Government of Tuvalu

Pacific Community (SPC)

ASSESSMENT REPORT: EXISTING DESALINATION UNITS IN TUVALU

November 2020

List of Abbreviations

ADB	Asian Development Bank
AUD	Australian Dollar
EU	European Union
FSM	Federated States of Micronesia
GCCA+SUPA	Global Climate Change Alliance Plus Scaling Up Pacific Adaptation
KRA	Key Result Area
PDD	Project Design Document
PEC	Pacific Environment Community
PRF	Project Readiness Financing
PWD	Public Works Department (Tuvalu)
RMI	Republic of the Marshall Islands
RO	Reverse Osmosis
SPC	Pacific Community
SPREP	Secretariat of the Pacific Regional Environment Programme
USD	United States Dollar
USP	University of the South Pacific

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1. Introduction:

This report provides findings from a rapid assessment study on existing Reverse Osmosis (RO) Units in Tuvalu and is prepared under the Global Climate Change Alliance (GCCA+) Scaling Up Pacific Adaptation (SUPA) project. The assessment aims to identify and document specifications of the existing RO units, their technical and operational capacity, their running and maintenance costs and performance. This activity covers Tuvalu's Key Result Area (KRA) 1.1, as outlined in the country's Project Design Document (PDD).

The GCCA+ SUPA project is about scaling up climate change adaptation measures in specific sectors supported by knowledge management and capacity building. The 4.5-year project (2019 – 2023) is funded with EUR14.89 million from the European Union (EU) and implemented by the Pacific Community (SPC) in partnership with the Secretariat of the Pacific Regional Environment Programme (SPREP) and The University of the South Pacific (USP) in collaboration with the governments and peoples of Cook Islands, Federated States of Micronesia (FSM), Fiji, Kiribati, Republic of the Marshall Islands (RMI), Nauru, Niue, Palau, Tonga and Tuvalu. The overall objective is to enhance climate change adaptation and resilience within ten Pacific Island countries. The specific objective is to strengthen the implementation of sector-based, but integrated, climate change and disaster risk management strategies and plans.

The government of Tuvalu selected water as their focus sector for the GCCA+SUPA project. The overall objective is to strengthen water security in Funafuti Island communities through the improvement of water catchment and access to water. The specific objective is improved supply, storage and distribution of potable water to communities and schools in Funafuti Island. The project has four key result areas: (1) Purchasing of a portable, solar powered, desalination plant; (2) Refurbishing of the water systems in Nauti Primary and SDA Primary School; (3) Procuring of a 10,000 Liter water truck; and (4) National coordination of the project activities.

