Henry & Hymas

Narara Ecovillage
Narara, NSW

Water Cycle Management Plan – Stage 2

Project Number: 19067

Date: 20/12/19 (Revision 4)

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- Central Coast Council Civil Works Specification Design Guideline 2018: Section 5 Site Earthworks Design
- Central Coast Council Civil Works Specification Design Guideline 2018: Section 6 Design requirements for Roads Civil Works
- Central Coast Council Civil Works Specification Design Guideline 2018: Section 7 Design of Pavements
- Central Coast Council Civil Works Specification Design Guideline 2018: Section 9 Design of Property Access, Car Parks, Paths and Cycleways.
- Central Coast Council Civil Works Specification Design Guideline 2018: Section 10 Stormwater Drainage Design
- Central Coast Council Civil Works Specification Design Guideline 2018: Section 11 Water Sensitive Urban Design (WSUD)
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- Water Services Association of Australia (2014), Gravity Sewerage Code of Australia, Version 3.1
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1. INTRODUCTION

This report has been prepared to support the development application (DA) to Central Coast Council (Council) for the proposed subdivision of Stage 2 of Narara Ecovillage (NEV), a community title development at Gugandi Road, Narara (also known as 25 Research Road, Narara).

The purpose of this report is to explain the proposed water cycle management at a conceptual level for for the proposed subdivision and its future development for residential purposes.

Stage 2 of NEV is the second phase of a multi-staged land development being carried out to support the creation of a resilient and caring community based on an ecovillage model and in accordance with the vision mission and aim shared by all the members of the NEV Co-operative. The NEV champions the creation of thriving communities by researching and applying principles of sustainability, resilience and support across all its cultural, commercial and environmental practices and the project is a physical expression of the community's aspirations and commitment in this regard.

This report should be read in conjunction with the following engineering drawings from Henry & Hymas which are also submitted to Council with the DA:

- 19067_DA_C000 rev 1
- 19067_DA_C100 rev 2
- 19067_DA_C101 rev 2
- 19067_DA_C102 rev 2
- 19067_DA_C103 rev 2
- 19067_DA_C104 rev 2
- 19067_DA_C105 rev 1
- 19067_DA_C150 rev 2
- 19067_DA_C151 rev 2
- 19067_DA_C152 rev 2
- 19067_DA_C160 rev 1
- 19067_DA_C161 rev 1
- 19067_DA_C162 rev 1
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- 19067_DA_C202 rev 1
- 19067_DA_C203 rev 1
- 19067_DA_C204 rev 1
- 19067_DA_C210 rev 1
- 19067_DA_C211 rev 1
- 19067_DA_C250 rev 1
- 19067_DA_C500 rev 1
- 19067_DA_SE01 rev 1
- 19067_DA_SE02 rev 1
- 19067_SK_W000 rev 1
- 19067_SK_W100 rev 7
- 19067_SK_W200 rev 1

- 19067_SK_W201 rev 1
- 19067_SK_W202 rev 1
- 19067_SK_W203 rev 1
- 19067_SK_W204 rev 1
- 19067_SK_W205 rev 1
- 19067_SK_W206 rev 1
- 19067_SK_P000 rev 1
- 19067_SK_P100 rev 3
- 19067_SK_P101 rev 1
- 19067_SK_P200 rev 1
- 19067_SK_R100 rev 3

In addition to the above, a draft design has been undertaken for the proposed recycled water treatment plant (further discussed below). Reference is made in the recycled water section to drawings that will be submitted as part of the DA. However, it is noted that recycled water treatment and distribution will be subject to approval under the Water Industry Competition Act (WICA) rather than Council.

It is noted that a lot of the internal potable, non-potable and sewer networks depicted inside NEV is under the WICA 2006 Act as per Licence Number 17_040 and Retail Supplier Number 17_041R. Accordingly the internal arrangements of the NEV potable, non-potable and sewer networks are not part of the required DA documentation submitted to Central Coast Council, however have been issued For Information Only.

2. SITE CHARACTERISTICS

The development site is located at 25 Research Road, Narara. The community title development is spanning over three stages with Stage 1 already approved and well under construction. Stage 2 covers the southern portion of the site as indicated in Figure 1 below.

Figure 1 - Overall staging

2.1 TOPOGRAPHY AND SITE DISCHARGE

The site comprising Stage 2 falls towards the east at varying grades up to approximately 25% with the western boundary approx 53m AHD and the eastern boundary approx 18m AHD. The site discharges to a tributary of Narara Creek.

The existing catchment is predominantly rural in character and falls towards the east and predominately existing swales with twin 825mm pipes traversing below Gugandi Road.

Figure 2 – Aerial view of the existing catchment

2.3 PROPOSED DEVELOPMENT

Narara Ecovillage is an intergenerational residential community on the Central Coast of NSW, surrounded by bushland, close to pristine beaches and an hour north of Sydney.

