Water Supply & Wastewater Design Report

Palmerston Island Cyclone Centre

PREPARED FOR INFRASTRUCTURE COOK ISLANDS

QUALITY ASSURANCE STATEMENT

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ISSUE	DATE	ISSUE DETAILS	AUTHOR	CHECKED	APPROVED
0	29/09/17	Issued for Comment	JT	SRG	SRG

710471 – Palmerston Island Cyclone Shelter

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Executive Summary

A new cyclone centre is proposed for Palmerston Island in the Cook Islands, to shelter the residents and visitors in the case of an extreme storm event. The structure has been designed to shelter up to 80 persons at a time, with offices expected to be used by up to 5 persons day to day. A water supply and wastewater solution has been designed for the shelter, with water supplied through a rainwater harvesting system, and wastewater managed by re-sue of an existing septic tank nearby the shelter, discharging treated effluent to a subsoil drainage trench.

1 Introduction

Palmerston Island, part of the Cook Islands in the South Pacific is a coral atoll with approximately 65 residents, accessible only by boat. The island experiences intense tropical storms and cyclones and currently has limited shelter for persons on the island during one of these events. Infrastructure Cook Islands proposes to build a new Cyclone Centre for the island to house residents and any visitors in the case of an extreme storm event.

1.1 Purpose of Report

The purpose of this report is to outline the design of Water Supply and Wastewater Disposal for the proposed Palmerston Cyclone Shelter. It is intended to be read in conjunction with the Civil Design Drawings.

2 Water Supply

Potable water is proposed to be supplied to the shelter by a rainwater harvesting system. Roof runoff will be directed to storage tanks located on the side of the building.

2.1 Water Supply Requirements

The cyclone shelter is expected to be used by up to 5 persons a day, however during extreme storm events, the shelter is designed to be occupied by up to 80 persons for a period of 3-5 days. Therefore the building will need to have a permanent supply of water suitable to adequately supply these persons for 3-5 days. Although it might generally be expected that the tanks will re-fill during a storm event, it will be conservatively assumed no inflow occurs during a storm event in case of damage to roof gutters/collection systems.

Assuming an extremely low water use scenario during an extreme storm event of 50 litres per person per day, water supply required for 80 persons for a period of 5 days gives:

Extreme event water supply volume = 5 days x 50l/p/day x 80 persons = 20,000 litres

The standard daily water demand for the building has been calculated based on a low water use scenario of 40l/person/day as the building is only expected to be used for office purposes during the day.

Standard Daily Water Demand = 40l/p/day x 5 persons = 200l/day

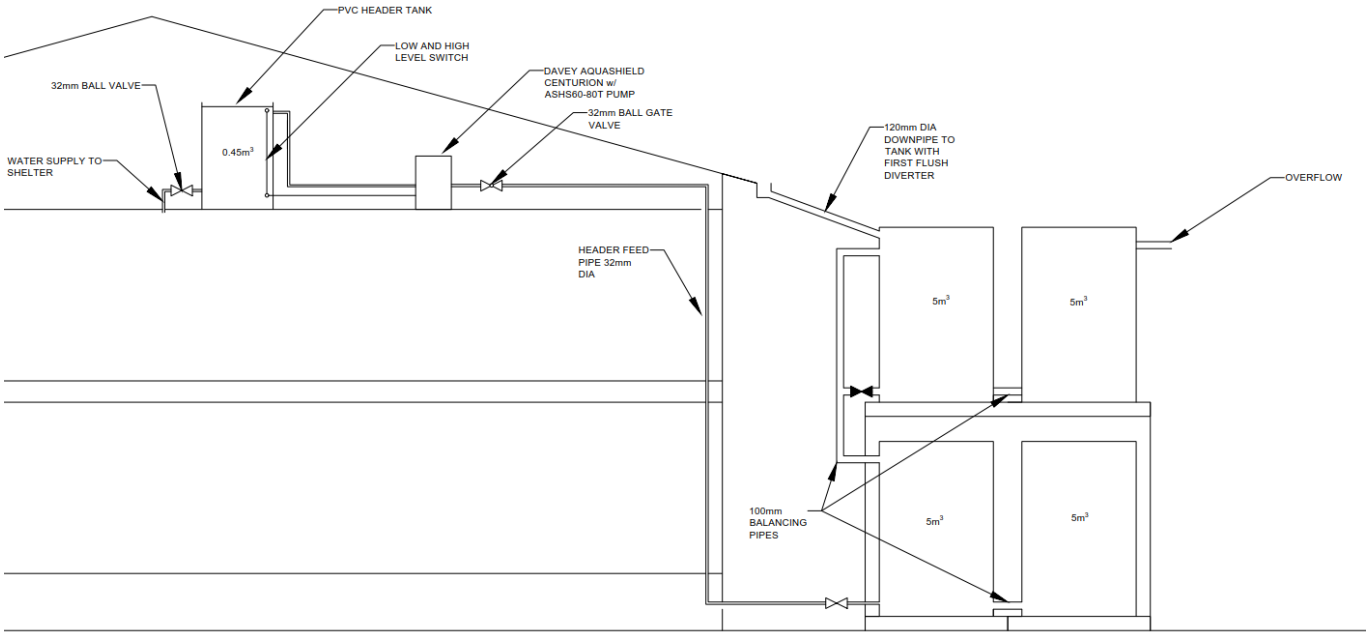
2.2 Water Reticulation System configuration

