Rous County Council
Desalination Investigation

Rous County Council

Investigation Report Number: 1364-IR-001

Rev 0

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1. Glossary of Terms

Abbreviations	
ADD	Average Day Demand
ADWG	Australian Drinking Water Guidelines
BW	Brackish Water
BWRO	Brackish Water Reverse Osmosis
CAPEX	Capital Expenditure
CDI	Capacitive Deionisation
CIP	Clean in Place
CPI	Consumer Price Index
CZMP	Coastal Zone Management Plan
HPB	Hydraulic Pressure Booster
HCl	Hydrochloric Acid
DWEER	Dual Work Exchanger Energy Recovery
DMF	Dual Media Filtration
EDR	Electrodialysis Reversal
EDTA	Ethylenediaminetetraacetic acid
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
FTE	Full Time Equivalent
EPL	Environmental Protection Licence
EIS	Environmental Impact Statement
HDD	Horizontally Directional Drilling
GMF	Granular Media Filtration
IBC	Itemised Bulk Container
IX	Ion Exchange
NPV	Net Present Value

Abbreviations

MCDI	Membrane Assisted Capacitive Deionisation
MCA	Multi Criteria Analysis
MF	Micro Filtration
MLD	Mega Litres per Day
MMF	Multimedia Filtration
NCCARF	National Climate Change Adaptation Research Facility
NF	Nanofiltration
NSW	New South Wales
OPEX	Operation Expenditure
PDD	Peak Day Demand
RO	Reverse Osmosis
RCC	Rous County Council
SBS	Sodium Bisulphite
SW	Seawater
SWRO	Seawater Reverse Osmosis
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
TSP	Trisodium phosphate
UF	Ultra-Filtration
LSI	Langelier Saturation Index
CCPP	Calcium Carbonate Precipitation Potential
SCCRWP	Southern California Coastal Water Research Project

2. Executive Summary

Rous County Council (RCC) has engaged GANDEN Engineers and Project Managers (GANDEN) to undertake a feasibility level proof of concept assessment for the provision of a desalination plant as a future water supply augmentation option for the region. The desalination plant would be responsible for the production of up to 10 mega litres per day (MLD), augmenting the Rous regional bulk water supply system.

The scope of the works for the assessment included: -

1. Review of previous options reports and investigation works, including assessment and confirmation that information and recommendations remain valid;
2. Confirmation of the required output and capacity of the desalination plant to supplement the regional bulk water supply;
3. Identification and assessment of potential locations of the desalination plant, to ensure that the plant is located with consideration to: -
    a. Network connectivity, and whether the location can tie into the existing network with minimal construction works (i.e. minimise length of pipelines required to connect by prioritising proximity to existing bulk supply mains),
    b. Pumping power, by locating the plant in proximity to an area of high demand and future growth to prevent reduce pumping power requirements; and
    c. Minimising disruption to community, environment, and aboriginal and cultural heritage.
4. Assessment of the various desalination technologies, plant intake and outlet structures using a Multi Criteria Analysis (MCA);
5. Development of a concept design layout;
6. Development and assessment of cost estimates for the preferred option including: -
    a. Capital Expenditure (CAPEX),
    b. Operational Expenditure (OPEX), and
    c. Whole of Life costs (Net Present Value (NPV) assessment); and
7. Benchmarking against similar desalination plants within Australia.

A summary of the assessment, outcomes and recommendations are provided within the sections below. For technical details and further supporting information, refer to the relevant sections within the body of the report and referenced appendices.

2.1 Proposed Site Location

Three (3) locations were identified for assessment. The locations were selected based on information provided in previous reports and in consultation with Rous County Council.

The locations assessed included: -

1. Byron Bay;
2. South Ballina; and
3. Lennox Head.

The site assessment was undertaken as a desktop study based on data provided by RCC and supplemented by data available online. The assessment considered site location, Aboriginal and Cultural heritage, social, economic and environmental impacts including coastal geological and sediment conditions, network connectivity and augmentation.

Note that only a single relatively large-scale facility has been considered. Two or even multiple facilities have not been considered further as this option is not considered economically or socially viable.

The preferred location for the plant was identified to be within the Byron Bay area. The proposed plant site is located on the parcel of land adjacent to the existing Sewage Treatment Plant (STP) due to the following advantages: -

- Provides minimal disruption to the wider community in a location unlikely identified for expansion;
- Easily accessible, located adjacent to existing Council assets and provides access to the wider water reticulation network and electricity networks;
- Provide redundancy for a large section of coastal water network through interconnectivity;
- Located to service growth area of Byron Bay, servicing Suffolk Park, Byron Bay, Ocean Shores, Brunswick Head and Bangalow;
- Current combined population in the area is 34,574 with a current drinking water demand of 8.4MLD; and
- Future demand projected to grow to 11MLD by 2036 (Population 44,770).

Note: further assessment of network integration and electrical headworks to be undertaken during the further design stages.

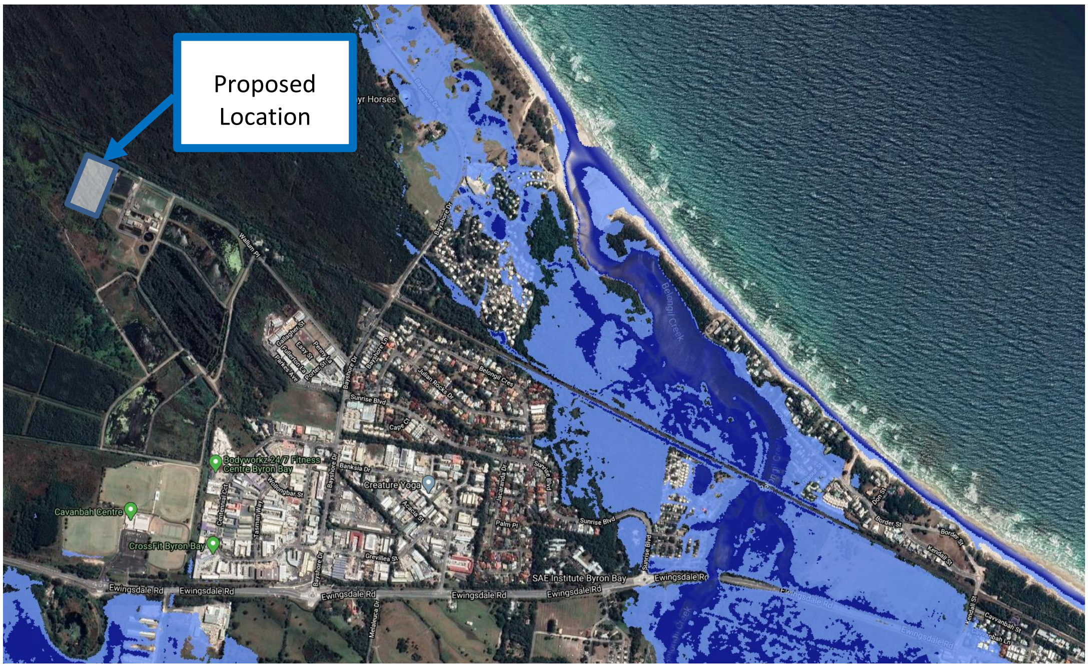

Figure 1 - Proposed Plant Location (Byron Bay)

2.2 Desalination Plant Options Assessment Overview

GANDEN and RCC identified the ultimate capacity for the desalination plant to be 10 MLD. Desalination plants are modular in nature and therefore construction can be staged to meet current and future demand. The initial plant will be developed to allow for a staged construction with an initial 5MLD plant, followed by incremental increases of 2.5MLD to achieve the ultimate 10MLD plant capacity.

GANDEN undertook a review of desalination technologies and major plant components, including: -

- Plant intake systems;
- Pre-treatment filtration systems;
- Desalination systems;
- Energy recovery devices; and

- Options for remineralisation.

Numerous options for each of the above components were identified and subject to assessment using a Multi-criteria Analysis (MCA). The MCA assessment utilises a gated approach which includes: -

- Gate 1 – Mandatory Criteria which included: -
  - Will it meet the water quality objectives;
  - Possible to implement in Rous County?
  - Practical to implement in Rous County?
- Gate 2 – Scoring Criteria including: -
  - Whole of life Costs (high level),
  - Proven technology,
  - Resourcing requirements,
  - Support, and
  - Process resilience.
- Gate 3 – Whole of Life Costs.

The MCA allowed for an objective assessment of various technologies. A summary of the options investigation for desalination options is provided in Figure 2. The findings recommended a Seawater Reverse Osmosis (SWRO) plant, which is the most common desalination system in Australia. SWRO is robust, reliable and provides good value for money.

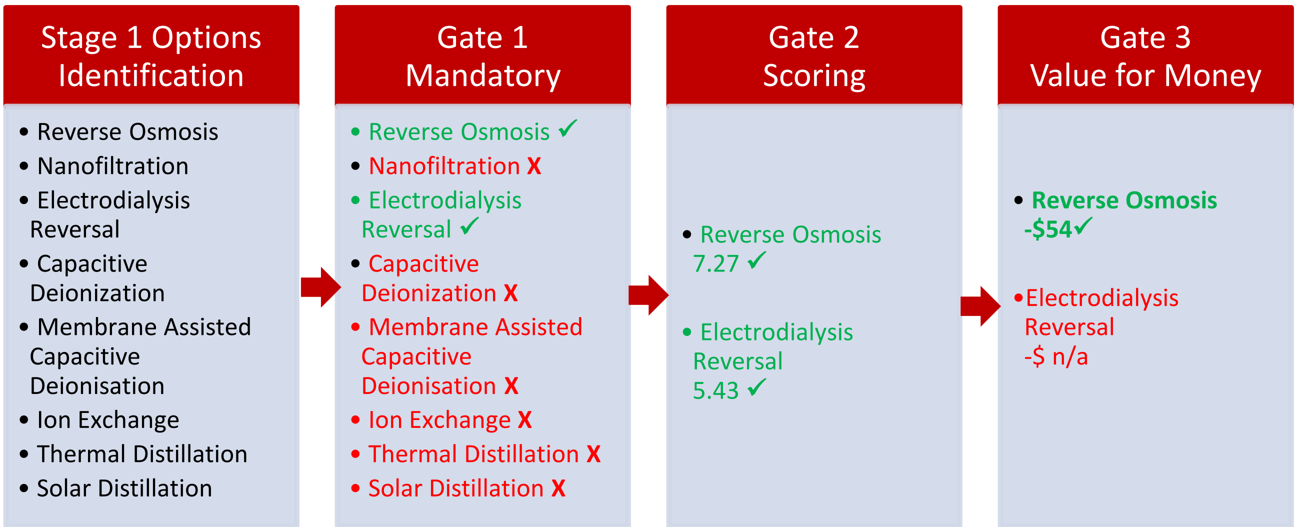

Figure 2: Desalination Technology Options Investigation Summary

A similar approach was undertaken to determine a suitable solution for the intake system. A summary of the intake system option assessment is provided in Figure 3. The recommended intake system for the plant is an Offshore Open intake, with a shared outfall pipeline. This type of technology is the most common for desalination in Australia and is considered robust, reliable, and good value for money while minimising any environmental impacts that may occur along the shoreline.

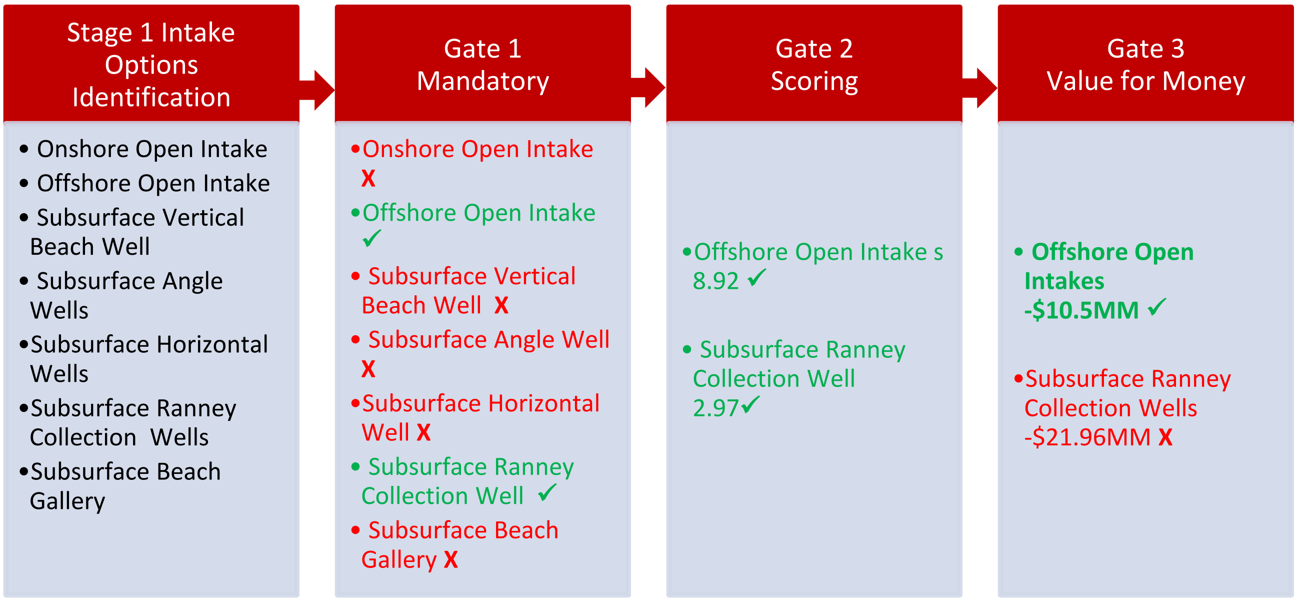

Figure 3: Sea water Intakes Investigation Summary

2.3 Recommendation and Concept Design

The recommended plant to meet the future demand is for the construction of a 10MLD Seawater Reverse Osmosis (SWRO) Plant with an offshore open intake and outfall. This plant would be suitable for the proposed site, adjacent to the existing Byron Bay STP. The initial plant will be developed to allow for a staged construction with an initial 5MLD plant, followed by incremental increases of 2.5MLD to achieve the ultimate 10MLD plant capacity.

A concept design has been developed utilising proprietary skid-based technology by Suez Water, however all major equipment suppliers can provide similar solutions, with similar plant footprints. The preference for skid-based solutions will allow for a staged construction approach.

A pictorial of the desalination plant and the plant layout is provided in Figure 4 and Figure 5 below. The plant would likely be constructed in a large industrial shed structure, housing all process equipment.

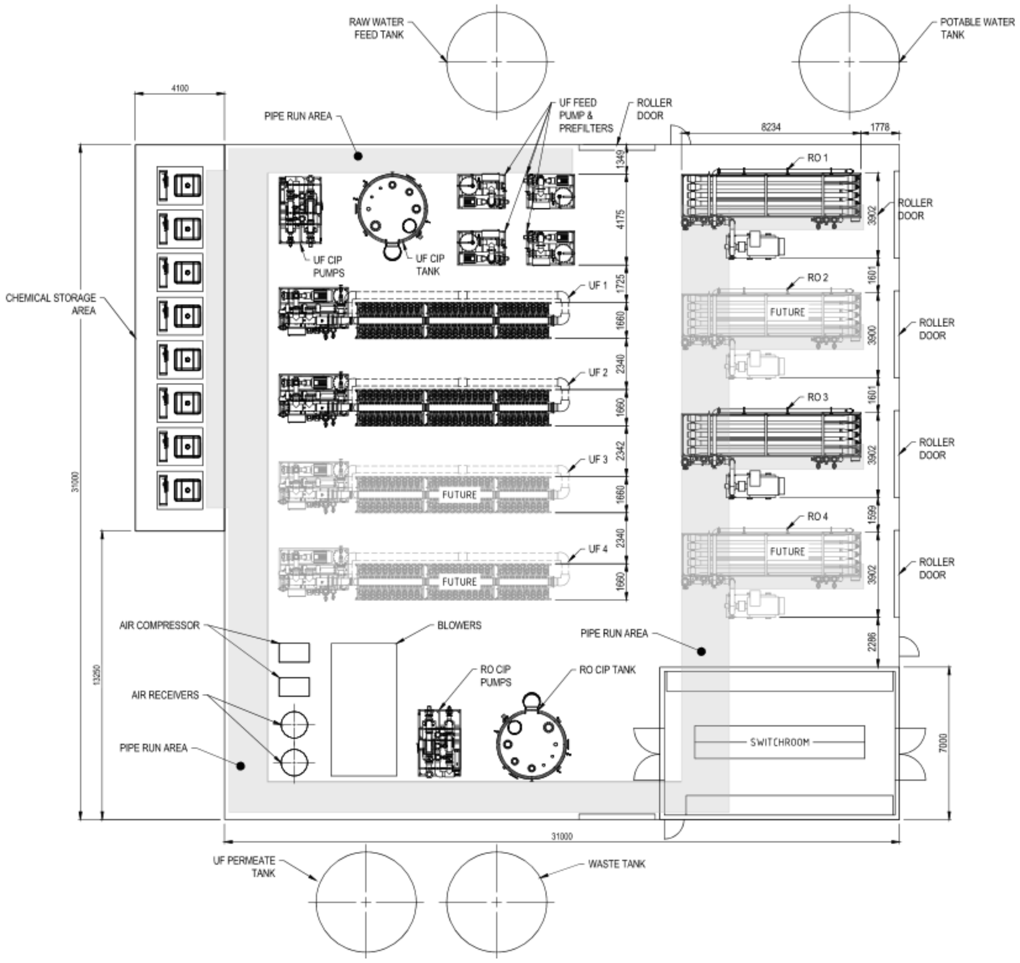

Figure 4: Concept Design Plant layout

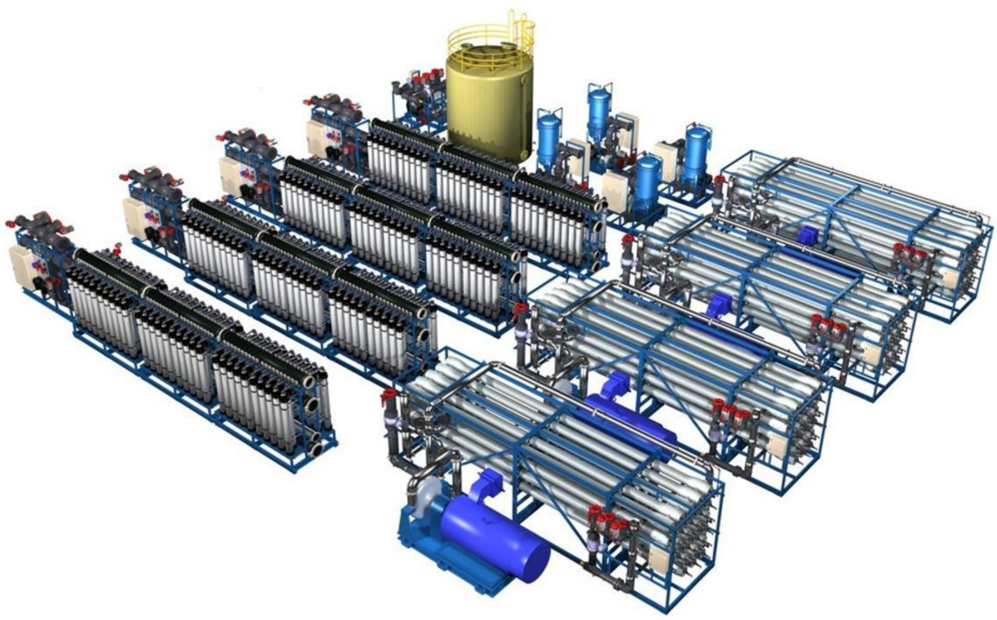

Figure 5 Pictorial of a 10MLD Desalination Plant consisting off 4 x 2.5MLD Trains

2.4 Capital and Operational Expenditure

GANDEN have developed Capital Expenditure (CAPEX) and Operational Expenditure (OPEX) for the proposed plant concept based on industry standard rates and in-house developed spreadsheets. The estimated Capital Expenditure for the plant is $45MM, which includes a construction contingency of 15%. Due to the uncertainty in the location, design solutions it was preferred to establish the capital cost through benchmarking.