The Ecovillage will have 150+ homes and is to be phased in 3 stages. Stage 1, with houses being built now, includes 42 standard blocks (average 550m^2), as well as 18 townhouse-style homes (cluster units) situated in the heart of the Ecovillage.

Stage 2 will consist of 43 residential lots ranging in size from 550 to +1000m^2 and the provision of associated infrastructure to service the subdivision A draft concept plan has been developed and NEV anticipate the commencement of lot selection (by members) later this year (2019). NEV expects that the civil infrastructure works will commence in 2020 and subdivision will likely take place in 2021.

The proposed development of Stage 2 will consist of the lot layout plan seen below in Figure 3.

Figure 3 – Lot layout for Stage 2 of the development

3. STORMWATER QUANTITY AND QUALITY ASSESSMENT

The objective is to provide stormwater controls for the proposed development including on-site stormwater detention (OSD) and water quality treatment in accordance with Central Coast Council development guidelines. These ensure that the proposed development does not adversely impact the stormwater flow rates discharging from the site and water quality of waterways within, adjacent and downstream of the site.

Various stormwater treatments are proposed that will ensure there is no adverse impact on the downstream ecosystem as a result of the proposed development. Refer to Civil Engineering Report (Henry & Hymas 2019) for more detail.

3.1 STORMWATER QUANTITY

Currently there is no formalised drainage system within the Stage 2 site apart from a swale which directs overland flows to a culvert adjacent to Gugandi Road.

The proposed drainage system has been designed to collect all concentrated flows from the future building pads and impervious surfaces such as roads, driveways, footpaths and roof areas. The piped drainage system has been designed generally to convey the 1 in 10-year ARI with adequate provision for the 1 in 100-year ARI to be safely conveyed overland.

Proposed bio-retention basins will be used for water quality purposes as well as On-site Stormwater Detention (OSD) to ensure that runoff from the development is appropriately managed. OSD will be provided to ensure that the post-developed flows do not exceed the pre-developed flows for storms up to the 1 in 100-year ARI event in accordance with Council requirements Part 6 Environmental Controls.

Table 1: Pre and Post Developed Flows

	5 year ARI	20 year ARI	100 year ARI
Pre-developed Flow (L/s)	0.968	1.3	1.61
Post developed Flow (L/s)	0.968	1.3	1.56

Refer to Civil Engineering report (Henry & Hymas 2019) for more detail.

3.2 STORMWATER QUALITY

Urban developments have the potential to increase gross pollutants, sediments, hydrocarbons and nutrient concentrations in stormwater runoff. To limit impact on downstream catchments, water quality measures at source and end of line treatments will be provided. This section describes the specific implementation of these measures for the proposed development.

Modelling was conducted to ensure that the water quality treatment targets nominated by Council will be achieved.

Council's removal targets as per Section 6.7.7.3.2 (GDCP 2014) are:

- 90% gross pollutant reduction;
- 80% reduction in Solids: suspended solids and gross pollutants (grit, sediment. leaves, grass clippings, litter); and
- 45% reduction in Nutrients: total phosphorus and total nitrogen

Water quality measures will be implemented for the site and this will be to ensure that stormwater runoff is treated sufficiently prior to discharge to the downstream stormwater system.

The water quality modelling software program MUSIC has been used to establish the effectiveness of the water quality treatment proposal. MUSIC has been developed by the Cooperative Research Centre for Catchment Hydrology, and is designed as a planning tool for water quality treatment trains for catchment runoff.

A MUSIC model has been developed to ensure that the water quality treatment targets nominated by Council will be achieved by NEV. Refer to Table 2 below which demonstrates that the development meets Council's pollution reduction requirements, as specified in 6.7.7.3 of GDCP 2013.

Table 2: Total Pollutant loads and reductions

Pollutant	Sources	Residual Load	Reduction %	Target Reduction %
Total Suspended Solids (kg/yr)	2870	465	83.8	80
Total Phosphorus (kg/yr)	6.11	2.3	62.4	60
Total Nitrogen (kg/yr)	45.1	23.4	48.5	45

Gross Pollutants (kg/yr)	381	0	100	90

4. MAINTENANCE AND MONITORING

If a water quantity or quality facility is to function well, it must be managed effectively. The procedures identified in this section aim to:

- Ensure that the proposed water management measures operate as designed and that the objectives are met;
- Extend the active lifespan of the provided facilities, delaying the need for a major refit or decommissioning;
- Allow owners to make informed decisions and ensure any future owners can effectively manage the facilities; and
- Save money by providing mechanisms through which problems such as blockages can be detected in the early stages.

The management of a water management facility such as a rainwater tank or on-site detention tank generally consists of three tasks:

1. Monitoring;
2. Inspection of screens, pipes, pits, etc.; and
3. Maintenance – Repairing damage to pits / structures and removal of sediment.