The system will be fed by rainwater runoff being collected and draining to four balanced 5000 litre storage tanks, with an overflow pipe allowing discharge to ground when full.

Potable water will then be pumped through a Davey Aquashield Centurion system, with a HS60-08T Pump, which will supply the 450 litre header tank located in the roof of the shelter, which subsequently supplies the building. A high and low level switch in the tank will be used to control the pump fill the header tank as required.

In case of power failure during an extreme storm event, the header tank will be able to continue to supply the building through gravity, though pressure and flow rate will be significantly reduced. The lower storage tanks will also be able to be used, to supply water from the lower level of the building. A diesel generator is expected to be available which should alleviate risk of system failure during a storm event.

Figure 1 - Water Supply Schematic Sketch



2.3 Water Treatment

The Davey Aquashield Centurion system consists of a three stage treatment system with UV filtration, and coarse and fine filters. This system is designed for rainwater harvesting purposes and is expected to provide an adequate level of treatment. These components will require maintenance with filters and UV lamp requiring replacing at regular intervals to ensure continued level of service of the system. Refer to the attached ‘Installation and Maintenance Manuals’ for maintenance requirements.

3 Wastewater

Wastewater generated from the Cyclone Centre is proposed to be drained from the building to the existing Health Centre septic tank system, located nearby. This tank will need to be extended to provide the required capacity to provide primary and secondary treatment to the wastewater, before being discharged to the existing subsoil drainage trench.

3.1 System Design

Standards used for assessment of existing and design of the new wastewater system:

1. AS/NZS 1456.1:2008 – On-site domestic wastewater treatment units. Part 1: Septic tanks
2. Auckland Council Technical Publication No. 58 (TP 58) – On-site Wastewater Systems: Design and Management Manual

3.2 Flow Estimates

The cyclone shelter is expected to be used by up to 5 persons per day on a regular basis, however in the occurrence of a cyclone or similar natural disaster, the shelter is designed to house up to 80 persons at any one time for up to 24 hours.

Auckland Councils TP58 document has been used to determine an estimate of the wastewater design flow for the day to day 5 person use scenario.

An average daily flow of 40 litres per person per day (l/p/day) is recommended by TP58 for a standard facility with day staff only. This flow is likely conservative given the undeveloped status of the island.

A 20% factor of safety has then been applied to allow a buffer capacity for pulse flows.

Standard Use Daily Flow = 40 l/p/day x 5 persons x 1.2 = 240 l/day

The shelter is also expected to be used periodically for gatherings and meetings. Based on an average island population of 55 persons, and Auckland Councils TP58 guidance document recommending a flow of 20 litres per person for a community gathering/banqueting the flow rate for this scenario is below.

Peak Daily Flow = 20l/person/day x 55 persons x 1.2 = 1320 l/day.

Average Daily Flow has been calculated assuming an event use of the building of twice per month.

Average Daily Flow (ADF) = ((1320l/day x 1) + (240l/day x 14))/14 = 334 l/day

During an extreme cyclone event, the structure will be designed to house up to 80 persons for a 3-5 day period. The extreme event flow expected is based on an extremely low water use scenario of 40l/p/day. This flow rate will only be practicable with extreme water conservation measures, allowing for toilet flushing and drinking and food preparation water supply only.

Extreme Event Daily Flow = 40 l/p/d x 80 persons = 3400 litres/day

3.2.1 Health Centre Flow Estimates

The adjacent health centre is a single bed facility. Design flow rates have been determined based the TP58 recommendations for a hospital of 220l/person/day. As the health centre is not expected to be occupied at all times, a 0.5 factor has been applied.