The capital cost has been benchmarked against similar sized desalination projects executed within Australia. Projects of similar size and nature are relatively rare. Two similar sized desalination projects include the Belmont Drought Response Desalination Plant in the Lake Macquarie City area, and the Agnes Waters Desalination Plant in the town of 1770, Queensland. A summary of the plant costings is provided in the table below, including an indicative cost per mega litre. The Agnes Waters plant is considered most representative. Based on a benchmarking assessment, the CAPEX assessment of **$54MM** is established.

Table 1 - Benchmarking for Similar Sized Plants

Project Name	Location	Capacity	Project Value (including intake/outfall)	CAPEX per MLD	Construction Year	CPI Adjusted Value[1]	CPI Adjusted CAPEX per MLD
Belmont Drought Response Desalination Plant (currently in design stages)	Lake Macquarie City, NSW	15 MLD	$90MM	$6MM (estimated)	Still in design development	$90MM	$6MM (estimated)
Agnes Waters Desalination Plant (1770)	Agnes Waters, QLD	1.5 MLD, 7.5 MLD Future	$29MM	$19.3MM/3.8MM	2010	$35MM	23.3MM/4.67MM

The CAPEX noted has a wide range of project variables, for instance some plants can include long associated pipelines and electrical headworks.

Smaller desalination plants or private (i.e. mining) plants have not been considered as a feasible measurement for benchmarking as the variability in scope makes cost comparison difficult.

2.5 NPV

The NPV that has been developed will allow detailed interrogation of the impact of CAPEX and assessment of OPEX over the life of the facility. The cost of a desalination plant is significant and the facility can only be justified from an economic sense when operated at close to full capacity at all times. Operation of desalination facility from a public perception point of view can only be justified when all other sources of drinking water supply have been exhausted (or are threatened to be exhausted). This is demonstrated throughout Australia where most desalination plants have sat idle for extended time periods only to be turned on in times of need. As examples, the Adelaide desalination plant has been turned on recently to reduce the impact on the Murray Darling Basin, and the Sydney desalination plant (with a doubling of capacity underway) has only been turned on recently as a response to the extended and unprecedented drought period.

Both these plants have been heavily criticised as a very expensive waste of money in recent years but are now proving invaluable to supply drinking water. In this light, the NPV assessment is more dependent on external conditions (mainly climate and population) which are very difficult to accurately predict. These climatic effects can't be reliably incorporated as part of the NPV assessment. What the NPV shows is that when operated, safe and reliable drinking water can be

[1] CPI Values from Reserve Bank of Australia, accessed 29/03/2020

supplied economically; however when mothballed or operated at low capacity, the costs are significant. The cost of staging of the capacity of the treatment plant has a minor impact on the overall NPV when percentage operation is taken into account.

Table 2 NPV Outcomes

Scenario	NPV of Cash Flow	IRR	Profitability Index
Scenario 1: 5MLD 2020, 10MLD 2035 80 year span	$34,830,334	4.0%	1.74
Scenario 2: 5MLD 2020, 10MLD 2030 80 year span	$39,859,351	4.2%	1.85
Scenario 3: 5MLD 2020, 10MLD 2025 80 year span	$45,307,916	4.5%	1.96
Scenario 4: 10MLD in 2020 80 year span	$50,931,192	4.8%	1.94
Scenario 5: 5MLD in 2020, mothballed 80 year span	-$81,775,805	n/a	- 0.74

2.6 Conclusions and Further Recommendations

Should RCC wish to proceed with Desalination as part of a diversification of water sources, it is proposed to further investigate the Byron Bay location, supported with a concept design of a conventional seawater desalination plant with a conventionally tunneled intake and outfall structure(s). From a network perspective, the preferred location at Byron Bay provides the water to the area of highest consumption and allows for relatively easy integration with the network (Water and Electrical). The cost associated with the completion of the plant is estimated at $54MM, full details of all assumptions are provided within the report. The costing has been established through a combination of a bottom up estimate and benchmarking against similar projects.

Further investigation still needs to be undertaken to establish a preferred location from an environmental and social perspective. Pricing for the proposed works is based on a concept design level of detail and will require a further cost estimation to be undertaken during detailed design development.

3. Contents

4. Background

Rous County Council (RCC) is undertaking a feasibility level proof of concept assessment and associated costings for the use of desalinated water sources as a future water supply augmentation option for the region. This would involve the production of desalinated water on a relatively small scale 10MLD – 12MLD to augment the overall secure yield of the Rous regional bulk water supply system. The sizing of the treatment plant was considered a given and has not been further considered as part of this project.

To complete this study GANDEN was engaged to attend a preliminary workshop with RCC to revisit previous investigation outcomes, discuss project direction and review preferred locations for a new treatment facility. Following the preliminary workshop, GANDEN developed an options analysis report (this document), which includes: -

1. Review of existing desalination reports by various vendors, Councils and Water Authorities around Australia;
2. Identify and outlining of pros and cons of current treatment technologies against industry standards and best practice, in reference to desalination within Australia and overseas;
3. Consideration of environmental and social planning issues;
4. Assessment of potential locations for desalination plant considering coastal geological and sediment conditions (including coastal inundation), infrastructure requirements, feed source water, integration to existing water distribution networks, available power infrastructure and reject water (brine) management requirements;
5. Multi-criteria analysis of each of the identified treatment technologies, incorporating: -
    a. Whether the technology is viable to implement;
    b. Practicality;
    c. Whether ADWG requirements will be met with technology (reliability/safety);
    d. Construction and operational cost estimations (CAPEX and OPEX); and
    e. 80-year Net Present Value (NPV) calculations which includes whole of life costings.

This project is an extension of previous works undertaking by RCC especially in relation to the cost estimate, as a number of concerns previously existed as to the current validity of the cost estimates and what was included within the cost estimate.

4.1 Review of Available information

GANDEN used the following information to undertake the assessment.

Council provided information:

- NSW North and Mid-North Coast Viability and Cost Effectiveness of Desalination (NSW Department of Commerce, 2006);
- Preliminary Feasibility Assessment of Desalination as a Water Supply Option (Geolink, 2011); and
- Future Water Strategy Integrated Water Planning Process (MWH, 2014).

This report updates and expands on previous investigations and other relevant studies undertaken. Summaries of the findings of these reports related to desalination options are presented. The outcomes of these reports have been summarised here and will feed into this assessment where appropriate.

4.1.1 NSW North and Mid-North Coast Viability and Cost Effectiveness of Desalination

The report presents a summary of desalination technologies; desalination technology selection issues; and desalination scenarios. A summary of the relevant scenarios is presented in Table 3 below.

Table 3. Desalination Scenarios - Costs at 95% Utilisation

Scenario	Capacity (MLD)	Power Cost ($/MWh)	Capital (million $)	30 yr NPV @ 7% pa (million $)	Unit Water Price ($/kL)
Two Pass SWRO + MF pre-treatment	20	80	52.7	119.2	1.38
Single Pass SWRO + sand filter pre-treatment	20	80	42.3	104.1	1.21
Two Pass SWRO + MF pre-treatment	5	80	18.0	37.7	1.75
Single Pass SWRO + sand filter pre-treatment	5	80	15.0	33.8	1.57

The report discusses options for membrane desalination plants at Brunswick Heads and at South Ballina. The membrane desalination plant at Brunswick Heads had a capital cost estimate of $60.9 million whilst the corresponding membrane desalination plant at South Ballina had a capital cost of $52.9 million. Note that RCC currently (2019/2020) prices their water at $1.66 per KL to each constituent Council.

4.1.2 Preliminary Feasibility Assessment of Desalination as a Water Supply Option

The 'Preliminary Feasibility Assessment of Desalination as a Water Supply Option' report identified three potential desalination scenarios for the Rous Water supply area. With regards to potential locations only general localities were identified. Specific parcels of land were not identified or assessed for the location of the desalination plant or associated infrastructure. The following localities and sources of feed water were selected, and related issues and opportunities are summarised in Table 5 below.

- Scenario 1- Tyagarah (groundwater feed water).
- Scenario 2 - Lennox Head (ocean feed water).
- Scenario 3 – South Ballina (estuarine feed water).

Treatment of saline groundwater is an unlikely option in lieu of the potential non-saline groundwater options available. RCC has three locations of low level groundwater salinity available (South Ballina, Lennox Heads and Tyagarah) however this coastal sand aquifer is understood to have limited capacity and has not been further considered as a sustainable source of raw water for the production of drinking water. Estuarine sources in the Richmond River have been assessed. No significant advantages over ocean water sources were identified when considering suitable locations, distance to demand centres and treatment needs. Estuarine water also has additional treatment requirements due to high turbidity.

For peak day demands for each of the below locations, refer Section 4.1.4 - Rous Water Long-Term Peak Day Demand Forecast (Hydrosphere Consulting).

Table 4. Preliminary Feasibility of Desalination Options (adapted from Geolink 2011)

Location (Source water)	Size of Plant & **Approx. Population Serviced**	Areas Serviced	Key Issues	Opportunities
Tyagarah (Groundwater)	5 MLD in 2030; with additional 2.5 MLD in 2040	Suffolk Park, Byron Bay, Brunswick	Tyagarah Nature Reserve runs along coast. Water main that passes Tyagarah would need to be assessed to ensure it could	Connection to Mullumbimby a possibility

	24,000 (2040) **27,000 (2050)**	Heads, Ocean Shores	handle flow and pressure of desalinated water input. Possible issue with power supply because Ewingsdale zone substation has limited capacity (note: may be alleviated by new substation at Suffolk Park). Demand of service area is less than county-wide shortfall in 2050.	Provides new water supply in location of large population growth. The Peak day forecast report provides detail on growth and peak demand.
Lennox Head (Ocean)	5 MLD in 2030; with additional 5 MLD in 2040 **44,000 (2040)** **52,000 (2050)**	Lennox Head, Ballina	Seven Mile Beach is popular with locals and tourists. Finding suitable location for infrastructure would be challenging. Potential for Emigrant Ck Dam to become partially redundant if water demand for Ballina / Lennox Head is largely met by desalination.	Provides new water supply in location of large population growth. The Peak day forecast report provides detail on growth and peak demand.
South Ballina (Richmond River estuary)	5 MLD in 2030; with additional 5 MLD in 2040 **44,000 (2040)** **52,000 (2050**	Lennox Head, Ballina	Proximity to area of significant conservation value and threatened species Power supply and pipeline connection to existing water reticulation network would need to cross river. Salinity of river water[2] at South Ballina is like sea water, therefore minimal benefits related to reduced treatment costs. Potential for Emigrant Ck Dam to become partially redundant if water demand for Ballina / Lennox Head is largely met by desalination.	Provides new water supply in location of large population growth.

Cross checking the population and forecast growth data from the Preliminary Feasibility study data using data compiled for Byron Shire Council and Ballina Shire council by '.id the population experts' show the population growth estimates to still be valid with the 2018 population of Ballina Shire (Lennox Head & Ballina) to be 44,208, and projected 2036 population estimated to be 51,236. The 2018 population for the area serviced by the proposed Tyagarah plant being 19,112 with recent population growth being 1.6-1.8% per year for 7 years (2012 to 2018). Information was checked at the Byron Shire Council and Ballina Shire Council community profile sections of the **.idcommunity** web site (https://forecast.id.com.au/ballina; and https://profile.id.com.au/byron/population-estimate).

The recommendation that a new desalination plant should be located so new water supply is in close proximity to large population growth forecast is valid. A scenario with multiple smaller desalination plants is not considered feasible as both capital and operating costs would be prohibitive.

[2] It is noted that desalination of tidal influenced brackish water is considered a risk to water quality and is not recommended.

4.1.3 Future Water Strategy Integrated Water Planning Process

The Future Water Strategy Integrated Water Planning Process report, prepared by MWH in 2014, captures the background information and the decision-making process for the development of the RCC Future Water Strategy (FWS) project. The report gives two marine desalination options at Tyagarah and South Ballina which are summarised in Table 5 below.

Table 5. FWSIWPP Desalination options description (MWH 2014)

Option	Description	Location	Connection
G1. Tyagarah	Desalination of ocean water extracted via a sub-surface beach well system at Tyagarah Beach to augment water supply. The plant would be staged with brine discharge via a new ocean outfall. The plant would best operate continuously. Opportunity to size to meet full supply deficit range. Renewable power is to be sourced. The key infrastructure associated with this scenario includes: • Beach well intake system, consisting of a horizontal collector well system beneath Tyagarah Beach • Pumping station and pipeline to transfer the feed water from the intake system to the desalination plant • Desalination plant to remove salt and other minerals from the water and produce fresh, desalinated water • Pumping system and pipeline to transfer the desalinated water from the plant to the connection point into the existing water reticulation network. • Discharge pipeline extending from the desalination plant to Tyagarah Beach and out into the ocean to the discharge location.	Marine water extraction at Tyagarah Beach	Approx.2 km to existing Rous Water bulk supply pipelines (300 mm) or Brunswick Head reservoirs
G2. South Ballina	Desalination of ocean water extracted via a sub-surface beach well system at South Ballina to augment water supply. The plant would be staged. Brine discharge via new ocean outfall or river. The plant would best operate with limited excess capacity on a semi-continuous basis. Opportunity to stage sizing to meet full supply deficit range and draw on estuarine water. Renewable power source is to be sourced. Potential to trigger Commonwealth EIS requirements (EPBC) and complicated approvals. The key infrastructure associated with this scenario includes: • Beach well intake system, consisting of a horizontal collector well system beneath South Ballina. • Pumping station and pipeline to transfer the feed water from the intake system to the desalination plant. • Desalination plant to remove salt and other minerals from the water and produce fresh, desalinated water.	Marine water extraction to the south of Ballina	Approx. 5km away from Pine Av Reservoir and would require crossing of the Richmond River

	• Pumping system and pipeline to transfer the desalinated water from the plant to the connection point into the existing water reticulation network. Crossing of Richmond River required. Discharge pipeline extending from the desalination plant to South Ballina and out into the ocean to the discharge location. (potential to discharge into Richmond River).		

Both desalination Options utilise a beach well intake system that consists of a horizontal collector well system, refer to section 5.5 for an overview, comparison and recommendation of different intake structures..

The benefits and constraints associated with each of the options are described below in Table 6.

Table 6. Desalination options constraints and benefits (from MHW 2014)

Option	Benefits	Constraints
G1. Tyagarah	Flexibility in staging to match variation in demands. Virtually limitless and permanent supply. Relatively flat topography	Ongoing energy usage for this type of treatment is high but potentially can be offset by employing renewable resources at additional cost. Low lying areas are flood prone. Pipeline to coast passes through Tyagarah Nature Reserve Byron Bay Marine Park is located offshore and the marine feedwater intake and brine disposal and could be contrary to the objects of the Marine Park. Potential conflict with tourism industry of Byron Bay (temporary offshore rig may decrease amenity of Byron/ Belongil Beach) High ongoing operations cost.
G2. South Ballina	Flexibility in staging to match variation in demands. Virtually limitless and permanent supply. Relatively flat topography	Ongoing energy usage for this type of treatment is high but potentially can be offset by employing renewable resources at additional cost. Potential quality issues due to proximity to Richmond River mouth. Known habitat of threatened species in in the district (Pied Oystercatcher) Low lying areas are flood prone. Need for major river crossing of the Richmond River. Has been allowed for in option configuration and costing. High ongoing operations cost.

The report gives the following estimates for CAPEX and OPEX costs for the 2 solutions as summarised inTable 7 below

Table 7.Summary of Desalination Options Capital and Operating costs (from MHW 2014)

Option	Capital Cost ($MM)	Operating Cost ($MM/annum)	Annualised Cost ($MM/annum)	Power (kWh/kL)	Footprint (ha)	Lead Time
Tyagarah	103	9.2	3.20	4.2	5	Long (>5yrs)

Option	Capital Cost ($MM)	Operating Cost ($MM/annum)	Annualised Cost ($MM/annum)	Power (kWh/kL)	Footprint (ha)	Lead Time
South Ballina	107	9.2	3.30	4.2	5	Long (>5yrs)

A breakdown of capital and operating costs is not provided. It is noted that the Capital Cost identified is significantly higher than what has been established within this report (and the NSW North and Mid-North Coast Viability and Cost Effectiveness of Desalination (NSW Department of Commerce, 2006). as no details are provided within the report as to how this pricing was established this has not been explored further.

4.1.4 Rous Water Long-Term Peak Day Demand Forecast (Hydrosphere Consulting)

Rous County Council engaged Hydrosphere Consulting in 2013 to undertake a predicted peak day demand at each of its sell point meters, forecasted until 2060. The findings of this report have been expanded on in GANDEN's desalination investigation report and used to validate water demand estimates made based on population forecasts and industry-recognised daily water demand per EP.

Table 8 - Hydrosphere Consulting Peak and Average Day Demand Forecast

	Connections	PDD (MLD)	ADD (MLD)	PDD:ADD
Parent Meter (2013 Actual)				
St. Helena	8,490	13.8	7.0	2.0
South Ballina (Knockrow & Alstonville)	14,930	21.2	9.8	2.2
Parent Meter (2030 Projected)				
St. Helena	11,077	18.0	9.2	2.0
South Ballina (Knockrow & Alstonville)	21,834	30.7	14.4	2.1
Parent Meter (2060 Future)				
St. Helena	12,872	21.0	10.6	2.0
South Ballina (Knockrow & Alstonville)	31,343	43.8	20.7	2.1

4.2 Readers Guide

This desalination options report is built around the following sections: -

- Section 5 Review of Desalination Technology (provides an overview of technology and a range of assumptions);
- Section 6 Review of Environmental & Social Planning (identifies applicable environmental & social planning concerns);
- Section 7 Site Location (provides an overview of possible sites with discussion around preferred location, considerations);
- Section 8 MCA (Assumptions and discussions);

- Section 9 Preliminary Concept Design of the SWRO plant (Concept design detailing a layout and all components of the plant); and
- Section 10 NPV Seawater Reverse Osmosis Desalination Plant.