4.1 RAINWATER RE-USE TANKS

The properties at NEV are exempt from BASIX due to the recycled water scheme which will be providing recycled water to each property. However individual property owners can elect to put in place a rainwater tank as part of the future development of each lot.

The following information (Table 3) has been extracted from the 'Guidance on use of rainwater tanks' supplied by NSW EnHealth (2010). It outlines the potential health hazards, causes, preventative measures, monitoring and corrective action with respect to rainwater tanks which will be made available to future property owners.

Table 3: Sources of potential health hazards and preventive measures

Health hazard	Cause	Preventative measure	Monitoring	Corrective action
Faecal contamination from birds and small animals	Overhanging branches on roof	Prune tree branches. Install first flush device.	Check tree growth every six months. Check device after rainfall.	Prune branches. Empty contents of device after rainfall.
	Animal access to tank	Protect all inlets, overflows and other openings to prevent entry by small animals and birds.	Check access covers are kept closed. Check inlets, overflows and other openings every six months.	Repair gaps. Secure access cover. If animal access suspected disinfect tank using chlorine.
		Maintain integrity of tank roof and body to prevent access points.	Check structural integrity of tank.	If a dead animal is found, empty and clean tank. If this has to be delayed, remove animal remains and disinfect tank using chlorine.

Mosquitoes	Access to stored water	Protect all inlets, overflows and other openings with mosquito-proof mesh.	Inspect water for presence of larvae at least every six months (in northern areas of Australia this should be done more often).	Repair screening of inlets and openings to prevent access and if larvae are present, to prevent escape of mosquitoes. Treat tanks with a small amount of kerosene or medicinal paraffin.
Lead contamination	Lead based paints and primers on roofs	Do not collect rainwater from roofs painted with products containing high lead concentrations (for example, pre-1970s paint). When painting roof, check suitability with paint retailer.		
	Uncoated lead flashing on roofs	Paint existing material or use pre-coated products.	Inspect roof and gutters every six months.	Use coated lead flashing or alternative materials on new roofs. Paint existing uncoated flashing.
	Increased corrosion of metals due to low pH from long periods of contact between rainwater and leaves	Keep gutters clean. Install leaf protection devices on gutters.	Inspect gutters every six months.	Clean gutters. If large amounts of leaves are detected on regular inspections clean more often.
Chemical contaminants from tanks, pipework etc	Water standing in metal pipes overnight or longer periods	Use plastic pipes	Inspect plumbing to identify pipe materials	Flush pipes in the morning for long enough to bring new water from the tank (several minutes).

Sulfide/rotten egg/ sewage odours	Anaerobic growth in accumulated sediment at the bottom of tanks	Regularly clean tank to remove accumulated sediment.	Inspect tank every 2-3 years.	Clean tank if required. If cleaning not practical (for example, in the middle of summer) disinfect tank with chlorine and flush chlorinated water through all pipework. If practical, pumping air into the tank, to add oxygen to the water, may also help to minimise tastes and odours.
	Slimes and stagnant water in pipe work	Avoid u-bends or underground pipework that can hold stagnant water. Install drainage points on buried pipe work.		
Musty or vegetable type taste and odours (no light penetration)	Accumulated material on roofs and gutters. May possibly include pollen	Remove overhanging branches from trees. Keep gutters clean. Install leaf protection devices on gutters.	Inspect gutters at least every six months.	Clean gutters. If large amounts of leaves (or pollen) are detected on regular inspections clean more often. If practical, pumping air into the tank, to add oxygen to the water, may also help to minimise tastes and odours.
Coloured water	Accumulated damp leaves in gutter	Keep gutters clean. Install leaf protection devices on gutters.	Inspect gutters at least every six months.	Clean gutters. If large amounts of leaves are detected on regular inspections clean more often.
Coloured water, particularly after rain (tiled roof)	Coloured coating from tiles washed into tanks. Re-suspension from sediments when fresh intake	Use colour-through tiles.	Inspect water after rainfall.	Remove sediment by cleaning the tank.
Musty, vegetable or fishy type taste and odours (light penetration)	Algal growth due to light penetration into tank or pipe work	Make sure tank is completely roofed and is impervious to light.	Inspect water every six months.	Repair roof. If practical, pumping air into the tank, to add oxygen to the water, may also help to minimise the tastes and odours.
Insects/water boatmen etc.	Access to stored water	Protect all inlets, overflows and other openings with insect proof mesh.	Inspect water for presence of insects and/or larvae every six months.	Repair screening of inlets and openings to prevent further access. Use simple coarse filter to remove remaining insects.
Small white flakes in water	Microbial growth	Keep gutters clean. Growth encouraged by nutrients contained in plant and soil material accumulated in gutters or at the bottom of tanks. Install leaf protection devices on gutters	Inspect gutters at least every six months. Inspect tank every 2-3 years.	Clean gutters and tank if necessary. Disinfect tank using chlorine.