Average Daily Flow (ADF) = 220l/p/day x 0.5 = 110l/day

3.3 Septic Tank Capacity

Benefits of a larger tank will generally outweigh the additional costs due to their increased capacity for solids storage allowing the tank to be pumped out less regularly, which in turn allows more effective biodegradation processes to occur, as a microbiome necessary for full biodegradation typically takes up to 2-3 years to become fully established. On Palmerston Island where pumping out of the tanks will likely be more difficult due to the small population, it will be beneficial to increase time between pumping out of the tank.

For the purposes of these calculations we have assumed a 7 year pump out period.

TP58 gives a sludge accumulation volume of 80 litres/person/year. As the facility will only be occupied during the day, and is not likely to be occupied every day, a reduced sludge volume of 40 l/p/year has been used, with sludge accumulation based on the average daily use of 5 persons. As the extreme storm events are expected to be rare, the sludge accumulation from periods where the shelter is in full use has been assumed to be negligible. Sludge accumulation for the Health Centre has been included also.

The calculations below shows the minimum tank settling volume required.

Sludge Accumulation Volume = 40 l/p/year x 6 persons x 7 = 1680 litres per year

The minimum tank capacity required to ensure a minimum of 24 hour retention time based on the extreme event daily flow is therefore:

Tank Capacity = 3400 + 110 + 1680 = 5190 litres

This volume allows for a 24 hour retention time with 1680 litres of sludge accumulation after 7 years, at which point the tank will need to be pumped out.

3.4 Septic Tank Configuration

It is proposed that the existing septic tank for the adjacent Health Centre be repurposed to cater to the requirements of the Cyclone Centre. The existing tank consists of approximately 3.4m^3 capacity settling chamber and a 1.9m^3 outlet chamber. The tank is believed to have an effluent filter fitted.

To provide the required 5.19m^3 capacity required for the Cyclone Centre and existing Health Centre, the existing settling chamber should be extended and the existing effluent filter should be replaced.

3.5 System Schematic and Configuration

A new tank is proposed to be installed in-line with the existing tank to extend capacity. The proposed tank will need to provide approximately at minimum 1.7m^3 of storage. To provide this a 2.1m^3 Devan Plastic Septic Tank (or similar) is proposed. Balancing pipes will be required to ensure the tank is not short-circuited, which may reduce the effective sludge settling volume. Two 200mm PVC pipes will allow sludge passage, while a third at the existing inlet level will allow suitable flow through the tank. The new chamber will require a new 100mm inlet and access chamber.

As it is possible the new chamber will fill with sludge earlier or the balancing pipes blocking than the existing tank, it is recommended that the tank be pumped out on a more regular basis of between 3-5 years.

Figure 2 below shows the proposed extension of the septic Tank.

Figure 2 - Septic Tank Schematic

3.6 Effluent Disposal

Effluent is proposed to be disposed of via the existing subsoil drainage trench.

Disposal area required has been calculated as per Auckland Councils TP58 document.

A design loading rate has been assumed for a Category 3 soil type (Medium-fine and Loamy sand – well drained), and the effluent flow rate uses the average daily flow for the building. A Factor of Safety of 1.5 has been applied.

Design Loading = 20 mm/day

Volume per day (ADF) = 334 litres/day + 110 litres/day = 444 litres/day

Area required = 0.444m^3/day / 0.02m/day x 1.5 (F.o.S) = 33.3m^2

The existing drainage trench has a surface area of 32m^2 and is therefore considered suitable for the design volume discharged.

When the cyclone centre is in full use and flows generated are significantly greater than the design volume, it is proposed the perforated drainage pipe be extended to an overflow outlet to allow discharge to either a trench or depression, or the existing swamp to the North of the cyclone centre. The outlet should be graded upwards at a very low grade (< 1%), however the outlet should be lower than the top elevation of the existing tank. It is anticipated that this overflow will only be required during an extreme storm event, when the building is in full use. In this circumstance, it is expected that overflows will be heavily diluted by rainfall runoff, flooding and storm surges, with health risks due to any exposure negligible.