5. Review of Desalination Technologies

5.1 Brief History of Desalination

Humans have been desalinating water for many centuries. It is believed that the first desalination was performed by the ancient Greek sailors as they boiled seawater to capture the evaporated fresh water on their boats. In modern times, the first commercial desalination plants were created in the USA and the deserts of the Middle East using multi-stage flash distillation methods in the mid 1950's. These plants required large amounts of energy to evaporate water.

The first membrane systems were started to be developed in the 1950s. The first Electrodialysis (ED) plant was commercialised in 1953 for an oil field campsite in Saudi Arabia.

The first commercialised Reverse Osmosis (RO) plant was the Coalinga Desalination Plant in the USA for brackish water in 1965. The first seawater RO plant was in Bermuda in 1974.

From the 1950 to the 1980's ED was the prominent technology with hundreds of installations around the world. In 1974 ED was further developed into Electrodialysis Reversal (EDR) where cleaning of salt off the membrane was performed by reversing the DC current being applied to the membrane. Previously acid or antiscalant chemicals were used to clean the membranes.

During the 1970's and 1980's the RO process dramatically improved by using thinner and more efficient membranes that did not require acid addition in the feed. These thinner membranes required less operating pressure, so energy requirement is reduced. Energy recovery devices were also developed that dramatically reduced the power requirements for RO. During the 1990's RO became the dominant method for desalination, this remains the case in 2020.

5.1.1 Desalination Worldwide

The International Desalination Association (IDA) estimates approximately 18,426 desalination plants exist worldwide producing over 90 billion litres of water per day, or 1% of the world's drinking water. The International Water Association (IWA) anticipates that desalination production will double by 2030. Approximately 120 countries have desalination plants with most water production capacity coming from Saudi Arabia, Oman, United Arab Emirates, the USA, Spain, Cyprus, Malta, Gibraltar, Cape Verde, Portugal, Greece, Italy, India, China, Japan, and Australia. Approximately 44% of the capacity is from the middle east. The IWA expects the middle east market to grow continuously at a rate of 7-9% but the largest growth regions are anticipated to be Asia, the USA and Latin America.

The IDA Association estimates that approximately 46% of the world's desalination water is produced by thermal distillation. Most of this is produced using waste heat from refinery processes or other heavy industrial processes to boil seawater for capture of the condensed steam.

The use of reverse osmosis is overwhelmingly the most common technology used on most new desalination plants worldwide.

5.1.2 Desalination in Australia

All major Australian desalination plants employ RO technology for brackish water and seawater desalination. Other desalination applications in Australia are generally limited to smaller, specialist industrial requirements, e.g. for boiler feed water, gas turbines cooling water or process water, though RO is generally selected for most industrial desalination applications as well.

The first major Australian seawater RO desalination plant was the Perth Seawater Desalination Plant, constructed in Kwinana in 2006. Water Corporation subsequently built the Southern Seawater Desalination Plant in Beenyup in two stages as part of an Indirect Potable Reuse (IPR) scheme. These plants are all in operation providing 150 billion litres of potable water per year.

Other major Australian SWRO desalination plants that have been built and at the time of writing are in various forms of operation are Gold Coast (operational), Sydney (operational), Adelaide (operational) and Victoria Desalination Plants.

The Tugun Desalination Plant on the Gold Coast was mothballed from fulltime water production in 2010. The QLD government has advised the plant may be required to supplement peak demand on the Gold Coast during the summer as early as 2020.

Adelaide's desalination plant at Port Stanvac has been operating at 10% of capacity since 2012. In November 2019 an agreement was reached between the Australian Federal Government and the South Australian government to significantly ramp up production of water to supply the Adelaide metropolitan area. This agreement was reached to allow farmers affected by drought to access further water from the Murray River.

In June 2012 the Sydney Water desalination plant at Kurnell was turned off. It was restarted in January 2019 and has been running at the full 250 MLD capacity since early August 2019 with plans underway to duplicate the capacity of this plant.

There are several smaller community, resort and mining towns seawater RO desalination plants around the country, such as Agnes Waters (QLD), Hamilton Island (QLD), Barrow Island (WA), Barrup (WA), Port Headland (WA), Port Lincoln(SA), Whyalla (SA), Kangaroo Island (SA) and Marion Bay (SA). Currently the Belmont Desalination plant is under development. Section 5.13 provides an overview of these plants inclusive of a cost per ML assessment.

5.2 Design Envelope

The following general assumptions have been made in the preparation of this report: -

1. Only on-site desalination treatment options were considered in this study;
2. Water demand and population growth figures had been outlined in the previous studies (Future Water Strategy Demand Forecast report, Hydrosphere Consulting, 2013) are applicable to the current study and have not been further investigated for validity;
3. Single location desalination plant (not multiple smaller plants);
4. Raw Water quality was calculated/assumed and Potable water quality was taken from ADWG[3].
5. Assumed Boron removal would be sufficient with Single Pass RO system[4].

Details for the assumptions used had been summarised within this Section;

5.3 Raw Water Envelope

No seawater water quality data set was available for the area nominated for raw water extraction. General assumptions were made in the preparation of this report using the Integrated Marine and Coastal Regionalisation of Australia (IMCRA v4. 0). This is a spatial framework for classifying Australia's marine environment into bioregions that are linked ecologically and are at a scale useful for regional planning. The relevant region for Council is identified as the Tweed-Morton Australian IMCRA mesoscale bioregion. From a general planning perspective, it is assumed that the water will therefore be similar to that found at the Gold Coast desalination plant located in the same IMCRA region. Refer to Figure 6 for further detail.

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[3] A request has been made to Seqwater to obtain data from the Tugun Desalination plant as this is considered a good benchmark for Nightcap however no data has been received at this stage.
[4] Note that the ADWG value for Boron has been increased to 4 mg/L (ADWG version 3.5 August 2018)

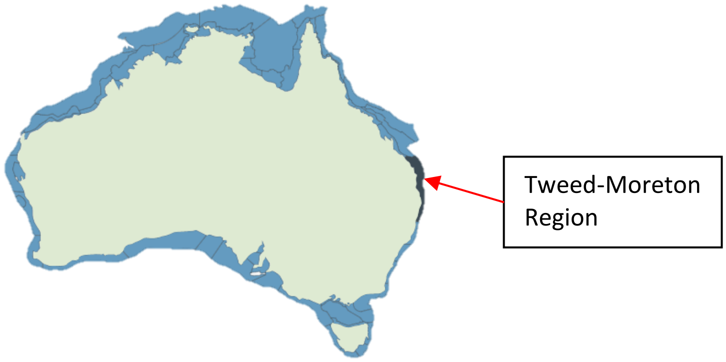


Figure 6: Map showing Australian IMCRA mesoscale bioregions and location of Tweed Moreton Region (*From Australian Commonwealth government waterquality.gov.au/nz guidelines website 2019)*

Table 9 below shows the typical feedwater quality for the plant, benchmarked against intake raw water quality of nearby plants. The table will be updated when this information becomes available. No concerns are noted around the ability of a desalination plant to meet the ADWG requirements.

Table 9. Key Parameters raw water envelope

Parameter	Min (mg/L)	Average (mg/L)	75th %ile (mg/L)	90th %ile (mg/L)	Max (mg/L)	ADWG (Aesthetic)
Chloride (Cl^-)	TBC	TBC	TBC	TBC	TBC	TBC
Sodium (Na)	TBC	TBC	TBC	TBC	TBC	TBC
TDS (Total Dissolved Solids)	TBC	TBC	TBC	TBC	TBC	TBC

5.4 Desalination Technologies

A wide range of desalination options have been considered in this investigation. The following desalination options were identified as potentially suitable to further assess within the Multi-Criteria Analysis: -

1. Reverse Osmosis;
2. Nanofiltration;
3. Electrodialysis Reversal Membranes;
4. Capacitive Deionization and Membrane assisted Capacitive Deionisation;
5. Ion Exchange;
6. Distillation – Thermal; and
7. Distillation – Solar.

5.4.1 Reverse Osmosis

Table 10. Reverse Osmosis technology summary

Option	**Reverse Osmosis** 
Description of Technology	The most widely used technology for Seawater Desalination (Seawater Reverse Osmosis (SWRO)) and Brackish Water Desalination (Brackish Water Reverse Osmosis (BWRO). RO consists of pumping water through RO membranes. The sodium and chloride ions from saline water have an ionic charge and it is this charge that allows rejection of the ion preventing it passing through the membrane. Pressure that is higher than the osmotic pressure required to keep the salt ions from passing through the membranes is applied upstream of the membrane, forcing water through the membranes and leaving the dissolved ions and other contaminants on the feed side for removal. The disposal of the Brine (the concentrate from the process that contains all the salts) is often difficult to manage.
Anticipated Salt Removal	98-99% salt removal
Energy Use	4 to 10 kWhr/m^3 for SWRO
Reference Sites for Seawater Desalination	• Perth Seawater Desalination Plant at Kwinana • Southern Seawater Desalination Plant in Beenyup • Tugun Desalination Plant on the Gold Coast • Sydney Water Desalination plant at Kurnell • Victorian Desalination Plant at Melbourne • Adelaide’s desalination plant at Port Stanvac • Hamilton Island (Qld), • Barrow Island (WA), • Port Headland (WA), • Port Lincoln (SA), • Whyalla (SA), • Kangaroo Island (SA), and • Marion Bay (SA).
Comments	Most used desalination technology in Australia and in the world.

5.4.2 Nanofiltration

Table 11. Nanofiltration technology summary

Option	Nanofiltration 
Description of Technology	Nanofiltration, in concept and operation, is much the same as reverse osmosis. The key difference is the degree of removal of monovalent ions such as chlorides. Reverse osmosis removes the monovalent ions at 98-99% level at 1380 kPa. Nanofiltration membranes' removal of monovalent ions varies between 50% to 90% depending on the material and manufacture of the membrane. Nano filtration is a technology mainly applied in drinking water purification process steps, such as water softening, decolouring and micro pollutant removal. During industrial processes nanofiltration is applied for the removal of specific components, such as colouring agents. The technology is mainly applied for the removal of organic substances, such as micro pollutants and multivalent ions.
Anticipated Salt Removal	50 to 90% salt removal
Energy Use kWhr/m3	0.8 kWhr/m^3 for NF
Reference Sites for Seawater Desalination	None found in Australia
Constraints	Monovalent ions not removed at the required amount. Based on the water quality requirements of the product water this technology is not suitable as removal of salts (monovalent molecules Na^+ and Cl^-) is not achieved.

5.4.3 Electrodialyis

Table 12. Electrodialysis Reversal (EDR) technology summary

Option	**Electrodialysis Reversal (EDR)** 
Description of Technology	Electrodialysis Reversal (EDR) is a process that applies an electrical charge to the saline water, drawing salt ions through a membrane to a negatively charged cathode and chloride ions to a positively charged anode. This process creates two streams of water: - one concentrated saltwater and the other desalinated water. EDR technology achieves high water recovery and by reversing the polarity of the applied electric current, the direction of ion flow is reversed, resulting in a self-cleaning membrane system ideal for treating impure wastewater. Unlike conventional membrane processes, the ions and not the water molecules are displaced across the membranes. EDR is less common. The main advantages are flexibility in water quality (TDS) levels, low pressure (hence potentially reduced OPEX) when compared to RO. This technology is typically considered when the source water contains contaminants such as high silica levels where conventional RO would struggle; this is not the case for seawater desalination.
Anticipated Salt Removal	50 to 95% salt removal
Energy Use	4 - 8 kWhr/m3 for EDR (Based on 2-4 kWhr/m3 for brackish water desalination of 20,000 mg/L salinity water)
Reference Sites for Seawater Desalination	**None for seawater desalination** Maspalomas, Canary Islands, Spain (Brackish groundwater desalination)
Constraints	Reference sites in Australia are available but are on brackish water for remote aboriginal communities for bore water desalination. Only a few companies supply the technology in Australia and therefore skilled labour is not readily available

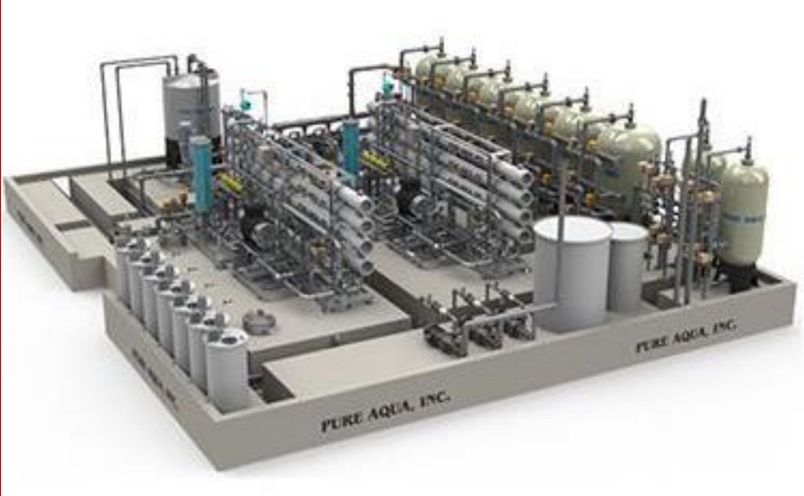
5.4.4 Capacitive Deionisation (CDI) and Membrane Assisted Capacitive Deionisation

Table 13 CDI & MCDI technology summary

Option	**Capacitive Deionisation (CDI) and Membrane Assisted Capacitive Deionisation (MCDI)** 
Description of Technology	Membrane capacitive deionization (MCDI) is presently an experimental technology that is yet to reach commercialisation. MCDI an ion-removal process based on applying an electrical potential difference across an aqueous solution which flows in between oppositely placed porous electrodes, in front of which ion-exchange membranes are positioned. Due to the applied potential, ions are adsorbed in the electrodes and a product stream with a reduced salt concentration is obtained. A promising technology but very few real-world applications are currently in place
Anticipated Salt Removal	75-85%
Energy Use	1 kWh/m^3 for brackish water unknown for seawater
Reference Sites for Seawater Desalination	**None globally for seawater desalination**
Constraints	Commercialised plants only exist for municipal wastewater recycling and cooling water production 10MLD & 120MLD in China.

5.4.5 Ion Exchange

Table 14. Ion Exchange technology summary

Option	**Ion Exchange** 
Description of Technology	Ion Exchange technology has been used in the Coal Seam Gas sector, but the technology is relatively expensive and is more suited for water with lower TDS, additionally further downstream treatment might be required. Ion exchange is a unit process in which ions of a given species are displaced from an insoluble exchange material by ions of a different species in solution. Certain ions in solution are preferentially adsorbed by the ion exchanger solid, and because electro-neutrality must be maintained, the exchanger solid releases replacement ions back into the solution. Ion exchange demineralisation with anion and cation exchange can be used to remove essentially all dissolved ions from water. Positively charged ions are exchanged for hydrogen ions and negatively charged ions are exchanged for hydroxyl ions. However, ion exchange is limited to a concentration of salts in the range of 100 to 150 mg/L. It is considered more of a polishing technology for where very high-quality water is required. Not considered viable based on the water quality objectives and the scale of the proposed works.
Anticipated Salt Removal	Unknown
Energy Use	Not available for seawater desalination
Reference Sites for seawater desalination	**None globally for seawater desalination**
Constraints	No reference sites in Australia. Is normally used in combination with other technologies such as reverse osmosis for additional boron removal. Skilled labour for this technology not readily available.

5.4.6 Thermal Distillation

Table 15. Thermal Distillation technology summary

Option	**Distillation – Thermal** 
Description of Technology	Thermal distillation is a technology that is used in industrial settings where there is a heat source available that can be used as the energy for the distillation process. The two most common systems employed are Multi-Stage Flash (MSF) and Multi-Effect Distillation (MED). MSF uses consecutive chambers to rapidly heat (flash-boil) the saline water multiple times, using successively lower pressure at each stage. The produced vapour from each stage is condensed into fresh water and collected. MED is a similar process to multistage flash distillation, using a series of condensation-evaporation processes (‘effects’), where steam is used to heat saline water, causing evaporation to occur. The resulting vapour is then condensed leaving fresh water to be collected.
Anticipated Salt Removal	99%
Energy Use	23-27 kWhr/m^3. High energy use, only viable in an industrial setting where waste heat can be used as a by-product.
Reference Sites for Seawater desalination	Hammersley Iron - Dampier, Western Australia. 1.8 MLD MSF Desalination Plant. Commissioned 1967 but decommissioned in the 1980’s. Ravensthorpe Nickel, Western Australia. 7.2 MLD multiple effect distillation (MED) plant commissioned 2006, mothballed 2011. Burrup 4.5 MLD mechanical vapour compression (MVC) plant commissioned 2004. Western Australia.
Constraints	No heavy industry source available to provide waste heat required for implementation.

5.4.7 Solar Distillation

Table 16. Solar Distillation technology summary

Option	**Distillation Solar** 
Description of Technology	Solar distillation relies on the sun's energy to heat and evaporate seawater. Most larger installations rely on mirrors that direct the sun at a central point to concentrate the solar energy. The steam is then captured as condensate for use as desalinated water.
Anticipated Salt Removal	99%
Energy Use	Minimal
Reference Sites for Seawater Desalination	Sundrop Tomato Farm - Port Augusta, South Australia 1.2MLD
Constraints	Requires a large area of land (51,500m² solar field for approximately 1.2 MLD production). Requires sunny days to work. Will not work at night.

5.5 Intake Options

The seawater intake and outfall systems are one of the key components of desalination plants, they are high-cost and high-risk items (primarily during construction) and have potentially large impacts on the receiving environment. Intake systems are designed to ensure sufficient and consistent flow of good quality seawater to be treated over the entire life of the desalination plant. The type and configuration of the intake system is largely determined by the location of the desalination plant and is affected by environmental considerations such as coastal topography, seabed tidal flow, wave action, potential for erosion and the potential for contamination from rivers during high rainfall and subsequent erosion and sediment transport events.

There are several different types of intakes in seawater desalination plant design and these can be divided into two main groups: open (direct or surface) and subsurface intakes (wells and infiltration galleries). Open intakes collect water directly from the water body via on onshore or offshore intake structure and pipeline connecting the intake to the desalination plant. Subsurface intakes (vertical beach wells, horizontal wells, slant wells and infiltration galleries), tap into the saline coastal aquifer to collect source water which filters through sand and bedrock.

The feasibility of subsurface intakes is site specific and highly dependent on the project size; the coastal aquifer geology (aquifer soils, depth, transmissivity, water quality, capacity, etc.); the intensity of the natural beach erosion in the vicinity of the intake site; and other environmental and socio-economic factors.

Both open ocean intakes and subsurface wells may have advantages and pose environmental and socio-economic challenges for the site-specific conditions of a given desalination project. Onshore intakes are usually the lowest cost type of intake, however, the selection of most viable intake alternative should be based on balanced life-cycle cost-benefit analysis and a very detailed environmental assessment.