4.2 ON-SITE DETENTION

The function of OSD is to temporary store/ retard stormwater runoff and precipitation of sediments and other bound pollutants. To maintain the integrity of the structures, inspecting and remove/ cleaning out of litter, sediment and debris should be carried out.

The OSD should be inspected every month for the first six months after construction is completed and after high flood events and clean out if required. After six months reassess the inspection and clean out rate based on past experience. Anticipated rate every twelve months.

4.3 BIO-RETENTION BASINS

The function of the bio-retention basins/raingardens are treat stormwater runoff and precipitation of sediments and other bound pollutants. To maintain the integrity of the structures, inspecting and remove/ cleaning out of litter, sediment and debris should be carried out.

The bio retention basins should be inspected every month for the first six months after construction is completed and after high flood events and clean out if required. After six months reassess the inspection and clean out rate based on past experience. Anticipated rate every twelve months.

5. WASTEWATER

The approach for NEV is an integrated water management system which aim to minimise the environmental footprint of the potable water, stormwater and sewage systems throughout the village. To achieve this, NEV have obtained a water utility license under the *Water Industry Competition Act 2006* (WICA) and will own and operate its own wastewater infrastructure under NEV Water.

Stage 2 wastewater collection network aims to utilise existing topography to gravity drain the development into the Council owned sewer infrastructure on Research Rd (south east corner of the NEV site) as much as possible. Part of the Stage 2 development will drain back into Stage 1 wastewater infrastructure and into buffer tanks installed with Stage 1 for pump out to Council sewer infrastructure.