A schematic of this provided below in Figure 3. An indicative site plan is provided in Figure 4

Figure 3 - Effluent Disposal Schematic

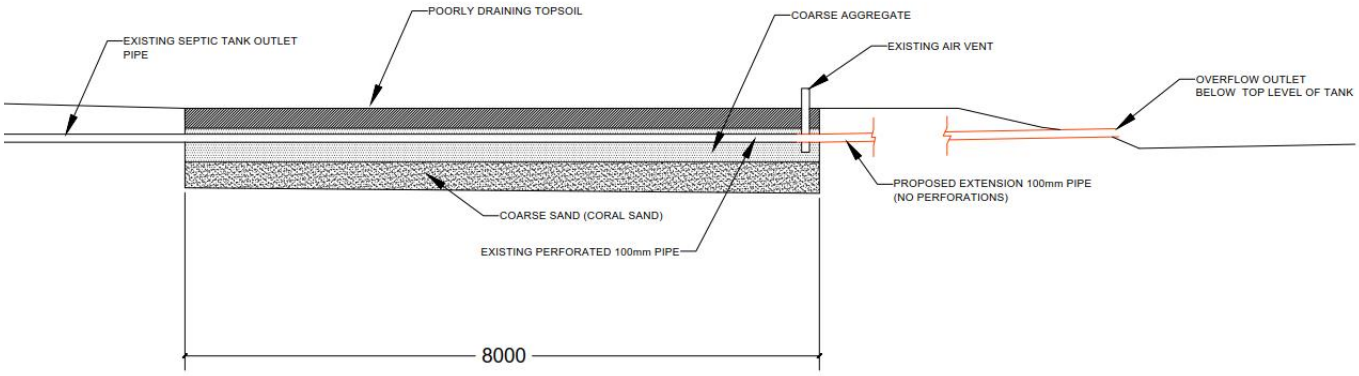
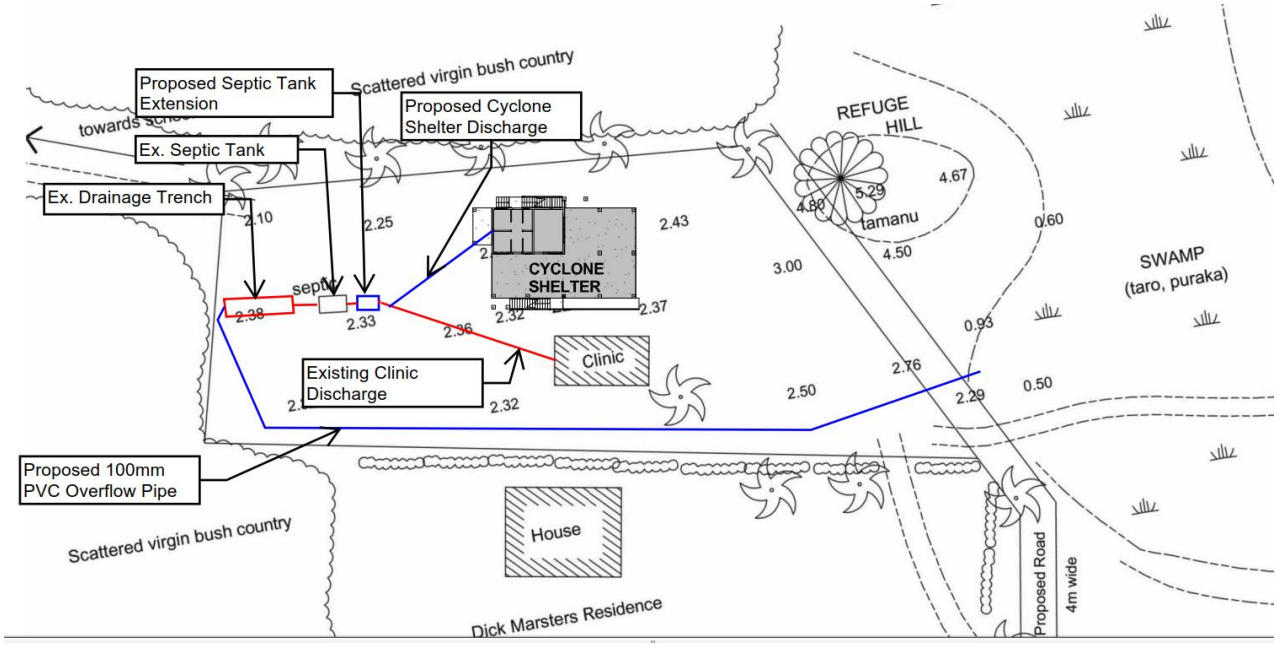


Figure 4 - Indicative Wastewater System Layout



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