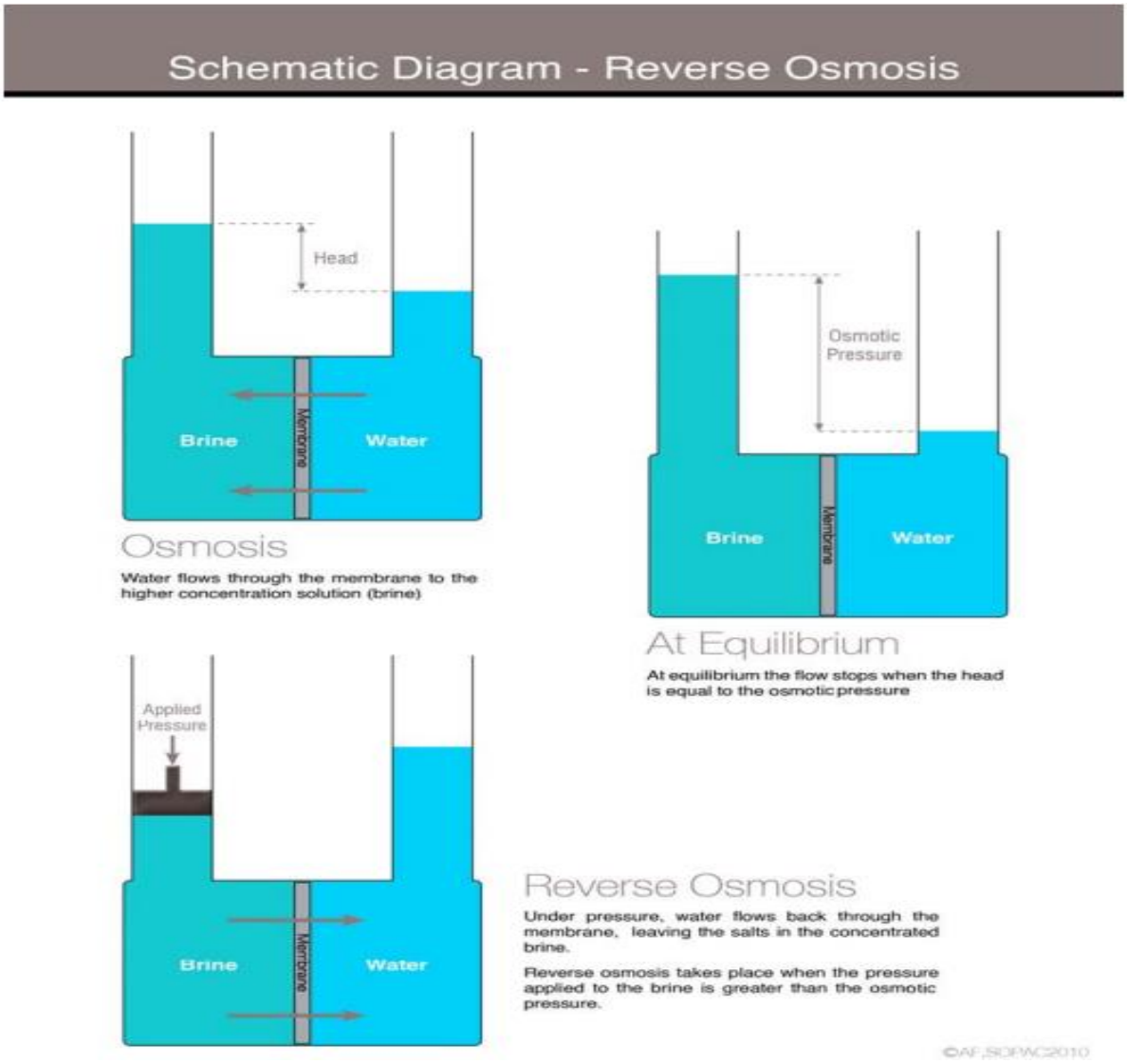
These activities have been designed as immediate water security measures that can be implemented within the project's 2020-2023 timeframe. As such they fit within the scope of a large-scale project funded by the Asian Development Bank to strengthen the water and sanitation sector in Tuvalu over the period 2020 to 2023 with its ensuing phase scheduled for approval in 2022. (Refer to Section 3 of this report for more details)

Tuvalu recognizes Reverse Osmosis (RO) or Desalination technology as a priority need to address water scarcity in the country. As such, Tuvalu since the late 1990s has depended on RO units to supply freshwater for its communities. With the groundwater classified as non-potable in most islands, freshwater supply is scarce in Tuvalu. RO units were initially introduced as a back-up supply system for freshwater, particularly in times of dry spells. However, this has changed, and RO units have now become a primary source of freshwater supply for communities, schools and government facilities. Desalinated water is transported to water storage systems such as community cisterns and rainwater tanks via a water truck.

2. Reverse Osmosis – the process:

Osmosis is the spontaneous diffusion of water or other solvent molecules through a semipermeable membrane. Water on either side of the membrane can diffuse and move in the direction towards a higher concentrated solution, diluting it until the two sides have equalised or until the pressure inside the cell is enough to prevent further water diffusing through. This pressure is called osmotic pressure. Man-made semi permeable membranes have similar properties. By applying a pressure greater than

the osmotic pressure of the membrane, water can be forced from the side of high salt concentration to low. This is reverse osmosis (RO) and is the principle used in reverse osmosis desalination technology. Pressure is applied to force a brine solution through a semi permeable membrane, retaining the more concentrated brine on one side and allowing only pure water through. RO typically requires considerably less energy than thermal distillation and is rapidly becoming the desalination and water purification technology of choice, overtaking thermal processes in the market. Regardless, the process remains energy intensive, due to the high pressures that are required to force the water through the filter membrane. The schematic diagram below illustrates the processes of reverse osmosis.