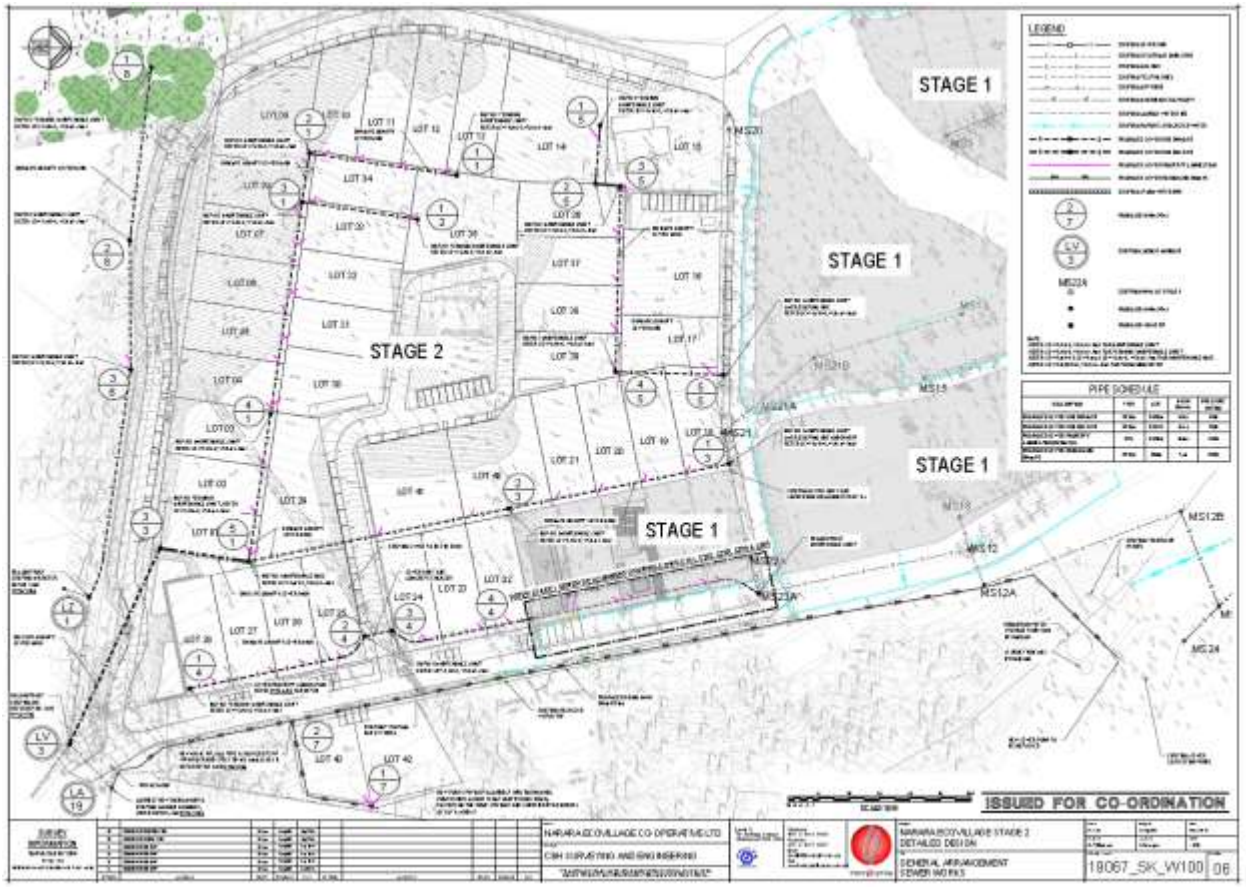

Figure 4 – Proposed sewer layout for Stage 2 of the development

5.1 WASTEWATER GENERATION AND MANAGEMENT

In accordance with the Wastewater Management Plan for Stage 2 of the development (Woodlots and Wetlands 2019), the estimated wastewater generation per dwelling is 100L/person/day. With an estimated 3 persons per dwelling/lot, the total wastewater generation from Stage 2 is around 12.9kL/day.

Seven lots within the Stage 2 subdivision (Lots 22-28) are proposed to be connected to the existing Stage 1 wastewater collection network that drains to existing underground tanks on the eastern border of the site. Wastewater will be pumped from these tanks via a rising main along Research Rd to Council infrastructure (manhole LA/19, refer drawing 19067_SK_W100) in accordance with a private pumping station approval from Central Coast Council. This approval is currently being sought. Lots 42 and 43 are proposed to incorporate their own pumping stations due to inability to gravity drain directly to Council sewer infrastructure. This pump station will discharge sewage from Lots 42 and 43 directly into the rising main leading to manhole LA/19. In addition, as part of Stage 2 wastewater collection, a new wastewater connection for the existing two lots located to the south west of the site has been proposed. This new collection network has been proposed to join the existing Council infrastructure at manhole LZ/1.

The remainder of Stage 2 lots will be gravity drained and discharged into Council infrastructure (manhole LV/3, refer drawing 19067_SK_W100). All of the collection network will be leak tight PE pipe and design flows have been calculated in accordance with the leak tight approach outlined in WSA 02-2002 Sewerage Code of Australia – Sydney Water Edition version 4.0 2017 (Water Services Association of Australia 2017). All sewers have been designed in accordance with relevant WSA codes including:

- WSA 02 – 2002 Sewerage Code of Australian – Sydney Water Edition version 4.0 (Water Services Association of Australia 2017)
- WSA 02 - 2014 Gravity Sewerage Code of Australia Version 3.1 (Water Services Association of Australia 2014)
- WSA 07 – 2007 Pressure Sewerage Code of Australia Version 1.1 (Water Services Association of Australia 2007)
- WSA 01 – 2004 Polyethylene Pipeline Code Version 3.1 (Water Services Association of Australia 2004)

Currently, a Section 305 application is being prepared for a water and sewer connection to Council's infrastructure. This will detail the design flows for each of the different points of connection and the details of the proposed pump station. It will also show the proposed staging of the development and the expected wastewater load at each stage to determine if and when augmentation of Council infrastructure is required.

The design flows for Stage 2 have been shown in Table 4.

Table 4: wastewater loads

Wastewater Loads	Vol (L/d)	Vol (ML/annum)
Stage 2 - Wastewater loads	12900	4.71

NEV Water provides all the wastewater, potable and recycled water services to the NEV site. NEV holds the Network Operator and Retail licenses under the NSW Water Industry Competition Act (WICA). Narara Ecovillage was granted the first community-owned water licence in NSW by NSW Minister for Energy and Utilities Don Harwin on the recommendation of the Independent Pricing and Regulatory Tribunal (IPART).

Accordingly, NEV will be the bulk supplier and network operator for all wastewater water within the site. and has an existing WICA license. However, as part of the initial WICA license, an on-site wastewater treatment system was proposed. This has now been abandoned with a connection to the Council wastewater infrastructure being the preferred solution. As such, NEV is in the process of updating its infrastructure operating plans relating to wastewater infrastructure on site.

6. POTABLE WATER SUPPLY

Stage 1 lots are currently serviced from a small Council connection to the east of the site via a 50mm Council potable line from Deane Street into an existing 30KL tank which is located next to the sewer infrastructure. The water is pumped with 3 x 5 L/S pumps which are inside the existing treatment shed to 3 x 150KL potable water distribution tanks at an elevation of approximately 80m AHD which supply potable water via gravity to the lots in Stage 1 and Stage 2. The water is rechlorinated at this point.

NEV are currently in the process of applying for Section 305 approval to connect to Council's water infrastructure near the entry of the site in Research Rd. This water connection is expected to service the full development and staging details will be provided in the Section 305 application.