Other considerations for the inlet structure is the fouling up of the inlet pipeline, older desalination plants have chemical dosing system to prevent fouling up of the pipeline which typically consist of sodium hypochlorite dosing in combination with acid dosing to kill any fouling in the pipeline. More recently Environmental Impact Statement (EIS) assessments have prevented these types of systems and a preference for pigging and/or fresh water flushes have been preferred to limit any potential impact on the receiving environment.

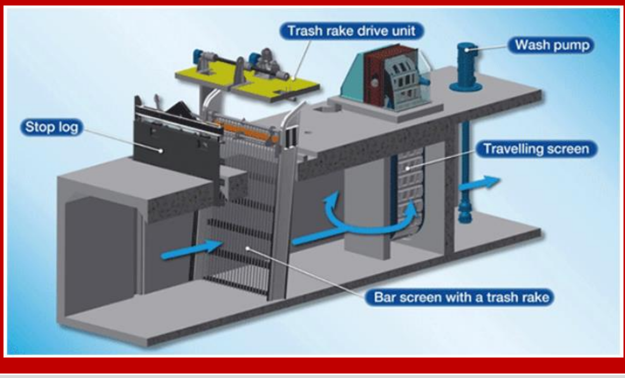
Table 17. Key design criteria for inlet structures of offshore intake systems

Feature	Typical Range	Notes
Number of inlet structures	2 (minimum)	Number of intake structures is dictated by plant design availability factor and size of intake conduit
Diameter (size)	2-20m	Most intake structures have circular shape.
Distance from mean surface water level to top of velocity cap	8m (minimum at mean water level) 4m (minimum at low water level) 20m (maximum) 12-20m (optimum)	Shallower intake structures may be needed if desirable depths cannot be achieved within 2000 m from the shore Structures deeper than 20m may not be cost effective
Distance from bottom to top of velocity cap	4m (minimum)	This distance is determined by the depth of sweeping current at the bottom.
Distance from the shore	300-2000m	Distance determined by the length of the tidal or active beach erosion zones
Distance between coarse screen bars	50-300mm	Wider distance is preferred for tropical environments with anticipated heavy shellfish/coral growth

Feature	Typical Range	Notes
Through screen velocity	0.10-0.15m/s	Screen velocity of 0.10m/s is recommended for source waters with jellyfish content higher than 1 organism/m^3. Through screen velocity should be determined for 50% of the area between the bar screens. This velocity will limit entrainment.
Chemical dosing/pigging/fresh water flush and soak		EIS will determine what is possible/preferred

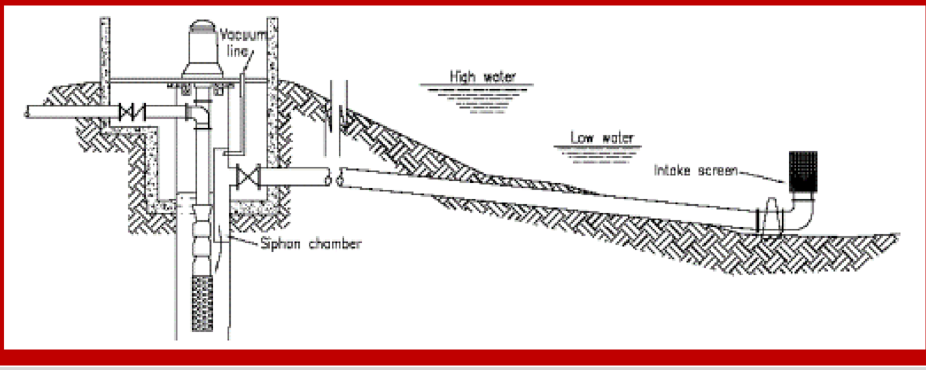
5.5.1 Onshore Open Intake

Table 18. Onshore Open Intake technology summary

Option	Onshore Open Intake 
Description of Technology	Water withdrawn directly from the body of water adjacent to the coast. Open intake or canal structure built in concrete wall structure on coast next to deep water channel or port. Intake comprises coarse and fine screens.
Capacity	Unlimited
Water quality improvement	None (screening only)
Maturity of technology	Mature
Advantages	• Very common technology globally • Lower energy consumption than beach wells • Easier lower cost maintenance as all components are onshore
Disadvantages	• Need to have deep water port or deep concrete lined channel at intake to facilitate • Poorer and inconsistent quality feed water due to waves, currents and coastal dynamics when compared with other intake structures • Increased cost of additional pre-treatment • Visual amenity will be negatively impacted
Reference Sites	Perth desalination plant Kwinana, Australia
Notes	Locating an open intake or intake canal directly on the beach is not considered feasible because it would likely result in an unacceptable environmental impact and degradation of the visual amenity in the surrounding area.

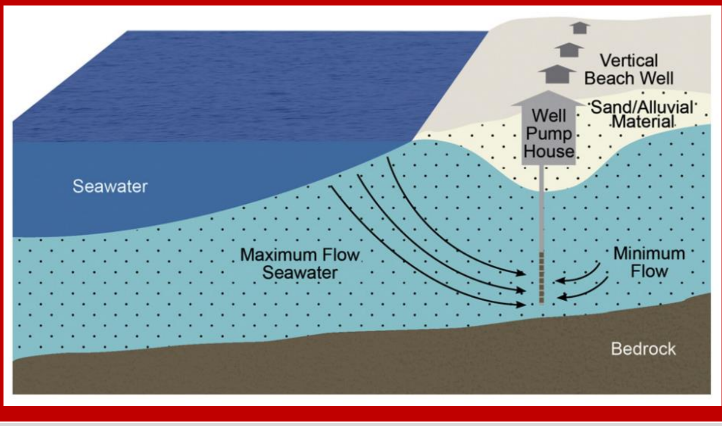
5.5.2 Offshore Open Intake

Table 19. Offshore Open Intake technology summary

Option	**Offshore open intake** 
Description of Technology	An offshore open intake system consists of the following components: - 1. Velocity cap or screen type inlet structure 2. Pipeline or intake tunnel connecting intake to shore structure/well 3. Onshore intake well chamber 4. Vertical well shaft 5. Submersible pump 6. Well pump house 7. Preliminary screens at water intake pump station A similar structure will be required for the outfall. The structure is constructed through a Horizontal Directional Drilled tunnel/ or TBM dependent on requirements
Capacity	Unlimited
Water quality improvement	None
Maturity of technology	Mature
Advantages	• Common technology globally • Intake well sump can be located off beach • Will have no effect on groundwater aquifers • No eyesore or structure on beach • Possible in areas of beach erosion • Multiple pipelines for intake and outlet systems can be drilled from a single pad • No pilot testing required
Disadvantages	• Increased treatment cost as no subsurface filtration by beach sand • Potential for impingement and entrainment of marine life • Some environmental disruption during construction likely • Biofouling into the pipeline requiring cleaning systems
Reference Sites	Agnes Water Desalination Plant, QLD Australia Gold Coast Desalination Plant, Gold Coast, QLD Australia Adelaide Desalination Plant, SA Australia
Notes	Open intakes are the most common used type of source water collection system for medium scale desalination plants

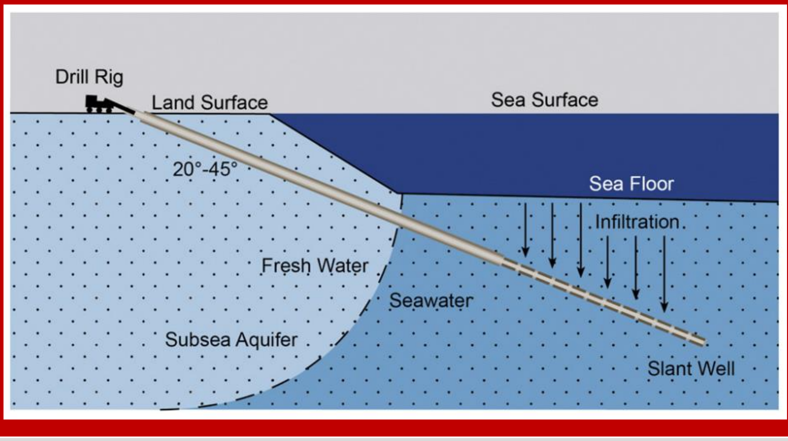
5.5.3 Nearshore Vertical Beachwell

Table 20. Nearshore Vertical Beachwell technology summary

Option	**Nearshore Vertical Beachwell** 
Description of Technology	The nearshore vertical beachwell consists of the following: - • Non-metallic well casing • Vertical well shaft • Well screen • Vertical turbine pump • Well pump house This technology relies on seawater being transferred through a sandy substrate into the well.
Capacity	Capacity from 0.1 to 4.0 MLD per well
Water quality improvement	Reduced suspended solids and turbidity
Maturity of technology	Mature
Advantages	• Common technology globally • No impingement /entrainment
Disadvantages	• Uncommon in Australia. (difficulty to source local expertise) • **Low capacity will require multiple wells (≥10 for 12MLD)** • **Potential negative impact on visual amenity as location on beach** • Potential impact of groundwater drawdown • Environmental disruption during construction likely • Supporting infrastructure including pipelines and electrical power must be installed on or under the beach. • **Potential for beach erosion to render inoperable or limit capacity** • Will require pilot testing
Reference Sites	None in Australia (approved previously for use at 2MLD Tuggerah emergency desalination plant in 2007 - Wyong Shire Council) Ibiza, Spain - 8 wells 26MLD feed volume Ghar Lapsi, Malta - 15 wells 57MLD feed volume
Notes	Unsuitable for areas of high erosion in Rous County

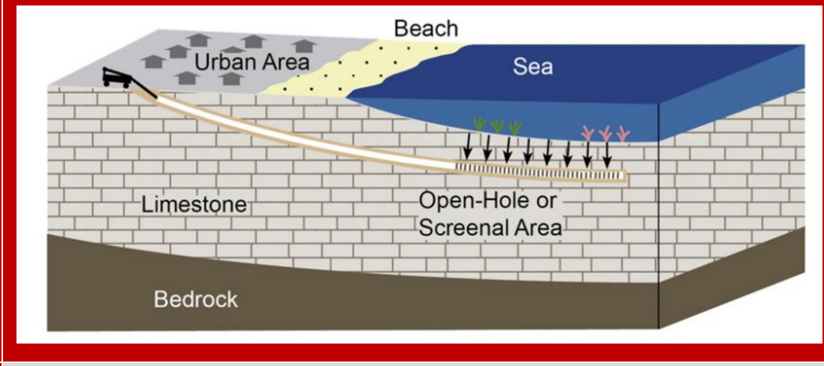
5.5.4 Angle Beachwell

Table 21. Angle Beachwell technology summary

Option	Angle Beach Well 
Description of Technology	Well shaft angles to extend from beach to beneath seafloor Well pump house
Capacity	**Unproven** but likely Capacity from 0.7 to 18.5 MLD per well
Water quality improvement	Reduced suspended solids and turbidity
Maturity of technology	Immature
Advantages	• Higher capacity than vertical well • No impingement /entrainment • Construction site and final well pad can be constructed in the back-beach zone or entirely off beach. • Minimal potential for groundwater drawdown • Beach erosion less likely to cause issues • Multiple wells can be drilled radially outward from a single well pad • Less impact on the environment
Disadvantages	• **Untested technology** • Uncommon in Australia (difficulty to source local expertise) • **Will require minimum of 2 wells for full plant capacity** • Some potential for environmental disruption during construction likely • Potential for seabed water to be anoxic with high concentrations of iron which will require a greater degree of pre-treatment • Will require pilot testing
Reference Sites	**Only one angle well has been tested to date in California**
Notes	Unproven technology too high risk to implement

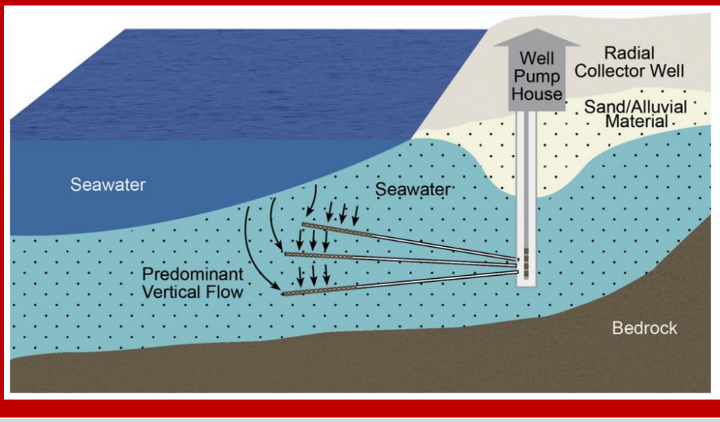
5.5.5 Horizontal Well Technology

Table 22. Horizontal Well technology summary

Option	**Horizontal Well** 
Description of Technology	Horizontal, perforated screens drilled horizontally 5-10m below seabed Typically inclined at 15-20 degrees Well shaft angles to extend from beach to beneath seafloor Well pump house located behind beach
Capacity	Capacity from 0.7 to 18.5 MLD per well (typically 3.5 to 5MLD)
Water quality improvement	Reduced suspended solids and turbidity
Advantages	• Higher capacity than vertical well • No impingement /entrainment • Construction site and final well pad can be constructed in the back-beach zone or entirely off beach. • Minimal potential for groundwater drawdown • Multiple wells can be drilled radially outward from a single well pad • Less impact on the environment
Disadvantages	• Untested technology in Australia (difficulty to source local expertise) • **Will require minimum of 2 wells for full plant capacity** • Some potential for environmental disruption during construction likely • Potential for seabed water to be anoxic with high concentrations of iron which will require a greater degree of pre-treatment • Will require pilot testing
Reference Sites	**None in Australia** Alicante, Spain - 30 wells 130MLD feed volume San Pedro del Piñata, Spain - 19 wells 130MLD feed volume Cartagena Canal, Spain - 20 wells 65MLD feed volume

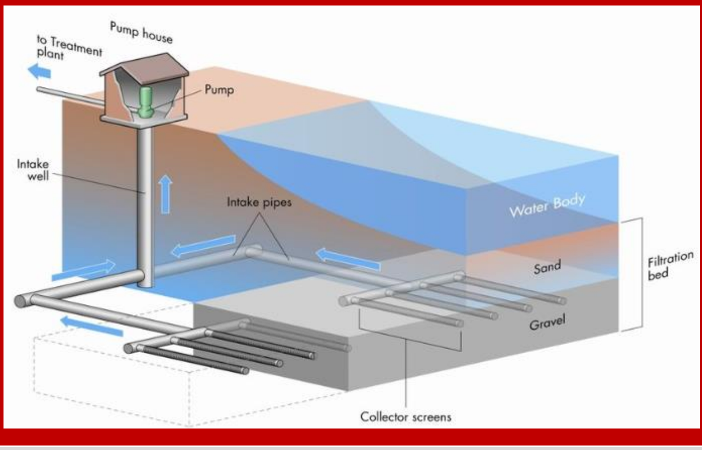
5.5.6 Radial Collector Well

Table 23. Radial Collector Well technology summary

Option	**Subsurface – Radial Collector Well** 
Description of Technology	Vertical Well shaft with concrete caisson functions as wet well One or multiple horizontal well shaft extension with filters radiating out from base Well pump house Standard vertical pump(s) installed on the caisson
Capacity	0.7 to 18.5 MLD per well
Water quality improvement	Reduced suspended solids and turbidity
Advantages	• Higher capacity than vertical well • No impingement /entrainment • Ability to have pump station and well head located off beach behind dunes • Reduced potential for groundwater drawdown (compared to vertical beach wells) • Beach erosion less likely to cause issues (compared to vertical beach wells)
Disadvantages	• Uncommon in Australia. (difficulty to source local expertise) • **Will require minimum of 2 wells for full plant capacity** • Environmental disruption during construction likely • **Potential for beach erosion to render inoperable or limit capacity** • Will require pilot testing
Reference Sites	**None in Australia** Santa Cruz, Mexico - 3 wells 15,000m^3/d feed volume
Notes	High risk potential for areas of high erosion in Rous County

5.5.7 Subsea Infiltration Gallery

Table 24. Subsea Infiltration Gallery technology summary

<table>
<tr><td>Option</td><td>Subsurface – Subsea Infiltration Gallery

</td></tr>
<tr><td>Description of Technology</td><td>Collector Screens 3m below seabed
Gravel packing layer
Filtration sand bed
Intake pipes and intake well located on back beach
Pump house & pumps</td></tr>
<tr><td>Capacity</td><td>Unlimited</td></tr>
<tr><td>Water quality improvement</td><td>Reduced suspended solids and turbidity</td></tr>
<tr><td>Advantages</td><td>• Higher capacity than vertical well
• No impingement /entrainment
• Ability to have pump station located off beach behind dunes
• No groundwater drawdown (compared to vertical beach wells)</td></tr>
<tr><td>Disadvantages</td><td>• Seabed must be excavated to install engineered filter system.
• Massive environmental disruption as large area of seabed must be removed and disposed to landfill, killing all bottom dwelling wildlife at that location.
• Very expensive to construct
• Very long construction time will have beach closed for long time</td></tr>
<tr><td>Reference Sites</td><td>None in Australia
Fukuoka, Japan 103,000 m^3/d with infiltration bed area of 2 ha</td></tr>
<tr><td>Notes</td><td>Locating a subsea filtration gallery is not feasible because it would result in an unacceptable environmental impact to surrounding area and would also have massive area of beach closed for extended period of time (1 year plus) during construction.</td></tr>
</table>

5.7 Outfall Options

An outfall is required to discharge the brine (reject from the RO) and backwash and CIP waste. An EIS will need to be undertaken to determine the allowable levels of salinity and what levels of backwash and CIP waste can be discharged to the ocean.

The outfall for a desalination plant will typically consist of an offshore pipeline with a diffuser or series of diffusers similar to what is described in section 5.5.2 for the inlet. These types of outfalls are typically in use for STP's (an option that can be explored is using a combined outfall for brine and sewage effluent).

Other options are discharge in tidal systems with a holding tank which would only release during an outgoing tide this would greatly limit operation of the plant and would require significant additional infrastructure and is therefore not a preferred option.

Selection of the outfall option can only be completed once the EIS has been completed, most likely this is an offshore pipeline with several diffusers.

5.8 Pre-treatment Filtration System

Pre-treatment based on conventional processes (coagulation-flocculation- media filtration) is the most applied approach at present (*Voutchkov 2013*). In recent years, several new full- scale MF or UF systems have been installed for pre-treatment prior to SWRO.

Pre-treatment filtration is a critical for maintaining performance of seawater desalination plants. As seawater typically has a higher tendency for membrane fouling SWRO requires more extensive pre-treatment processes than ground water and surface water plants (*Greenlee 2009*). As a result, the main factor for the successful operation of a desalination plant is maintaining constant high feed water quality. Rous County coastal areas have generally consistent feedwater, however after heavy rainfall plumes of very turbid, fine silt laden, water linger and migrate up the coast emanating from estuaries in the region. Under those circumstances Desalination is often used to supplement drinking water supply as traditional treatment plants are often not able to treat water at full capacity due to raw water deterioration.