3. Upcoming Water Security Projects:

The Government of Tuvalu recently signed a US$13 million project with the Asian Development Bank (ADB) on strengthening the water and sanitation sector in Tuvalu. The project, designed in two phases, comprises of a project readiness financing (PRF) phase valued at US$4 million and an ensuing project with an indicative cost of US$9 million.

The PRF implementation timeframe is 2020 – 2023 and is focused on setting up important enabling environment to ensure the ensuing projects are efficiently delivered and produce effective outcomes. It contains two key outputs: Output 1 *"Enabling environment for the ensuing investment project created"* and Output 2 *"Investment scope identified, and detailed engineering design completed"*. One proposed enabling activity under Output 1 is the establishment of a centralized water authority in Tuvalu. Currently water management is spread across a number of portfolios and a centralized authority is envisaged to improve water management.

Outputs for the ensuing project phase will be determined and confirmed in the implementation of the PRF however, a new RO unit is tentatively planned under the ensuing phase scheduled for approval in 2022.

Other projects focusing directly on strengthening the water sector in Tuvalu are the Vaitupu Water Security Project and the regional project on Reducing Water Scarcity. Both projects are funded by the Government of New Zealand (Ministry of Foreign Affairs and Trade) and implemented SPC in partnership with the government of Tuvalu for the Vaitupu and Water Security Project, and with the government of Cook Islands, Kiribati, Republic of the Marshall Islands, Tokelau and Tuvalu for the regional Reducing Water Scarcity Project.

The Vaitupu Water Security project (2020 - 2022) will focus on the construction of infrastructure to improve groundwater resource management. Vaitupu island is one of the three raised islands in Tuvalu. Key activities include the construction of a groundwater infiltration gallery, pumping facilities, water storage facilities, construction of pipelines to connect water from water reserves to the urban centre, construction of a filling station and the rehabilitation of freshwater ponds.

The Reducing Water Scarcity project (2020 – 2023) is a regional project working across five atoll nations namely Cook Islands, Kiribati, the Republic of the Marshall Islands, Tokelau and Tuvalu. It aims to improve resilience of island communities to water scarcity through improved water management. For Tuvalu, project activities will be decided in quarter one of 2021 but focus will be on the outer islands.

4. Findings:

4.1 Existing RO Plants and their Conditions

Desalination was originally reserved for emergency use in Tuvalu but is now used as one of the primary sources of fresh water, especially in Funafuti.

Table 1 lists the RO plants existing in Tuvalu, their locations and conditions. As described in the table, there are only two RO plants that are fully operational - one 10m3/day RO plant and one 100m3/day plant. The existing operational plants are insufficient to meet the water demand of the country. From the two plants, one is categorized portable and can be deployed to outer islands in case of drought or in water emergency crisis. Again, this is inadequate to supply efficient freshwater supply to the nine islands of Tuvalu.

Currently there is a new 300m^3/day RO unit purchased by the Government of Tuvalu and stored in Funafuti waiting to be installed. The installation is pending technical assistance from the RO supplier, Suez Company. Once this assistance is acquired, installation of the unit will commence in Funafuti.

In the past, two smaller plants were also installed in other parts of the group, Vaitupu and Nanumaga (both 30 m^3/d). These plants were donated by the Japanese Government as a measure to counter the water shortage problem during the state of emergency proclaimed in August 1999. Due to the lack of skills available on these outer islands, the plants were not maintained, as a result the plants are currently beyond repair.