The potable connection from Council infrastructure will connect to the existing 30kL tank and will be pumped to the potable water distribution tanks utilising the existing 3 x 5L/s pumps. The reticulation network to the Stage 2 lots including lots 42 and 43 is by gravity from these distribution tanks. All infrastructure within the site will be owned and operated by NEV Water and a bulk water supply (minus retail approach) will be negotiated with Council for the supply.

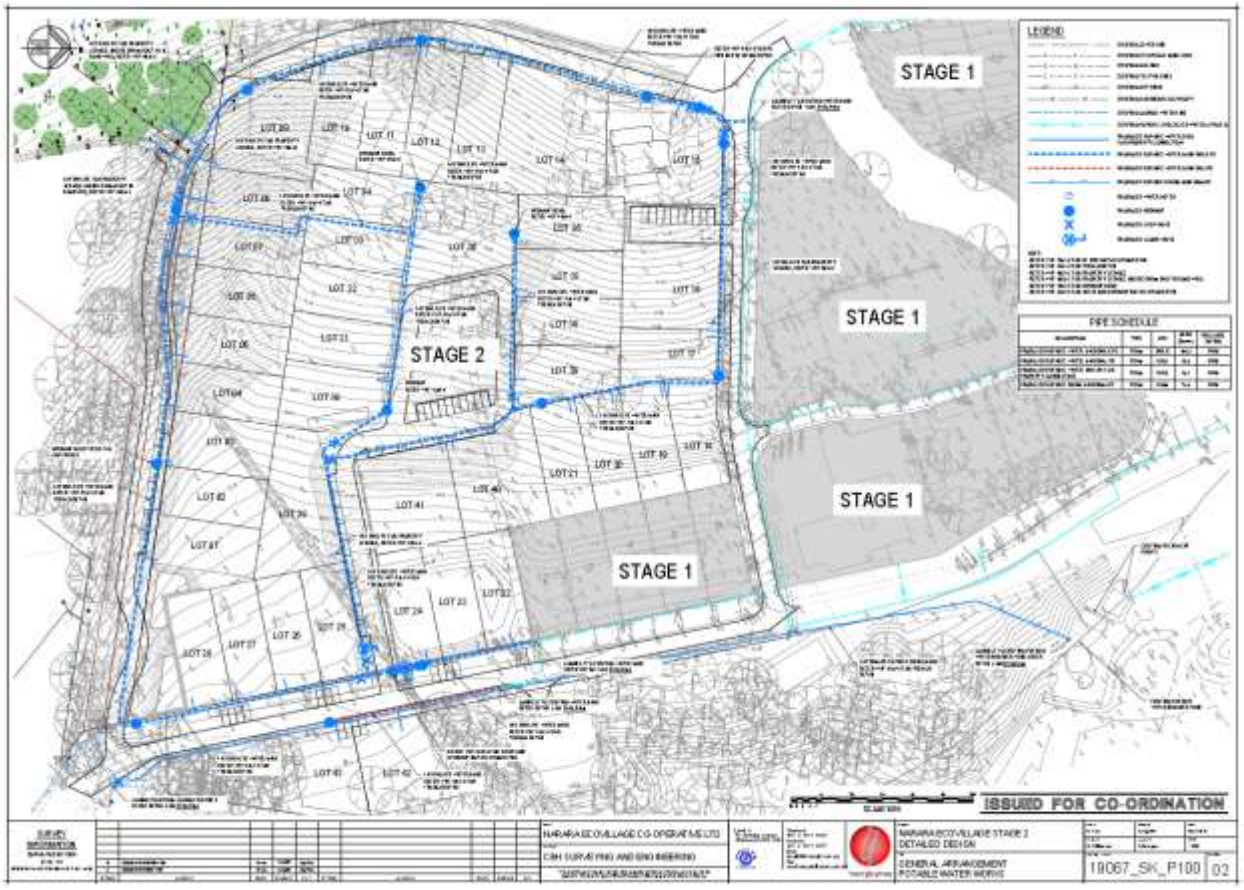

Figure 5 – Proposed potable water layout for Stage 2 of the development

6.1 POTABLE WATER DEMAND

The potable water demand has been estimated referring the Water System Planning Guideline (Sydney Water 2014) for single dwellings where the average daily potable water demand for each property is 500 L/dwelling/day for a dual reticulation system. Therefore, the whole development potable water demand estimate can be summarized below:

Table 5 Potable water usage calculation

Potable water usage estimation	**Estimated number of dwellings**	**Potable water usage (L/d)**	**Potable water usage (ML/year)**
Stage 2	43	21,500	7.85

The total storage capacity is 450kL, being comprised of 3 x 150KL tanks, allowing more than 15 days of supply with no inflow. NEV will apply for a connection from Council's main capable of providing 3L/s to the development which will be pumped to the header tanks via a break tank. Peak demands will be handled by the existing 450kL potable water header tanks.