Filtration is required to remove particulate contaminants from the seawater for the protection of the RO membranes. The commonly accepted quality indicators of RO feed water in this respect include: -

1. Turbidity;
2. Suspended solids concentration; and
3. Silt density index (SDI).

Turbidity, usually expressed as nephelometric turbidity units (NTU), is determined through measurements of intensity of light scattered by suspended particles in water samples.

Suspended solids concentration, measured as Total Suspended Solids TSS, is determined by filtration of measured volume of water sample and weighting of dry residue on the filter.

The SDI is determined through measuring the rate of filtration of water sample through the filter. $SDI=100*(1-t_0/t_{15})/15$. Figure 6 below shows the configuration of SDI equipment.

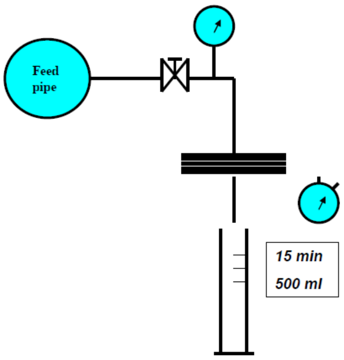


Figure 7: Schematic Configuration of Silt Density Index (SDI) Equipment (From *Wilf 2018)*

Poor feedwater quality results in increased cleaning frequency of RO trains. The relationship between SDI increase and RO cleaning frequency is shown in Figure 7 below. This relationship shows the importance of maintaining feedwater quality. Increased feedwater quality results in reduced RO plant down time for membrane cleaning and resulting from this increased RO membrane life.

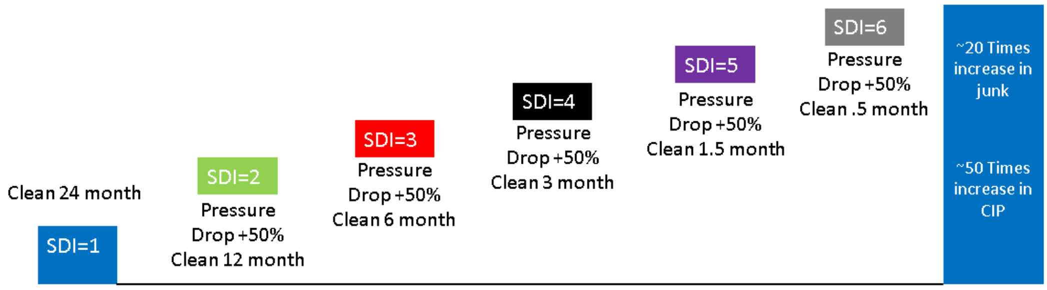


Figure 8: Relationship between SDI and RO cleaning frequency

5.8.1 Media Filtration systems

Granular media filtration is the most commonly used filtration process in existing full-scale SWRO plants (*Jamaly 2014*). Filter media type, uniformity, size and depth are of key importance for the performance of seawater pre-treatment filters. Dual media filters (DMF) typically include 0.4 to 0.8m of anthracite over 1.0 to 2.0m of sand.

When the source seawater contains a large amount of fine silt or the seawater intake experiences algal blooms dominated of micro-algae (0.5 to 20 µm), multi-media filters MMF (0.45 to 0.6m of anthracite, 0.2 to 0.3m of sand, and 0.1 to 0.15m of garnet or limonite) are often be employed (*Voutchkov 2017*).

Granular media filters can be classified as gravity and pressure filters depending on the driving force used for filtration. Gravity filters are operated at water pressure drops between 1.8m and 2.4 m. Pressure filters typically run at feed pressures equivalent to 15 to 30m of water column. According to Voutchkov (*2010*), pressure filters are typically used for small and medium size capacity SWRO plants (< 20,000m3/day) and gravity filters are used for any sizes of desalination plants

Media filtration MMF and DMF will only remove suspended solids >10 µm in size. Any solids smaller than 10 microns will pass through the sand filters.

Table 25, below shows the advantages and disadvantages of media filtration technologies.

Table 25. Media Filtration technology summary

Option	**Media Filtration**

	
Description of Technology	Media filtration systems generally consist of the following: - • Pressurised or open tanks containing granular filtration media • MMF - layers of anthracite, sand and garnet in a filter vessel • DMF - layers of anthracite and sand in a filter vessel • Pressure or gravity may be used as the driving force to transport water through the filter media • Pressure transmitters trigger automated backwashes on filter differential pressure • Air scour system to improve performance of backwash system
Filtrate Water Quality	Turbidity normally ≤ 1.0 NTU when feed turbidity ≤10 NTU SDI_{15} normally ≤ 3.0
Advantages	• Slightly lower capital cost for construction (5%), than Membrane filtration • Slightly lower power consumption
Disadvantages	• Higher chemical costs due to coagulant and process chemicals required for optimisation • Additional solids handling required for high solids in backwash resulting from coagulant dose. Backwash wastewater must be treated prior to disposal • Increased continual dosing of hypochlorite to prevent bio-growth in filters • Increased power consumption • Larger footprint ~30-50% larger than membrane filtration can be an issue when coastal real estate is expensive
Reference Sites	Perth Kwinana Desalination Plant, WA Dual Media pressure filters Sydney Desalination Plant, Kulwin, NSW, 600MLD treated by 12 DMF gravity filters

5.8.2 Membrane Filtration systems

Membrane filtration when used as a pre-treatment for seawater desalination is generally achieved using microfiltration and ultrafiltration. The principle of micro filtration and ultrafiltration is physical separation. The extent to which dissolved solids, turbidity and microorganisms are removed is determined by the size of the pores in the membranes. Substances that are larger than the pores in the membranes are fully removed. Substances that are smaller than the pores of the membranes are partially removed, depending on the construction of a refuse layer on the membrane.

Pore size in Ultrafiltration filters is generally 0.01 to 0.02 µm (microns). When particle analysis of feed water shows suspended solids' size <10µm filtration is best achieved using UF and shows considerable improvements over conventional filtration methods removing suspended solids <5 µm in size. In these instances, if ultrafiltration is not utilised, secondary cartridge filters will need to be replace very frequently (lasting days instead of many months).

Membranes with a pore size of 0.1 – 10 µm perform micro filtration. Microfiltration membranes remove all bacteria. Only part of the viral contamination is caught up in the process, even though viruses are smaller than the pores of a micro filtration membrane. This is because viruses can attach themselves to bacterial biofilm.

Microfiltration (MF) and ultrafiltration (UF) membranes are becoming the preferred pre-treatment technology for RO systems. This is especially true of project locations that experience wide variations in feed water quality. Among the UF, and MF membranes, UF membranes seem to be the most common.

To prevent plugging or damaging of membranes by hard and sharp particles from the feed water, water needs to be pre-filtered before microfiltration or ultrafiltration processes take place. The pores of the pre-filtration unit need to be ≤ 100µm.

The table below shows the advantages and disadvantages of membrane filtration technologies.

Table 26. Membrane Filtration technology summary

Option	**Membrane Filtration (Ultrafiltration / Microfiltration)** 
Description of Technology	Membrane filtration systems generally consist of the following: - • Physical configurations include hollow fibre, spiral wound, cartridge and tubular • Hollow fibres that can be operated in the outside-in or inside-out direction • Pressure or vacuum may be used as the driving force to transport water across the membrane surface • Pressure (35 to 240 kPa) or vacuum (-20 to -83 kPa for outside in membranes only) • Pressure driven membranes are encased and mounted on racks • Vacuum driven membranes are immersed in tanks • Pressure transmitters trigger automated backwashes on trans membrane pressure. • Air scour system to improve performance of backwash system • Chemical enhance cleaning system (hypochlorite, citric acid etc.) • Fine pre-screens (100µm) to prevent damage by hard/sharp particles in feed
Filtrate Water Quality	Turbidity consistently at or below 0.1 NTU SDI ~ 1
Advantages	• Consistent high quality and quantity of RO feed water • Increased RO plant uptime where feed water quality is variable • Due to lower SDI values, RO can be operated at 20% higher flux if feasible, reducing RO capital costs • Less chemical cleans for RO can be reduced to once per year or less frequently. • Small footprint ~50% reduction compared with media filtration • Chemical use is lower, dependent on raw water quality • Coagulants only required for short periods during high turbidity spikes resulting from sustained periods of rainfall • Less solids handling no need for additional solids handling for backwash wastewater • If membrane filtrate flows direct to SWRO train can eliminate need for expensive additional cartridge filters
Disadvantages	• Slightly higher power consumption • Slightly higher capital cost for construction (~5%)
Reference Sites	Adelaide desalination plant, SA (Evoqua MEMCOR® CS) Perth Southern desalination plant, Binningup, WA (Evoqua MEMCOR® CP) Agnes Water desalination plant, QLD (Evoqua MEMCOR® CP)

The current trend is to use a variable coagulation regime, reducing the concentration from a minimal concentration during poor feed quality episodes to zero when quality is good.

There are many membrane filtration manufacturers most of whom have representatives in Australia. Table 27 below (From *Lau, 2014 & 2015*) show the key players in the membrane filtration market and the technologies offered for seawater filtration applications.

Table 27. Commercial Seawater UF membranes

Manufacturer	Product (polymer)	Filtration mode I/O - Inside out O/I - Outside in CF - Cross flow DE – Dead-end S – Submerged E - Encased	System Type	Flux l/m²/h	Typical Recovery %
Dow	IntegraFlux™ SFD-2880 (PVDF)	Encased O/I	UF	40-120	N/A
Evoqua (US Filter)	MEMCOR® CP MEMCOR® CS	E. O/I DE S. O/I DE	UF	25-70	90-98.5
Hydranautics	HYDRACAP MAX ™ (PVDF)	E. O/I	UF	59-120	95-98
Hyflux	Kristal 2000	E. O/I	UF	55-75	85-99
Inge	Dizzler XL™(PES)	Encased I/O DE and CF	UF	68-145	85-98
Koch	KOCH (PVDF)	E. I/O	UF	100 BW 68 OI	88-93 BW* 80-90 OI
Norit X-Flow	XIGA (PES/PVP) Seaguard 55 (PES)	E. I/O DE E. I/O	UF	71 4-172	90-96
Pall (Asahi)	Microza FLUXPRO™	E. I/O E. O/I	MF UF	440 96-180	>95 >95
Suez WTS	ZeeWeed™1500 (PVDF) ZeeWeed™ 700B (PES)	E. O/I E. I/O	UF	17-68	85-99

*BW=Beach Well OI=Open Intake

5.9 RO Train Energy Recovery

Energy recovery devices are used on SWRO trains to reduce the energy demand of the plant. The energy recovery devices are used in seawater desalination plants to reduce power consumption of the high-pressure feed pumps by up to 60%. RO membranes require feed water to be of enough pressure to drive the desalination process. Because the brine stream exiting the pressure vessel is still highly pressurized, the energy that would otherwise be wasted can be captured to offset the energy required to pressurize the feed water.

There are two types of energy recovery devices in desalination plants isobaric and hydraulic/centrifugal devices. Some of the devices used to recover energy from brine to reduce power demand are reviewed below. The selection of energy recovery devices will be dependent on the design of the SWRO trains. Different manufacturers incorporate different devices in their modular equipment.

5.9.1 Pressure Exchanger PX

The **Pressure Exchanger** (PX) is an isobaric energy recovery device. The PX was developed in the early 1990s by Energy Recovery Inc. in San Leandro California.

A pressure exchanger acts like a fluid piston, transferring energy between high-pressure and low-pressure fluids through continuously rotating ducts. These ducts are part of the rotor, the only moving part inside the pressure exchanger. Figure 8 shows the internal components and fluid flows of a pressure exchanger unit. The rotor, sleeves and end covers are ceramic, and a result do not suffer from corrosion related issues. The housing is fibreglass.

Key to the operation of a pressure exchanger is the mic0ron-level clearance between the rotor and the sleeve. Fluid circulating within this clearance acts as a bearing, minimizing friction for an extremely efficient exchange of pressure energy. This bearing can suffer scaling related seizure if antiscalant dosing fails due to this small clearance.

- Delivers energy savings of up to 60% and efficiencies up to 98%
- Installed at Perth-Kwinana, Perth-Binningup, Adelaide and Victoria-Wonthaggi Desalination Plants

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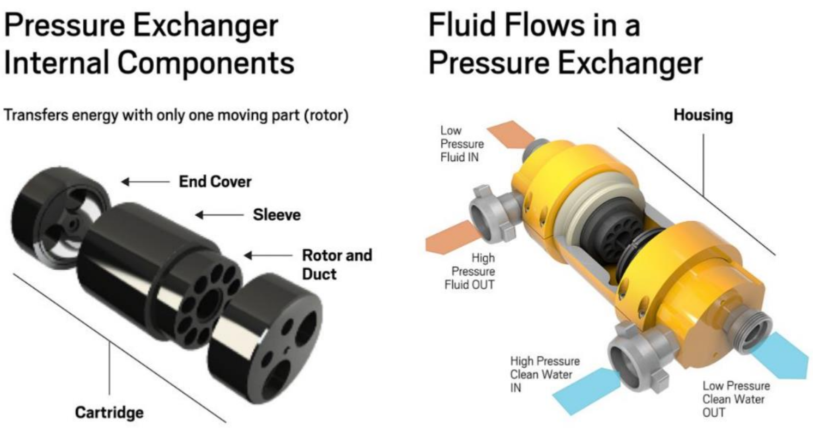


Figure 9. Pressure Exchanger components & fluid flows

Figure 10. Energy Recovery Inc Pressure exchangers at Perth Desalination Plant

5.9.2 FEDCO Hydraulic Pressure Booster (DWEER)

The **Dual Work Exchanger Energy Recovery** (DWEER) is an isobaric energy recovery device. In the 1990s developed by DWEER Bermuda and licensed by Calder AG (Flowserve).

The DWEER system uses a piston double chamber reciprocating hydraulically driven pump, and a patented valve system in a high pressure batch process with large pressure vessels, similar to a locomotive, to capture and transfer the energy lost in the membrane reject stream See Figures 10 and 11. Its advantage is its high efficiency rate, but it suffers from complex and large mechanical components which are susceptible to corrosion from seawater due to its metal composition.

- 90% of energy is recovered from the seawater concentrate and is used to pressurise the incoming seawater.
- This reduces the plant's energy needs by up to 60%.
- Installed at Gold Coast - Tugun, Sydney - Kurnell, Perth Binningup and Adelaide Desalination Plant.

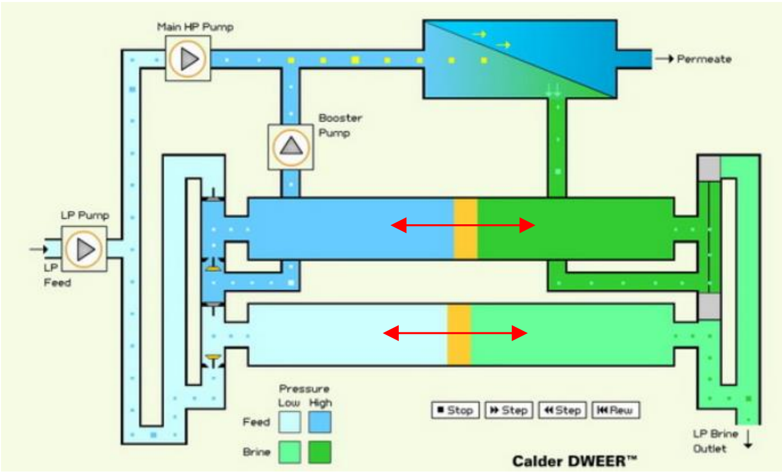


Figure 11. DWEER Energy recovery device showing flows

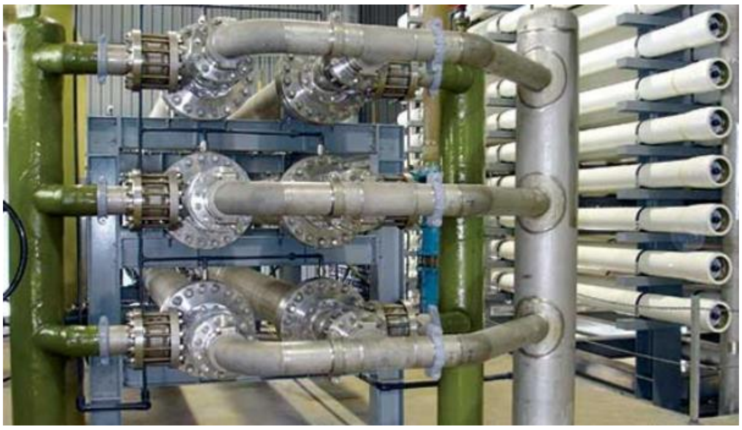


Figure 12. Photo of DWEER devices installed in desalination plant

5.9.3 FEDCO Hydraulic Pressure Booster (HPB)

The FEDCO Hydraulic Pressure Booster (HPB) is a centrifugal energy recovery device. The hydraulic pressure booster was developed in the 1990s.

The hydraulic pressure booster has an impeller and a turbine, which are coupled to a shaft within the same casing. The main feed pump and the impeller and runner are placed in series. See Figure 12 for flow configuration.

Generally, as these devices are coupled directly to the RO train High-pressure feed pump, their use is restricted to smaller RO trains sizes of around 1- 1 ½ MLD.

- Delivers energy savings of up to 50% and efficiencies over 80%.
- Installed in SUEZ WTS SeaTECH-E-Series packaged plant systems globally.

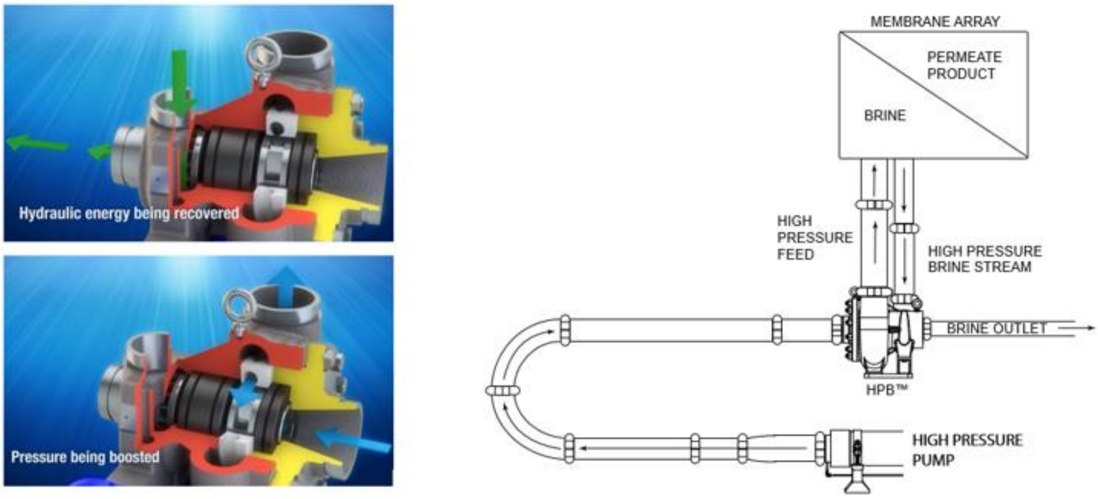


Figure 13. Hydraulic Pressure Booster Flow path

5.10 Remineralisation of SWRO Permeate

The SWRO permeate has most minerals removed which makes the water aggressive, the water has a high corrosion potential (sometimes called plumbosolvency)[5], If this water is not treated this water can adversely impact on assets in the reticulation scheme and infrastructure owned by customers. The corrosivity of the water is expressed as the Langelier Saturation Index (LSI) or, as is used by most water utilities in Australia, the Calcium Carbonate Precipitation Potential (CCPP).