Figure 1: 100m3/day Desalination Unit in Funafuti

Table 1: Existing RO Units in Tuvalu

Desalination Plant	Year Installed	Donor	Supplier / Manufacturer	Quantity	Status	Location	Remarks
10m3/day	2011	PEC Fund	Hitachi	3	1 still operational 2 broken-down /mechanical failure	Nanumea/Nanumaga/Vaitupu	Portable desalination plant only use on outer islands, when emergency water supplies is required.
100m3/day	2010	PEC Fund	Hitachi	1	Operational	Funafuti	Operate 24/7 and will shut down only when: • Heavy rain • 90% of the total volume of the Government water reservoir is filled.
65m3/day	2009	Japan Government	Water boy	1	Broken-down/mechanical failure	Funafuti	The RO broke-down since 2010, and it has been replaced with the 100m3/day RO.
50m3/day	1999	Hitachi Company, Japan	Water boy	1	Broken-down /mechanical failure	Funafuti	The RO broke-down since 2018, and it is irreparable.

4.2 Operations, Maintenance and Performance.

The RO units are operated and maintained by Tuvalu's Public Works Department (PWD).

Presently, the functional 100m3/day desalination plant is serving the entire Funafuti. The plant is operated 24 hours a day and desalinated water is delivered to households via a water tanker. The usual delivery capacity rate is 2,000 litres per delivery. Funafuti has a population of approximately 6,716 (2017 Census) with 849 households spread across nine main villages and three adjacent islets. The existing capacity of the delivery tanker is 10,000 litres, allowing a practical number of approximately 5 households to be supplied per delivery trip. This means the total number of households that can be supplied in a day is 30. However, the actual logistics which involves water production, loading and delivery allows an estimate of 16 to 20 houses to be supplied in each 18-hour period. Additionally, a tanker down-time of 6 hours is required to allow for desalinated water to accumulate in holding tanks. This down-time helps ensure deliveries do not outpace production.

Water delivery is a charged service and the public is charged at AU$13.00 per 500 gallons. The operational cost of the existing operational RO units is estimated at US$100,000 - $150,000 with a maintenance cost at AU$19,000 annually. So, to enable the Government of Tuvalu to cover running and maintenance costs of the existing RO units, the full cost of water delivery needs to be charged at AU$86.00 per 1000 gallons. The Government of Tuvalu is presently subsidizing the difference in cost.

There are only two water trucks in Tuvalu that transport desalinated water from RO plants to consumers. This is inadequate and the PWD requires at least 2 more 10,000 litres water trucks to meet delivery demands. Any extra desalination capacity would not significantly increase the efficiency of supplying water to the community without increased transport capacity. This is an important point that illustrates the significant additional capital and operational costs associated with the distribution of desalinated water.

4.3 Outer Islands

The RO units are mobilized to outer islands in times of water shortage. During the 1999 drought, two 30m^3/day RO Units were deployed to Vaitupu and Nanumanga islands to counter the water shortage experienced during the drought. The units were donated by the Government of Japan and managed by the PWD in Funafuti.

Presently, 3 units remain in the outer islands (Nanumea, Nanumanga and Vaitupu) as shown in Table 1 however, two have broken down. Unlike Funafuti, RO units in the outer islands are only used to supply back-up potable water in times of water crisis. Communities in the outer islands often rely on rainwater for their primary supply of freshwater.

5. Recommendation

Based on this assessment and as the key body responsible for overseeing, implementing and managing Tuvalu's infrastructure (including water), the PWD recommends a new 20m3/day desalination plant for the Government of Tuvalu. The proposed plant will be very useful in increasing the supply of clean drinking water to the communities of Funafuti during normal rainfall conditions as well as to the outer island communities during droughts. The plant is to be operated and used in Funafuti together with the two existing plants (100m3/day and 10m3/day) and the soon to be commissioned 300m3 plant, and to be deployed to outer islands in times of water emergencies. The RO plant operators from PWD, Funafuti, will be the responsible operators for the proposed 20m3/day plant when deployed to the outer islands.