As NEV strives to be water efficient, it is estimated that the potable demand figures used may be inflated. However, more conservative figures have been used for design purposes.

The potable water reticulation network has been designed by tapping in to the potable water network already built for Stage 1 of the development. A full scale hydraulic model was built using the demands outlined above and maximum peak hour demand in accordance with WSA 03 (Water Services Association 2011). The distribution network meets the requirements set out in Table 6 below.

Table 6 Potable water network design requirements

Item	Requirement	Code	Comments
Minimum pressure at property boundary	25m	Water System Planning Guideline (Sydney Water 2014)	Minimum pressure is met at the boundary of all properties
Scour valves	Low points at end of mains, low points between valves, maximum water main drainage time 1h between isolation points	Water Supply Code of Australia WSA 03—2011-3.1 Sydney Water Edition 2014	Concept design meets requirements
Isolation valves	Maximum valve spacing, location of valves for ease of maintenance, all sections of main to be able to be isolation, dewatered and charged	Water Supply Code of Australia WSA 03—2011-3.1 Sydney Water Edition 2014	Concept design meets requirements
Hydrants	Hydrant locations (high points and low points, ease of access, swabbing and flushing etc), spacing, between stop valves	Water Supply Code of Australia WSA 03—2011-3.1 Sydney Water Edition 2014, AS 2419.1:2017	Complies (hydrant spacing meets requirements under AS 2419 and Council rural areas requirements)
Hydrant pressure and flow	Min 10L/s and 150kPa	AS 2419.1:2017	Complies

7. RECYCLED WATER SUPPLY

The recycled water on site will be supplied by the NEV dam which is under an existing extraction licence (WAL 16886) from the NSW Office of Water . The dam water is proposed to be treated to a quality suitable for recycled water usage for toilet flushing and irrigation at each of the homes as per the Australian Guidelines for Water Recycling. In addition to potable water and sewer, all homes will have a third recycled water "purple pipe" plumbed into each property. The recycled water plant will have allowance for further treatment to allow the water to be used for laundry as well. However, as laundry usage is not currently part of the existing WICA license for recycled water supply within NEV, it will have to be negotiated with IPART prior to being implemented on site.

The system is proposed to have an offtake that takes the dam water and treats it through screening, media filters and UV and all backwash flows are proposed to drain into a proposed infiltration swale. Refer to Henry & Hymas drawings 19409_SK_C901 for a process overview. The water is then pumped to the existing 100 KL recycled water header tank that stores recycled water and treats it via chlorination and then sends it for distribution via the dual reticulation system at NEV. Stage 1 recycled water reticulation has already been installed and Stage 2 reticulation has been designed to connect to the existing Stage 1 reticulation. The proposed recycled water treatment plant is located near the existing dam.

As a control measure, a potable top up is proposed for filling up the 100KL header tank in case of insufficient dam storage, high demand, dry weather, shut down of the treatment rooms, etc so, it is ensured that the residents have guaranteed water available for laundry, toilet flushing and irrigation.