LSI Indication: -

1. LSI<0 Water is under saturated with respect to calcium carbonate. Under saturated water tends to remove existing calcium carbonate protective coatings in pipelines and equipment;
2. LSI=0 Water is neutral. Neither scale-forming nor scale removing; and
3. LSI>0 Water is supersaturated with respect to calcium carbonate (CaCO3) and scaling.

There are three options to increase the minerals to ensure the desalinated seawater water does not damage infrastructure.

The first option is to remineralise by blending desalinated water with other sources. the second option is the direct dosage of chemicals while the third option is to remineralise by passing all or part of the flow through a calcite filter.

5.11 Blending Desalinated water with other Water Sources

Blending of the RO permeate with either seawater or brackish water may be considered a low-cost method to increase the concentration of some ions in desalinated product. However, this method invariable add other, undesired components, to the water (*Birnhack, 2018*). The concentrations of all the introduced ions are a function of the blended water composition and the blending fractions, making control over the product water quality limited. Consequently, blending is not recommended for water intended for domestic use (*Fritzmann, 2007*). Alternatively, the RO permeate can be blended with water from a conventional treatment plant in practice as mixing large volumes of water requires significant infrastructure and both water sources are than linked which limits redundancy.

The following advantages are noted: -

- Reducing the overall RO capacity that is required for the desalination plant as a result of the volume of seawater or brackish groundwater introduced into the final product water flow;
- Lower operating and chemical costs; and
- Smaller footprint.

The following disadvantages are noted: -

- Blending of the two different streams will require careful management when water quality is varied;
- Negative environmental and economic implications such as elevation in the concentrations of boron, chlorides; and sodium ions; and
- It reduces the overall redundancy and flexibility to operate the system as part of the wider network.

[5] Plumbosolvency is the ability of a solvent, notably water, to dissolve lead. (Plumbum is Latin for lead). In the public supply of water this is an undesirable property. In (usually older) consumers' premises plumbosolvent water can attack lead pipes and any lead in solder used to join copper. Concrete-lined pipes and tanks, and even steel pipes can be corroded by plumbosolvent water.

5.12 Direct Dosage of Chemicals

Direct dosage refers to direct injection of chemical to the water. The chemicals may be either in a slurry form (hydrated lime), dissolved in a solution (calcium salts), or in a condensed liquid form ($CO_{2(l)}$) that transforms into $CO_{2(g)}$ and dissolves into the water. Typical direct dosage treatments combine the addition of total hardness and alkalinity to the water.

The following advantages are noted: -

- Simplicity;
- Relatively low capital cost;
- Increased flexibility in control of product water quality;
- Smaller footprint; and
- Most frequently used method in Australia so increased potential for operator knowledge of process.

The following disadvantages are noted: -

- Higher operational costs due to high cost of chemicals; and
- Unavoidable addition of unwanted counter ions.

5.12.1 Calcite Dissolution Process

Remineralisation of the RO permeate will can be achieved using add another process step to the system by using calcite reactors. The reactors are often mistakenly referred to as filters. These reactors add minerals to the water and improve both the pH and the LSI. This option provides flexibility in the operation, the RO permeate water can either be completely treated with the calcite reactor or a side stream partially treated and blended. The preferred operating regime can be determined based on the quality produced by the SWRO. This option provides additional operational flexibility.

The following advantages are noted: -

- Remineralisation of the RO permeate will allow for independent control of the LSI of the product water;
- Increased flexibility and redundancy in plant operation; and

The following disadvantages are noted: -

- Additional Capital Expenditure for reactor beds;
- Increased plant footprint; and
- Increased operating costs when using the remineralisation process.

For smaller desalination plants Calcite Dissolution is the most selected methodology for remineralisation. For smaller plant around 1 MLD the increased cost of installing Calcite Reactor Vessels is less notable compared to cost of installing Lime and CO_2 dosing systems. Across all the Big 6 Australian Desalination plants (Gold Coast, Sydney, Adelaide, Victoria, Perth & Beenyup) remineralisation is achieved using Lime and CO_2 direct dosing. It is recommended that Lime and CO_2 dosing are used for remineralisation in the RCC desalination plant.

5.13 Benchmarking Review of Comparable Australian Seawater Desalination Projects

Desalination plants within Australia that have been completed in the past two decades of a similar style and size have been reviewed to provide benchmarking and an overview. The Belmont Drought Response Desalination Plant and the Agnes Waters Desalination plants are considered the best from a comparison perspective and further information is provided in the below sections specifically on these two projects. Pricing has been adjusted for CPI to accommodate for any change in CAPEX over time note that is a practical approach to allow for change in pricing but does not take into account any changes in technology and/or pricing.

Although these projects differ considerably in scope, production levels and environment

Project Name	Location	Capacity	Project Value (including intake/outfall)	CAPEX per MLD	Construction Year	CPI Adjusted Value[6]	CPI Adjusted CAPEX per MLD
Belmont Drought Response Desalination Plant	Lake Macquarie City, NSW	15 MLD	$90MM	$6MM (estimated)	Still in design development	$90MM	$6MM (estimated)
Agnes Waters Desalination Plant (1770)	Agnes Waters, QLD	1.5 MLD, 7.5 MLD Future	$29MM	$19.3MM /3.8MM	2010	$35MM	23.3MM/ 4.67MM
Adelaide Desalination	Port Stanvac, SA	300 MLD	$1,830MM	$6.1MM	2012	$2,085MM	6.95MM
Gold Coast Desalination Plant	Tugun, QLD	125 MLD	$1,200MM	$9.6MM	2009	$1,480MM	11.84MM
Sydney Desalination Plant	Kurnell, NSW	250 MLD	$1,803MM	$7.212MM	2010	$2,260MM	9.04MM
Melbourne Desalination Plant	Wonthaggi, VIC	410 MLD	$5,700MM	$13.9MM	2012	$6,496MM	15.84MM
Perth (Southern) Desalination Plant	Binningup, WA	270 MLD	$955MM	$3.537MM	2012	$1,090MM	4.04MM
Kwinana Desalination Plant	Kwinana, WA	130 MLD	$389MM	$3MM	2006	$522MM	4.02MM

CAPEX Pricing per ML produced shows a relatively wide range (4.02-15.84MM) which reflects a wide range of scope (for instance the Wonthaggi project included a major power upgrade which significantly added to the CAPEX of the project). A basic benchmarking exercise shows that the average CAPEX per ML is **7.8MM** per ML.

Two projects are more comparable in scale, Agnes Water and Belmont Drought Response, these have been considered in further detail in the below. Benchmarking exercise against these two projects provides a CAPEX per ML around **5.38MM** per ML.

5.13.1 Agnes Water 1770 QLD.

Gladstone Regional Council engaged Trility and Osmoflo to design, build, operate and maintain an expandable 1.5 MLD containerised seawater desalination plant at Agnes Water. The plant is comprised of two containerised microfiltration and Reverse Osmosis units, with the ability to treat 7.5 MLD when expanded. The raw water intake and reject brine outfall infrastructure consists of a 600 m section of 630mm PE pipe, constructed via horizontal directional drilling. It is understood that the project was delivered at a loss to the contractor.

[6] CPI Values from Reserve Bank of Australia, accessed 29/03/2020

Overall capital cost for the desalination plant and intake/outfall infrastructure was approximately $29MM. The plant requires two FTE to run. The CPI adjusted value of this plant is approximately $35MM.

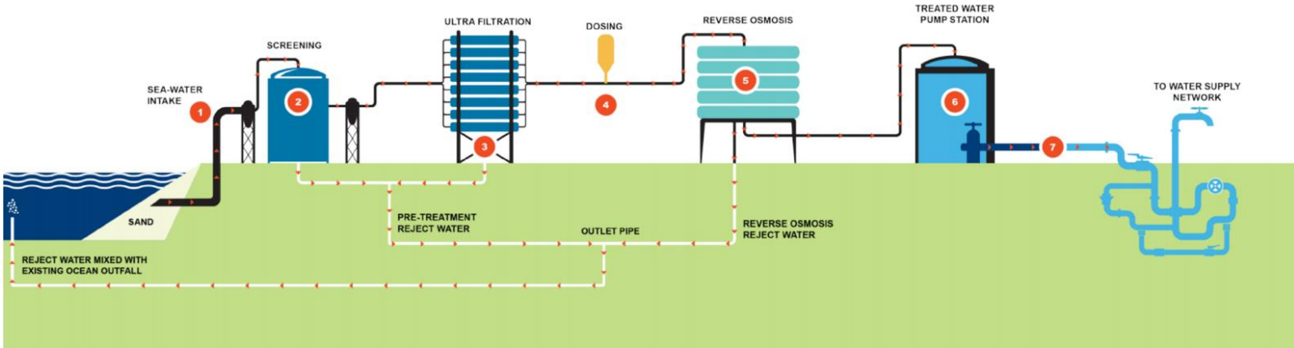
5.13.2 Belmont Drought Response Desalination Plant, NSW

Hunter Water Corporation are planning to construct a drought response desalination plant, adjacent to the Belmont Wastewater Treatment Works in Belmont South, near Lake Macquarie in NSW. The Project has a suburb of currently part way through the approval process in NSW The Project is for the construction and operation of a drought response desalination plant, designed to produce up to 15 MLDay of potable water, with key components including:

- **Seawater intakes** – The central intake structures would each be a concrete structure (referred to as a caisson) of approximately nine to 11 metres diameter, installed to a depth up to 20 m below existing surface levels. The intake structures would be finished above the existing surface (0.5 m to 1 m) to prevent being covered by dune sands over time. The raw feed water (seawater) input is proposed to be extracted from a sub-surface saline aquifer. This would be extracted by intake pipes located approximately eight to 15m below ground level radiating out from the central structure. Pipelines and pumps are required to transfer the seawater to the desalination plant.
- **Water treatment process plant** – The water treatment process plant would comprise a range of equipment in potentially containerised form. Services to and from the process equipment (e.g. power, communications, and raw feed water (seawater)) would comprise a mix of buried and overhead methods. The general components of the water treatment process would comprise:
  - *Pre-treatment:* a pre-treatment system is required to remove micro-organisms, sediment, and organic material from the seawater.
  - *Desalination:* a reverse osmosis (RO) desalination system made up of pressurising pumps and membranes. These would be comprised of modular components. In addition, a number of tanks and internal pipework would be required.
  - *Post treatment:* desalinated water would be treated to drinking water standards and stored prior to pumping to the potable water supply network.
- **Brine disposal system** – The desalination process would produce up to 28 MLD of wastewater, comprising predominantly brine, as well as a small amount of pre-treatment and RO membrane cleaning waste. The waste brine from the desalination process would be transferred via a pipeline to the existing nearby Belmont WWTW for disposal via the existing ocean outfall pipe.
- **Power supply** – Power requirements of the plant would be met by a minor upgrade to the existing power supply network in the vicinity of Hudson and Marriot Streets. A power line extension from the existing line along Ocean Park Road into a new substation within the proposed drought response desalination plant would also be required.
- **Ancillary facilities** – including a tank farm, chemical storage and dosing, hardstand areas, stormwater and cross drainage, access roads, and fencing, signage and lighting.

Figure 14 provides a visual schematic of the indicative processes related to the operation of the drought response desalination plant.

Figure 14. Belmont Drought Response Plant - Indicative desalination process (from Hunter Water 2019)



The desalination plant has a reported cost estimate of $87 million and Hunter Water have advised a Total Cost for the project of $100 million (Hunter Water 2019). The plant will utilise 4 FTE to operate and run.

6. Review of Environmental & Social Planning Aspects

According to the Australian Water Association (AWA 2014), desalination is often the last resort to address water supply security and/or quality. This is due to the higher cost of production, compared with traditional water resources, except when the latter is scarce due to drought and/or political situation. Key barriers to increasing adoption of desalination technology for municipal water supplies include: -

- Capital and operating costs;
- Public perception (energy use, environmental impact);
- Environmental impact (energy consumption, management of waste saline concentrates, disposal of large quantities of membrane modules);
- Lack of transparent assessment of desalination plant versus treatment of natural catchment supplies with respect to water security; and
- Lack of centralised repository of information pertaining to the use, performance and lessons learnt from existing desalination plants in Australia.

Construction of a new fresh water source (such as a new dam or bore water system) does not offer the resilience that a seawater desalination plant or recycled water treatment plant offers to a community during prolonged periods of drought.

Recycled water is generally able to achieve high water quality, often greater than current potable water standards, through its treatment systems; however, the public perception of recycled water as drinking water does not allow for the uptake of recycled water for drinking water purposes. Cost of providing recycled water to households is prohibitive and a number of issues reported in the media has swayed the public away from this option.

Public perception of seawater desalination is strongly associated with coastal environmental impacts and high energy demand. A long-standing preference for desalinated water for potable use over other alternative supplies was confirmed in a recent international survey (*Hurlimann 2016*). The combination of continuing improvement in the economics of desalination technology, growing coastal populations, multiple demands on surface water and coastal groundwater supplies, reticence to utilise urban wastewater, and unlimited availability of seawater calls for greater scrutiny of desalination (*Haddad, 2013*).

Studies from different countries topically overlap but have reached varying conclusions on public attitudes and their drivers. Demographic variables appear to be minimally helpful in predicting support for desalination, while an individual's active use of marine resources and strong ocean attachment are consistent predictors of lack of support. Coastal residents seem aware of subsurface ocean processes and are opposed to subsurface infrastructure development that impacts these processes. Positive or negative attitudes toward the public agencies and private companies regulating or proposing/operating desalination facilities influence whether the public supports the projects themselves. It has been observed globally that residents of affluent coastal communities demonstrate not-in-my-backyard (NIMBY) attitudes (*Haddad et al 2018*).

In the AWA/Deloitte 2014 State of the Water Sector Report 2014 an overwhelming number of respondents (96%) believed that desalinated seawater can be treated and managed to a level that is sufficient for safe and reliable potable supply (Figure 15). However, views on whether it is an environmentally sustainable and cost-effective source of potable water varies across jurisdictions.

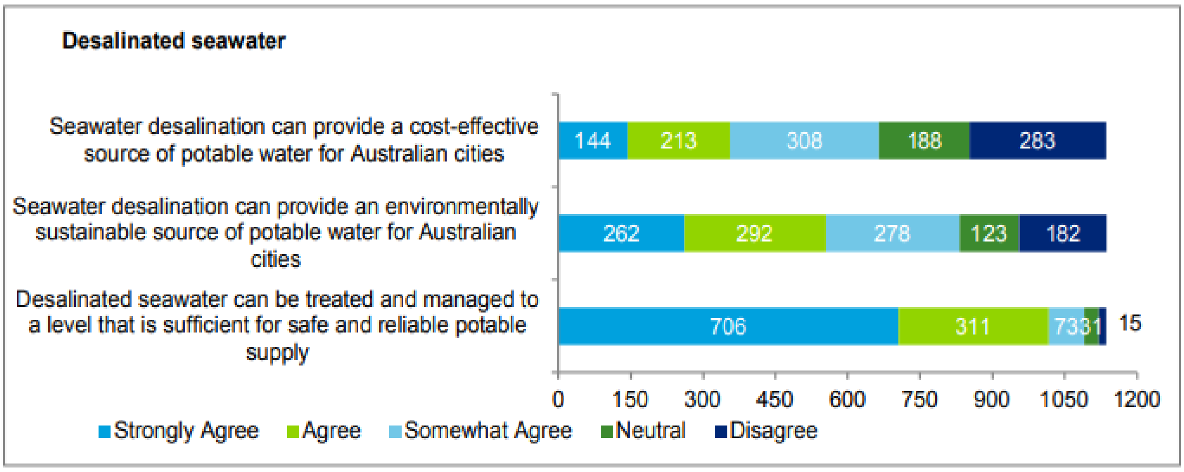


Figure 15: The Australian water sector's views on desalination

The desalination plant location, operation and management will need to comply with a wide range of legislation and policy that governs the management of the coastline and wider region. This includes, but is not limited to;

- Commonwealth Acts and agreements;
- State Government Acts, Environmental Planning Instruments (EPIs);
- State Environmental Planning Policies
- Regional Plans; and
- Local Environment Plans .

Statutory instruments and policies applicable to the project are shown in Table 28, below. This report does not expand to cover the management implications or application of these relevant to the plant.

Table 28. Key Legislation, Policy & Plans that Apply to the project

Key Legislation, Policy, Plans and Agreements
Commonwealth Environment Protection and Biodiversity Conservation Act 1999 China-Australia, Republic of Korea-Australia & Japan-Australia Migratory Bird Agreements Native Title Act 1993 Protection of the Environment Operations Act 1997 Roads Act 1993 **NSW** Crown Lands Act 1989 Environmental Planning &Assessment Act 1979 Fisheries Management Act 1994 Heritage Act 1977 National Parks and Wildlife Act 1974 Coastal Management Act 2016 Marine Estate Management Act 2014 Marine Parks Act 1997 Environmental Planning & Assessment Act 1979 Mining Act 1992 No 29 Local Government Act 1993 Fisheries Management Act 1994 Pipelines Act 1967 Protection of the Environment Operations Act 1997 Water Act 1912 Water Management Act 2000 Local Land Services Act 2013 Crown Land Management Act 2016 Biodiversity Conservation Act 2016

Biosecurity Act 2015
NSW aquifer interference policy
State Environment Planning Policy – Coastal Management 2018
State Environment Planning Policy – Infrastructure 2007
State Environment Planning Policy – State and Regional Development Management 2011
Threatened Species Conservation Act 1995
Local
Ballina Coastline - Coastal Zone Management Plan
Ballina Coastal Reserve Plan of Management 2011
Ballina Coastal Reserve Precinct Plans 1-5 2009
Lake Ainsworth (water estuary) Management Plan 2002
Lennox Headland Masterplan
Lennox Point Vegetation Management Plan 2006
Shaws Bay Management Plan Volumes 1 & 2
Byron Biodiversity Conservation Strategy 2004
Byron Shire Coastal Management Program _Draft
Byron Bay Eastern & Western Precinct CZMP
Brunswick Estuary - Coastal Zone Management Plan

In addition to the above allowance should be made for a community engagement process to ensure all concerns within the community are noted and where possible mitigated. Desalination has proved to be polarising in other communities with misinformation around the effects on the receiving environment frequently being cited. The social license to operate a desalination plant needs to be carefully considered during the planning stages.

