject site.

Therefore the proposed development is unlikely to have an impact on any heritage items.

This is supported by the findings of SEA in **Annexure 8.**

5.5.2 Indigenous Heritage

The subject site is not identified in Shoalhaven LEP or other environmental planning instrument as containing any known items of cultural indigenous heritage. Notwithstanding this, in consideration of this issue an Aboriginal Heritage Assessment (AHA) was prepared by SEA which has examined the proposal and its impacts on Aboriginal and cultural heritage. A copy of this report is included as **Annexure 8**. This section is based on the findings and recommendations of the AHA.

5.5.2.1 Methodology

The AHA undertaken by SEA was undertaken in accordance with the provisions of the *National Parks and Wildlife Act 1974* and the *Environmental Planning and Assessment Act 1979.* The Assessment included the following tasks:

- undertake research of past archaeological publications;