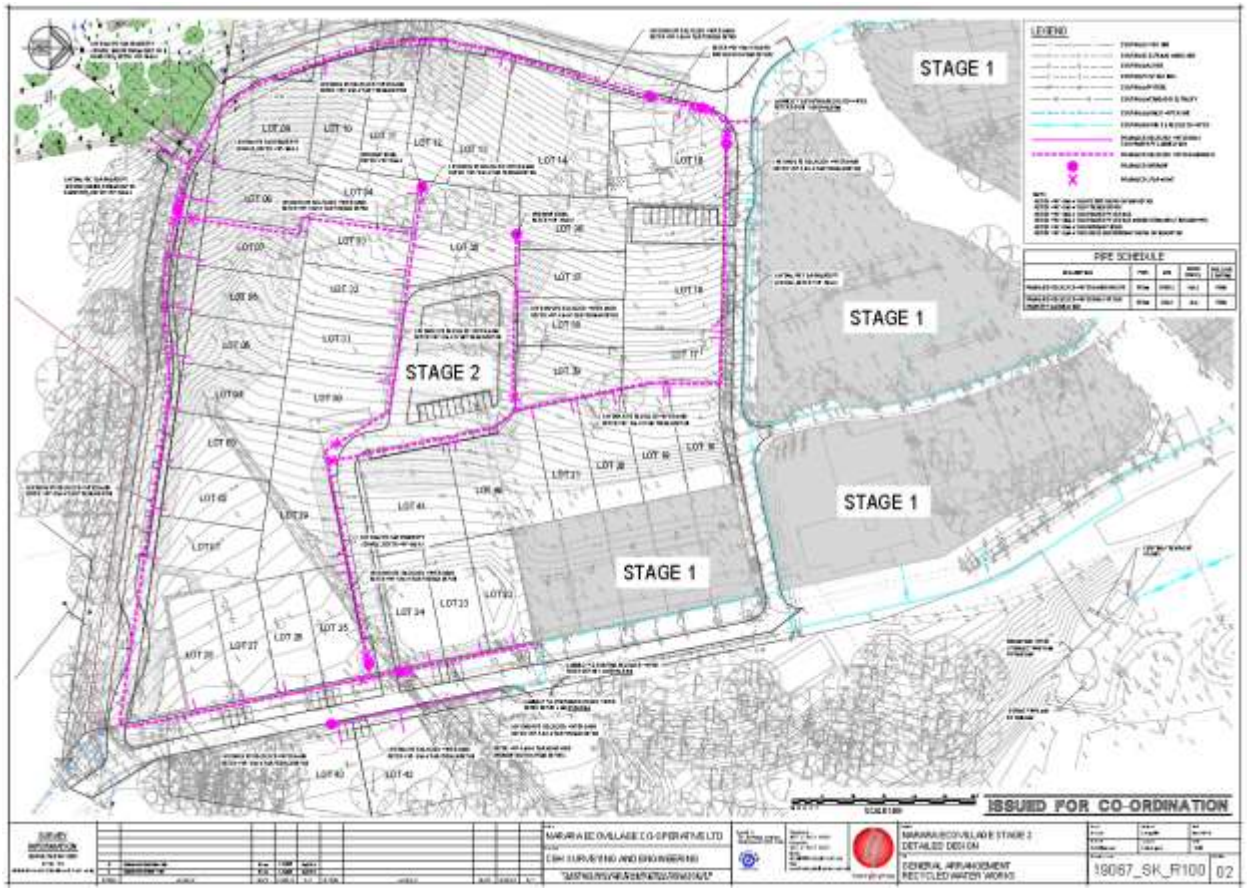

Figure 6 – Proposed recycled water layout for Stage 2 of the development

7.1 RECYCLED WATER DEMAND

Referring to Wastewater Management Plan (Woodlots and Wetlands 2019), the recycled water usage per day for laundry, irrigation and toilet flushing is estimated below:

Table 7 Estimated recycled water usage

Type of recycled water usage	L/dwelling/day
Toilet flushing	74
clothes washing	76
Irrigation around individual dwellings	147
Total	**297**

This is comparable to the Water System Planning Guideline (Sydney Water 2014) for single dwellings where the average daily recycled water demand for each property is 350 L/dwelling/day for a dual reticulation system.

Table 8 Stage 2 recycled water usage

Status	**Estimated number of dwellings**	**Recycled water usage (L/d)**	**Recycled water usage (ML/year)**
Stage 2	43	12,771	4,661

NEV Water will be the bulk supplier and network operator for all wastewater water within the site and the recycled water system will be managed via an Infrastructure Operating Plan, a Water Quality Management Plan, a Commissioning Plan and an Operation and Maintenance Manual.

The recycled water reticulation network has been designed by tapping in to the recycled water network already built for Stage 1 of the development. A full scale hydraulic model was built using the demands outlined above and maximum peak hour demand in accordance with WSA 03 (Water Services Association 2017) and Water System Planning Guideline (Sydney Water 2014). The distribution network meets the requirements set out in Table 9 below.

Table 9 Recycled water network design requirements

Item	Requirement	Code	Comments
Minimum pressure at property boundary	20m	Water System Planning Guideline (Sydney Water 2014)	Minimum pressure is met at the boundary of all properties
Scour valves	Low points at end of mains, low points between valves, maximum water main drainage time 1h between isolation points	Water Supply Code of Australia WSA 03—2011-3.1 Sydney Water Edition 2014	Concept design meets requirements
Isolation valves	Maximum valve spacing, location of valves for ease of	Water Supply Code of Australia WSA 03—2011-	Concept design meets requirements

	maintenance, all sections of main to be able to be isolation, dewatered and charged	3.1 Sydney Water Edition 2014	
Hydrants	Hydrant locations (high points and low points, ease of access, swabbing and flushing etc), spacing, between stop valves	Water Supply Code of Australia WSA 03—2011-3.1 Sydney Water Edition 2014, AS 2419.1:2017	Complies (hydrant spacing meets requirements under AS 2419 and Council rural areas requirements)
Hydrant pressure and flow	Min 10L/s and 150kPa	AS 2419.1:2017	Complies

8. CONCLUSION

This Water Cycle Management Plan demonstrates that under the proposed concept plans, all water elements from the proposed development will be able to be treated to acceptable levels in accordance with relevant legislation, the wastewater generated on site will be sent to the Council wastewater network, the potable will be supplied from the Council potable supply and the recycled water will be supplied entirely from the NEV dam under a WICA license.

The consideration of the proposed water cycle management demonstrates the viability of the proposed development, with regards to water cycle operations.

For and on behalf of:

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