6.1 Environmental Considerations

Four main environmental challenges and potential impediments associated with developing desalination facilities include: -

- Potential ecological impacts associated primarily with seawater intakes;
- Potential environmental and ecological impacts associated with brine discharge;
- Potential environmental impacts on coastal land;
- Native title considerations; and
- Energy consumption constraints.

Missimer et Al. (2018) concluded that seawater desalination in all capacity ranges along shorelines of the world can be designed and operated without causing significant environmental impacts. Environmental Impact Assessments (EIA) must be undertaken to establish the parameters to design against. Monitoring must be in place to establish background conditions and during operation to continuously assess environmental conditions and compliance. The incorporation of Environmental Management Plans (EMP) into management protocols will ensure environmental impacts are managed and mitigated effectively during the construction and operation of the desalination plant.

6.1.1 Potential Ecological Impacts Associated with Seawater Intakes

The main ecological concerns related to seawater and estuarine desalination facilities are impingement and entrainment of aquatic organisms associated with water intakes. In addition, when chemical cleaning of the intake structures is used, these can be a source of concern (both for regulatory agencies and the community).

Impingement occurs when marine organisms are trapped against intake screens and other filter mechanisms at the source water intake point by the velocity and force of water flowing through them. The fate of impinged organisms differs between intake designs and among marine life species, age, and water conditions. Anecdotally some hardy species may be able to survive impingement and be returned to the sea, but the 24-hour survival rate of less robust species and/or juvenile fish may be less than 15%.

Entrainment occurs when smaller organisms pass through an intake screen and into the process equipment. Organisms entrained into process equipment are generally considered to have a mortality rate of 100%.

Impingement primarily affects fish and larger organisms that cannot be pulled through screens or filters, whereas entrainment primary affects smaller organisms (e.g., phytoplankton, zooplankton).

Measure to eliminate or minimise the potential for impingement and entrainment of marine organisms should be taken including the following measures:

- Screen intake structures to minimize entrainment of marine species;
- The inflow rate should be less than the prevailing current so that marine life can easily swim around the intake without being caught;
- The through screen velocity of intakes must be lower than 0.15 m/s;
- Use of velocity caps on intakes structures change intake flow direction from vertical to horizontal. This configuration helps in ways: (1) it eliminates vertical vortices and avoids withdrawal from the more productive aquatic habitat closer to the surface; and (2) it creates a horizontal velocity pattern which gives juvenile and adult fish an indication of danger detected by lateral receptors along length of most fish. (See Figure 15);
- Locating the intake outside the littoral zone should result in reduced environmental impacts this should be >335 metres from the shore; and
- Locate the intake >3m above the seabed to prevent entrainment of bottom dwelling species

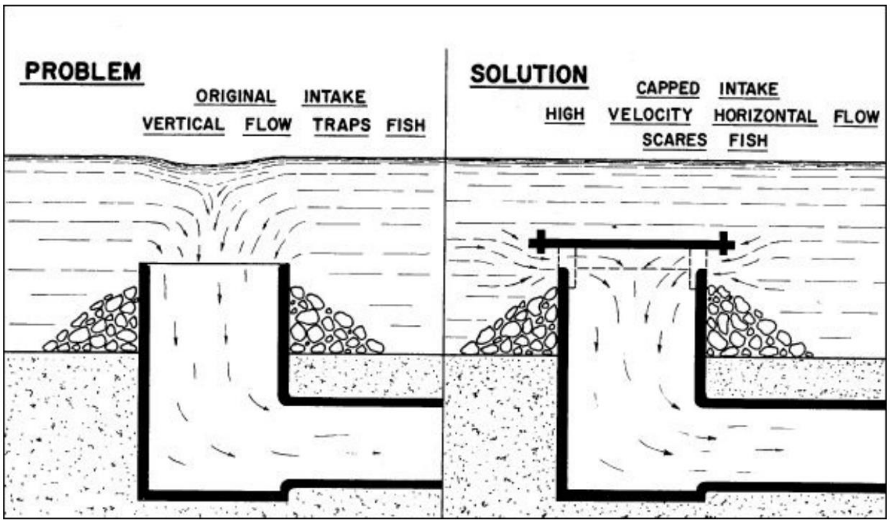


Figure 16: Velocity Cap for Entrainment Reduction (source US EPA)

6.1.2 Potential Environmental and Ecological Impacts Associated with Brine Discharge

Brine, also known as concentrate or reject, is the highly concentrated saline water produced as a by-product in desalination processes. This liquid stream contains most of the dissolved solids of feed water in concentrated form, as well as some pre-treatment chemicals (e.g., residual amounts of antiscalants, coagulants and flocculants) and microbial contaminants. The main environmental concerns associated with brine disposal are: increased salinity of receiving water bodies and soil, regional impacts of high-TDS brine on marine benthic communities near the discharge point, aesthetic problems, disposal of pre-treatment and membrane cleaning chemicals, disposal of corrosion metals such as copper, ferrous iron and nickel (*Panagopoulos 2019).* A list of the potential physical and chemical impacts of desalination plant brine discharges on the marine environment is given in Table 29 (*modified from Maliva & Missimer 2012*).

Table 29: Physical and chemical properties of brine from seawater desalination plants

Physical Properties	
Salinity	Up to 65,000–85,000 mg/L
Temperature	Ambient seawater temperature
Plume density	Negatively buoyant
Dissolved oxygen	If wells used, typically below ambient seawater DO because of the low DO content of the source water. If open intake used, approximately the same as the ambient seawater DO concentration.

Biofouling control additives and by-products	
Chlorine	If chlorine or other oxidants are used to control biofouling, these are typically neutralized before the water enters the membranes to prevent membrane damage.
Halogenated organics	Typically low content before harmful levels
Removal of suspended solids	
Coagulants	May be present is conditioned and the filtered backwash is not treated (e.g., iron-III-chloride). May cause effluent colouration if not equalized prior to discharge.
Coagulant aids	May be present if source water is conditioned and the filter back-wash water is not treated (e.g., polyacrylamide).
Scale-control additives	
Antiscalants	Typically low concentrations below toxic levels.
Acid (HCl or H_2SO_4)	Not present (reacts with seawater to form harmless compounds, i.e. water and chlorides or water and sulphates: the acidity is consumed by the naturally alkaline seawater, so the discharge pH is typically similar or slightly lower than that of ambient seawater)
Contaminants caused by corrosion	
Metals	May contain elevated concentration of iron, chromium, nickel, molybdenum if low quality stainless steel is used in the facility.
Cleaning chemicals	
Cleaning chemicals	Alkaline (pH 11–12) or acidic (pH 2–3) solutions with additives such as: detergents (e.g., EDTA), oxidants (e.g., sodium perborate), biocides (e.g., formaldehyde)

Brine can be harmful to the environment due to its salinity, temperature and chemical substances. Both brine salinity and temperature depend on the production process. The brine salinity is generally 1.6 to 2 times higher than the seawater salinity (35 g/L). Regarding the temperature, the brine produced by membrane-based technologies is at ambient seawater temperature or around 1 ^{o}C warmer so temperature will not have a detrimental effect. This differs from thermal based desalination plants where the brine temperature may be 1.3 to 1.8 times higher than ambient sea temperature. (*Missimer and Maliva 2018*).

The choice of the most suitable brine disposal method depends on numerous factors. These factors are quantity, quality and composition of the brine; the geographical location of the disposal site; availability of receiving site; the permissibility of the option; public acceptance; capital and operating costs and the capacity of the facility for future expansion (National Research Council, 2008). Disposal options for seawater desalination plants include use of evaporation ponds, discharge with wastewater, outfalls the ocean, or saline rivers that flow into an estuary, or injection into a confined aquifer (NRC 2008, Cooley et al. 2006). The most practical discharge methodology for Council will be to use a discharge outfall to the ocean.

Brine has a high salt concentration, and as a result, it is denser than the waters into which it is discharged. Once discharged, brine tends to sink and slowly spread along the ocean floor. Mixing along the ocean floor is usually much slower than at the surface, thus inhibiting dilution and resulting in elevated salt concentrations near the outfall. Diffusers can be placed on the discharge pipe to promote mixing. The Perth desalination plant has monitoring programs in place to evaluate impacts associated with brine discharge. These studies suggest that the short-term impacts of brine discharge can be addressed through dilution and use of multi-port diffusers. The Australian regulation used to control salinity limits of brine discharge at the larger Australian desalination plants are summarised in Table 30 (from *Abessi 2018*).

Table 30 Salinity limits of brine discharge at some Australian desalination plants

Plant	Salinity Limit	Compliance Point (relative to discharge)	Sources
Perth, WA	Increment < 5% Increment ≤1.2ppt at 50m and ≤0.8ppt at 1000m	- 50m and 1000m	Southern California Coastal Water Research Project (SCCRWP)
Kurnell, Sydney NSW	Increment ≤1ppt	50–75m	SCCRWP

Plant	Salinity Limit	Compliance Point (relative to discharge)	Sources
Tugun, Gold Coast, QLD	Increment ≤2ppt	120m	Gold Coast Desalination (GCD) Alliance

Diffuser configuration:
Olabarria advises that for the optimisation of the diffuser, the following criteria must be met (Olabarria 2015):

- The diffuser section should be placed perpendicular to the prevailing ocean current. If there is no one prevalent current direction, then a T-port diffuser can be used.
- Design flows must be discharged satisfactorily through the ports to ensure continuity of flow. Generally, the total cross-sectional areas of the ports should be less than 0.7 times the cross-sectional area of the main pipe at any point in the diffuser. A port diameter of less than 75 mm is susceptible to blockage.
- Maintain enough flow in each port to prevent the intrusion of seawater by gradually increasing port sizes towards the end of the pipe.
- Ensure an even distribution of flows, through all the diffuser ports, because the flow is directly related to the achievable initial dilution, and the worst performing port will be considered as representative of the performance of the diffuser.
- Maintain scouring flows within the diffuser section.
- Optimum dilution will be obtained with diffusers discharging between 45º and 60º to the horizontal and with alternate ports directed in opposite directions.
- The distance between any two ports must be such that the plumes do not merge during the rise of the buoyant plumes.
- The jet velocity must not be less than 3.5 m/sec.

Reducing the amount of chemicals used in the desalination process can decrease the environmental impact of brine discharge. Pre-treating the source water with membrane technologies, such as microfiltration or ultrafiltration, can reduce the use of chemicals throughout the desalination process (Elimelech and Phillip 2011).

Research by Kelaher published in 2019 found that when brine was discharged by the Sydney Desalination Plant that fish numbers around the discharge point increased. Following the commencement of discharging, there was a 279% increase in the abundance of fish around the outlet, which included substantially greater abundances of pelagic and demersal fish, as well as fishes targeted by recreational and commercial fishers. Following the cessation of discharge, abundances of fishes mostly returned to levels such that there was no longer a significant effect compared to the period prior to the commencement of the desalination plant’s operations. Overall, the study results demonstrate that well-designed brine discharge outfall and processes can also enhance local fish abundances and species richness (Kelaher 2019). This is shown in Figure 17 below, from Kelaher’s report.

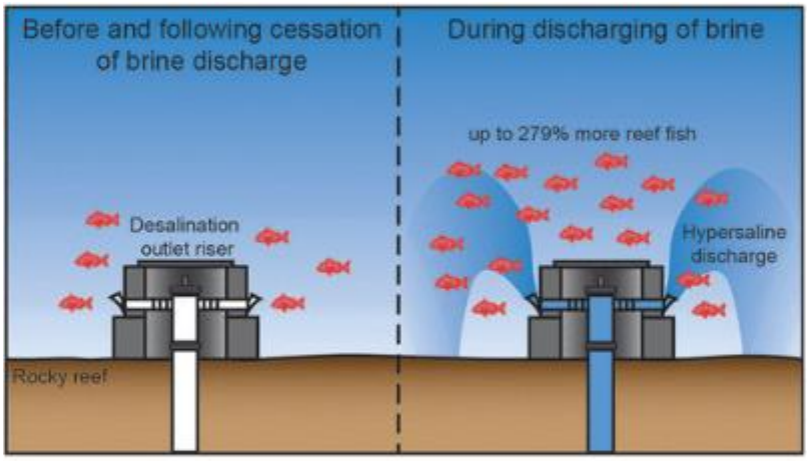


Figure 17: Brine discharge increasing number of fish at Sydney Desalination Plant

Measure to minimise the environmental and ecological impact of desalination plant brine discharge should be taken including consideration of the following measures: -

- If ferric chloride is used as a coagulant backwash wastewater should be treated to remove contaminants using sludge press and drier;
- Mix low and high pH cleaning chemicals to neutralise them prior to discharge; and
- Minimise chemical use across plant as much as possible to limit chemical contamination of brine.

6.1.3 Potential Environmental Impacts on Coastal Land

To limit energy consumption desalination plants should be located as close to the water source as feasible this will limit the overall pumping cost and therefore the cost of operation of the desalination plant. Land in close proximity to the ocean is typically of high ecological value and has high levels of community engagement and any proposed location should be carefully considered and supported by a community engagement plan. These same factors need to be considered for the placement of pipelines, pump stations and power requirements.

Typically, desalination plants are constructed near other existing infrastructure to limit further impacts and degradation of public amenity where possible.

6.1.4 Native Title Considerations

Native title considerations need to be addressed further when a site has been selected. The below Figure 18 provides an overview of the relevant land councils within RCC. For the proposed locations the following land councils are relevant.

Table 31 Relevant land council

Location	Local Aboriginal Land Council	Native Title Claims	Native Title Determinations
Byron Bay	Tweed Byron	Byron Bay Bundjalung People	Bundjalung People
Ballina	Jali Land Council	n/a	n/a
Lennox Head	Jali Land Council	n/a	n/a

Figure 18 Local Aboriginal Land Councils and Native Title Determinations

Figure 19 Native Title Determinations

6.1.5 Energy Consumption

Desalination of seawater to produce potable water is an energy intensive process. In the SWRO process the high-pressure pump is by far the main consumer of power because of the need to pressurise the feed water to 60-70 bar to overcome the osmotic pressure of seawater This is a direct result of the high salt concentration in seawater. Modern SWRO plants have energy consumption rates in the range of 3000–4000kWh per ML of drinking water (*Alonso 2018*).

Energy consumption in desalination plants have been reduced using technology to minimise energy consumption. Energy reducing features such as variable speed drives, high efficiency motors and low energy use membranes can be used in the plant design. Energy recovery devices are used in seawater desalination plants to reduce power consumption of the high-pressure feed pumps by up to 60 %. RO membranes require feed water to be of enough pressure to drive the desalination process. Because the brine stream exiting the pressure vessel is still highly pressurized, the energy that would otherwise be wasted can be captured to offset the energy required to pressurise the feed water.

Potentially offsetting energy consumption by green energy sources can assist in the social operating license. Green energy peak production would not synchronise with the continuous demand for desalination, which introduces another risk for the cost and reliability of electricity requirements. This has not been further considered in this report due to the lack of reliable data (for forward projections) available.

6.2 Environmental Protection Measures for Fish and Wildlife

Protection of wildlife and sensitive habitats are of vital importance and concern during the construction and operation of the seawater desalination plant. While Environmental Impact Assessment conditions and design features will dictate many of the protection measures that are ultimately implemented, the following list details typical measures employed during construction and operation of coastal desalination plants.

- Screen intake structures to minimize entrainment of marine species;
- Ensure flow velocities through intake structures are such that impingement of marine species is minimised;
- Site facilities away from sensitive areas such as dunes, beaches, oyster reefs, mangroves, sea grass beds, and wetlands;
- Directionally drill pipelines under sensitive areas if avoidance is not feasible;
- Conduct vegetation clearing activities outside of the migratory bird nesting season;
- Limit construction to the minimum extent required;
- Implement erosion controls during construction;
- Re-vegetate disturbed areas with native vegetation; and
- Reduce artificial lighting on facilities located near turtle nesting areas (if applicable).

It is concluded that SWRO desalination in all capacity ranges along shorelines of the world can be designed and operated without causing significant environmental impacts. However, proper environmental impacts analyses must be made before design and appropriate monitoring must be conducted during operation to continuously assess environmental conditions. This would allow adjustments to be made that can be used to alleviate actual impacts.

The scope of any environmental monitoring and any ongoing requirements will depend heavily on the conditions placed on the Environmental Authority (EA) which will be developed after EIS an allowance has been made in the OPEX to accommodate for this.

7. Site Location

Siting is the first step in minimising the environmental and social impact of the desalination plant. Environmental and hydrogeological factors such as bathymetry, waves, currents, depth of the water column, sediment, and tidal regime are characteristics of the marine environment that must be considered when selecting the location for the plant. These factors determine the extent of the mixing of discharged brine, the quality of intake water, and the impact of coastal structures on marine life and the environmental sensitivity/vulnerability of the marine habitats (*Rachel 2002*).

The location of the proposed desalination plant is considered from a technical perspective, considerations in regard to public perception and any preferred location from this perspective was identified but were not assessed further. These considerations will need to be assessed in more detail at a concept design stage.

Hopner and Windelberg (Hopner 1996) divided the global marine habitats into 15 categories according to their sensitivities to the effects of desalination plants, shown below in Table 32. The least sensitive habitats being at the top of the table and most sensitive habitat being Mangroves at number 15. Most of the coast in Rous County is the least sensitive of these habitats being as it comprises high energy rocky or sandy coastline with coast parallel current. These locations should be considered over estuarine locations.

Table 32. Sensitivities of marine habitats to desalination plants

Sensitivities	Marine habitats
1	High-energy oceanic coasts, rocky or sandy, with coast-parallel current
2	Exposed rocky coast
3	Mature shoreline (sediment mobility)
4	Coastal upwelling
5	High-energy soft tidal coast
6	Estuaries and estuary-similar
7	Low energy sand-, mud-, and beach rocks-flats
8	Coastal sabkhas
9	Fjords
10	Shallow low-energy bay and semi-enclosed lagoon
11	Algal (cyanobacterial) mats
12	Seaweed bay and shallows
13	Coral reefs
14	Salt marsh
15	Mangal (mangrove flats)

Desalination plants should be located away from tourist developments and populations. Coastal zones, because of their landscape, importance for fishery, tourist housing and recreation, are always highly sensitive to development. Any desalination plant construction or operational activity in Australia is permitted only after strict Environmental Impact Assessment (EIA) studies. Safe distance from inland, or marine environmentally sensitive or significant ecosystems should be considered. Environmental management and monitoring programs must be implemented to cover air, soil, and aquatic media (*Abessi 2018*).

Most of the RCC coastal region has been highly modified in the past through clearing, grazing and sand mining. Since the cessation of these activities some areas are returning to their 'natural' state. The region contains sites of high conservation value, littoral rainforest (SEPP26) and adjoining wetland at the southern end of Boulder Beach (south of Lennox Head).

7.1 Aboriginal and Cultural Heritage Sensitivities

There are several sites that have Aboriginal and post-settlement heritage values including but not limited the headlands at the southern end of Boulder Beach and Lennox Point. These need to be further considered during further development of the site. The selection of the site will likely be sufficient to mitigate any Aboriginal and Cultural Heritage sensitivities that might exist by selecting a site that has been previously disturbed. Construction methodologies such as tunnelling can be adopted to further limit impact on these aspects.

7.2 Coastal Geological and Sediment Conditions

Longshore drift along the northern NSW coast has been the subject of numerous detailed studies, including several focused-on erosion at Tweed Heads, Kingscliff, Cudgen and Byron Bay, especially Belongil Spit. CoastAdapt online tools were used to investigate coastal conditions that could have potential to affect the desalination plant location and stability of beaches. The Shoreline explorer tool was used to study the Coastal Sediment Compartments, geomorphology and sensitivity of the coastline.

The CoastAdapt online tool provides information, maps and resources to plan for and adapt to coastal climate impacts. It was developed by the National Climate Change Adaptation Research Facility (NCCARF) with input from government, community, industry and business. NCCARF was established in 2008 and is currently funded by the Australian Government until the end of June 2017.

There are three sediment compartments that run from North to South down the coast in the region. The sediment compartments are shown in Figure 20 below, and more detailed description of the coastal processes given in the Coast Adapt reports in Appendix A.

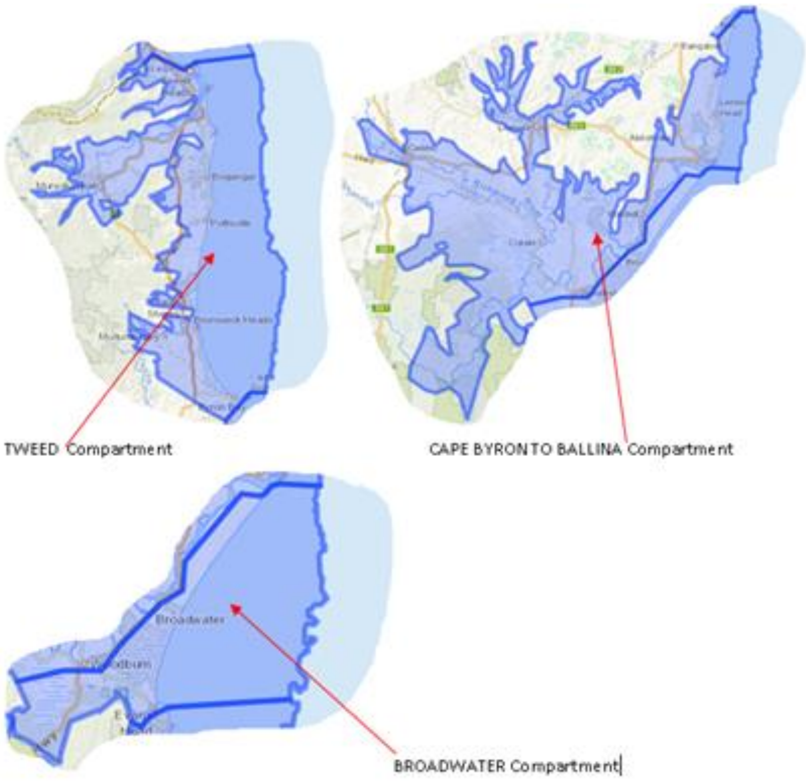


Figure 20: Sediment Compartments areas RCC desalination plant Study Area (From CoastAdapt Shoreline Explorer)

The three sediment compartments Tweed, Cape Byron to Ballina and Broadwater are all sensitive to erosion being rated 4 and 5 (on a scale of 1-5). Indicating the areas are prone to erosion, have existing erosion issues and places where beach sand has been removed by erosion. Erosion potential will have a notable effect on the technology that can be used for desalination plant seawater intake structures.

Table 33. Sediment Compartments in RCC desalination plant Study Area

Sediment Compartment Name	Tweed	Cape Byron to Ballina	Broadwater
Included Area	From Point Danger to Cape Byron	From Cape Byron to Richmond River	From Richmond River to Evans Head
Geomorphology	Isolated rock headlands, zeta-form bays, sandy beaches, dunes and active blowouts (mixed Pleistocene-Holocene bay barriers infilling embayments), Tweed River mouth and estuary.	Volcanic and metasedimentary headlands, zeta-form bays, sandy beaches, and narrow foredune ridges, few active blowouts, Richmond River mouth and estuary.	Zeta-form sandy beach, Pleistocene indurated sands, transgressive dunes, backbarrier flats
Sensitivity Rating	Sensitivity rating is generally a 4, with several sections already 5. The southern end of several of these beaches is sensitive and undergoing periodic erosion and overwash.	Sensitivity rating is a 4, with several sections likely to be 5. The southern end of one beach is eroding and Pleistocene dune sands are exposed in places	Sensitivity rating is a 4.

The area that has been nominated for a desalination plant has predominantly 3 main types of shoreline shown in Figure 21: Dominant Shore Types and Erodibility classification in Study Area. The map also gives guidance on the potential for erosion of each shore type.

- Dominantly sandy shores;
- Dominantly hard rock shores; and
- A small bay of dominantly undifferentiated soft sediment (south of Lennox Head).

This assessment will need to be considered when selecting intake structures due to the risk associated with erosion around inlet and outfall structures.

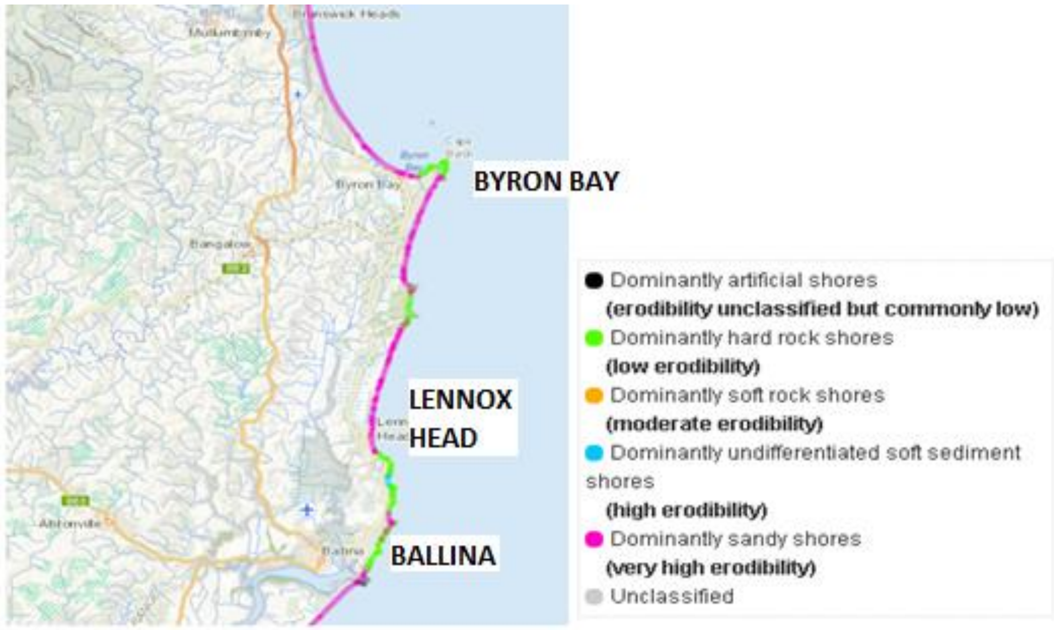


Figure 21: Dominant Shore Types and Erodibility classification in Study Area (Source: CoastAdapt Shoreline Explorer)

7.3 Site Selection

Along with environmental and any potential Cultural Heritage concerns, site selection should consider connection to the existing distribution and power supply systems. The location of the plant must also accommodate population growth and future demand and provide sufficient redundancy to the drinking water reticulation network.

The potential site locations have been selected to meet the following mandatory criteria: -

- May source water from seawater – intake water quality must not be affected by tidal conditions;
- Provides new water supply in areas of large population growth or existing high population to justify the capital expenditure; and
- Has suitable nearby electrical infrastructure and water reticulation networks that can support the proposed facilities.

During the project pre-start and information sharing workshop, GANDEN and Rous County Council stakeholders discussed preferred locations for desalination plants that meet the above criteria. These locations have been further expanded on in the section below. Based on previous investigations undertaken on behalf of Council, no other locations have been considered.

7.3.1 Byron Bay

In addition to the resident population, Byron Bay is a popular tourist destination. With regular large spikes in tourism numbers due to its' popular festivals, beaches, active sports and local produce. Population numbers, water consumption and projected are provided in the below Table 34.

Table 34 Byron Bay Current Population and projected

Location	Current Population	Current Daily Water Requirements (MLD)[7]	Projected Estimated Population (2036)	Projected Daily Water Requirements (MLD)
Byron Bay (city only)	6218	1.5	8051	2
Byron Bay LGA (including Byron Bay Bangalow, Ocean Shores, Suffolk Park and Brunswick Head)	**34574**	**8.4**	**44770**	**11**

The current and ultimate (2036) contributions to demand (in terms of MLD) were determined by applying an estimated potable usage of 242 L/EP/day. Based on this, it is estimated that tourists in Byron Bay will contribute an additional 1.10 MLD to current demand and 1.21 MLD to the ultimate demand. This is inline with the Future Water Strategy: Demand Forecast Report by Hydrosphere Consulting (2013) which predicts a ADD off 10.6MLD for 2060. For the purpose of this report this has not been further considered as the impact of the predicted demand can be allowed for in the staging of the works.

The preferred site location identified during the initial project meeting is adjacent to the existing sewage treatment plant on Wallum Place. This location was selected due to its proximity to the nearby electrical infrastructure, and its ability to relatively easily supply the treated water to the St. Helena Reservoir. In addition, the parcel of land next to the sewage treatment plant is unlikely going to be further developed for other purposes. This reservoir has the ability to supply the following areas through the existing reticulation network: -

- Suffolk Park,
- Byron Bay,
- Ocean Shores,
- Brunswick Head, and
- Bangalow.

The combined demand of all of these areas would be able to justify the future plant expansion of 10 MLD and will provide redundancy in the network by removing demand from Rocky Creek Dam (Nightcap WTP).

[7] Based on 220 litres of Potable Water, Per Person, Per Day, plus an additional 10% (22L) of non-revenue water, which is defined as water that has been produced and is “lost” before it reaches the customer.

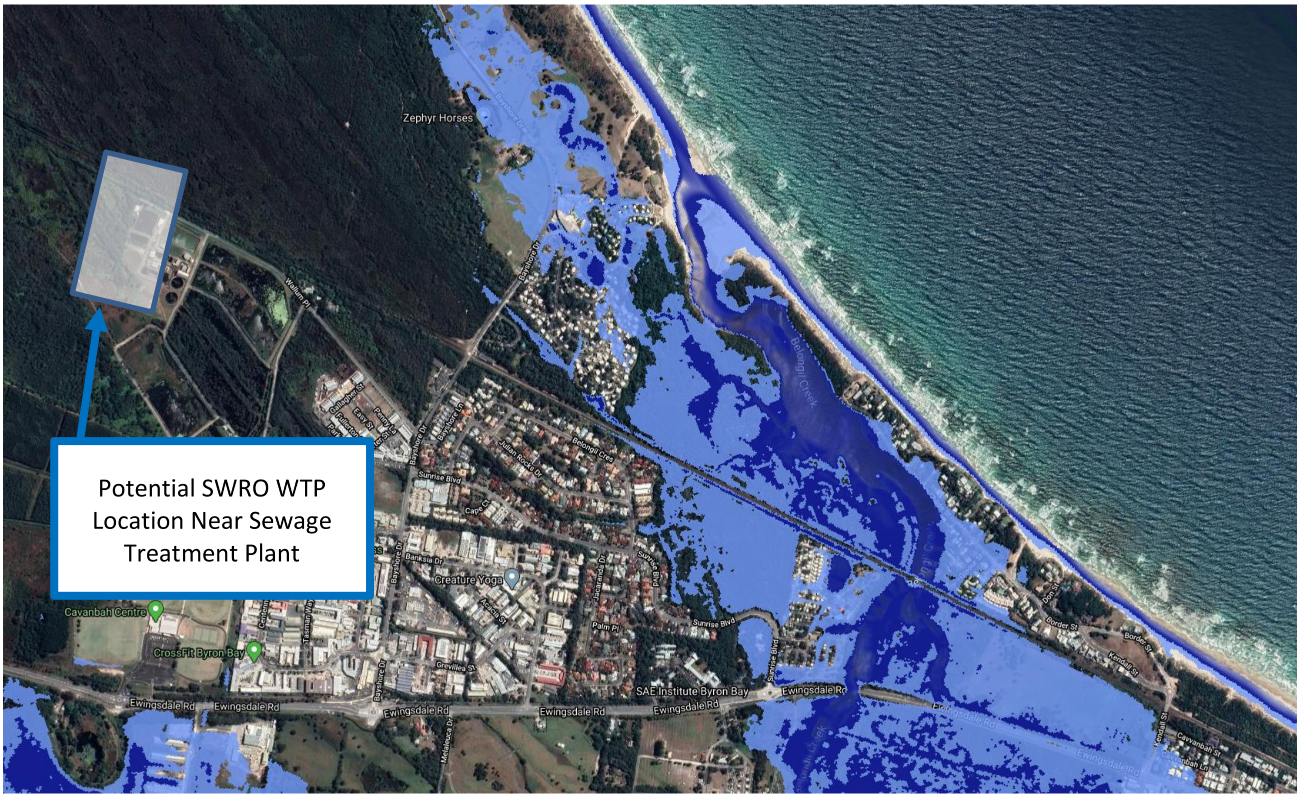


Figure 22 - Coastal Risk Australia 2100 Highest Tide Mapping – Byron Bay

Figure 23 - Potential Location - Byron Bay

Table 35 - Opportunities, Risks and Constraints: Byron Bay Site Location

Opportunities	Risks and Constraints
• High demand area and high population growth area • Rous County Council may operate facility to react to additional potable demands at Byron Bay during seasonal events and tourism influxes. • Simple connection to existing electrical infrastructure and potable water mains. • No perceived risk of coastal inundation as per Coastal Risk inundation flood mapping.	• Potentially expensive building envelope. • Tyagarah Nature Reserve runs along coast, highly sensitive to erosion. • Community perception would need to be managed carefully.

7.3.2 Ballina Shire Local Government Area

Two potential locations were proposed for the LGA of Ballina Shire, these locations are: -

- South Ballina; and
- Along the coastline between Lennox and Skennars Head.

Both of these plant locations will enable connections to the existing potable water storage networks and will provide redundancy in the reticulation network.

Table 36 - Ballina LGA Population Forecast

Location	Current Population	Current Daily Water Requirements[8]	Projected Estimated Population (2036)	Projected Daily Water Requirements
Ballina City	18277	4.5 MLD	18775	4.5 MLD
Lennox Head and Skennar Head	8011	2 MLD	11014	2.6 MLD
Ballina City, Lennox Head and Skennar Head	**26288**	**6.5 MLD**	**29789**	**7.2 MLD**

7.3.2.1 Ballina

The proposed South Ballina location would supply water to the Ballina Heights Potable Water Network by horizontally directionally drilling (HDD) to connect power and product water across the Richmond River, which would add considerable additional expense to the supply scheme.

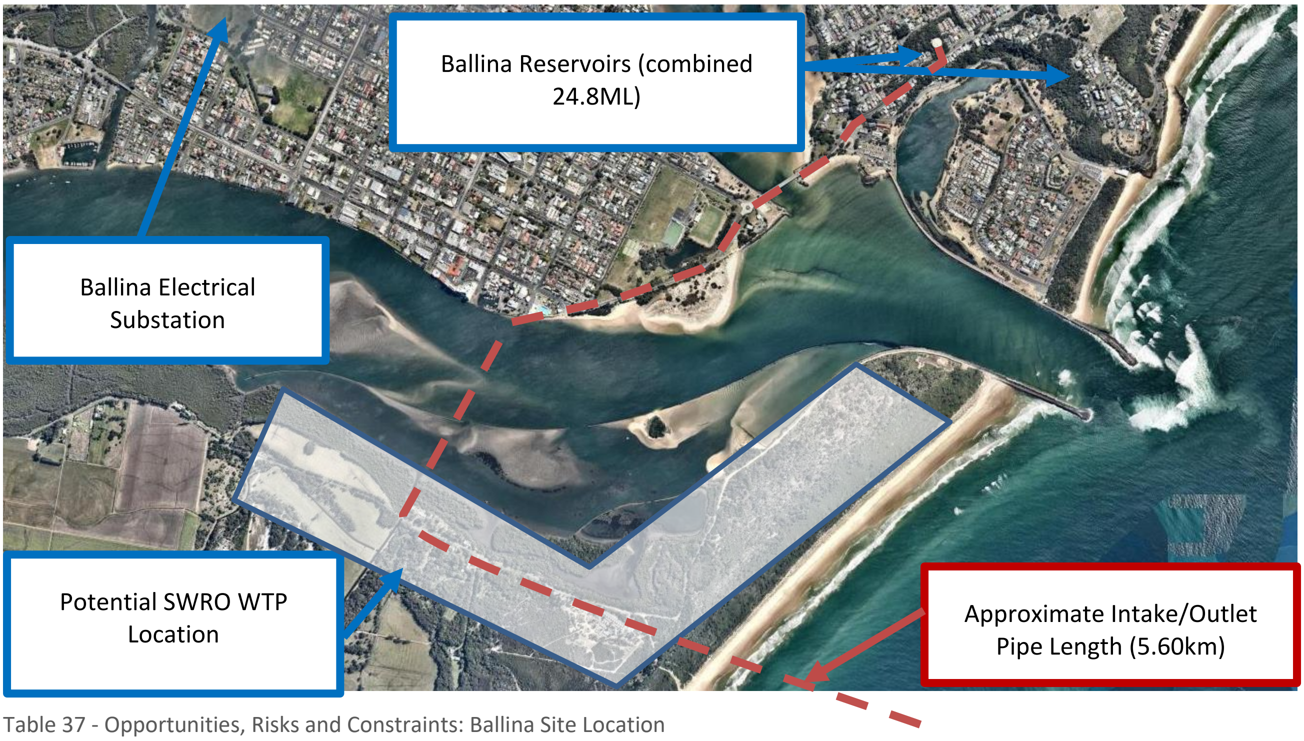


Table 37 - Opportunities, Risks and Constraints: Ballina Site Location

[8] Based on 220 litres of Potable Water, Per Person, Per Day, plus an additional 10% (22L) of non-revenue water, which is defined as water that has been produced and is "lost" before it reaches the customer.

During periods of high rainfall or surface runoff, there is a significant risk of outfall plumes at the Richmond River seaway. The raw water intake must be situated outside of this plume to reduce TSS in the raw water entering the plant.

Figure 24 – Observed Richmond River sediment plume, this needs to be considered when designing inlet/outlet structures

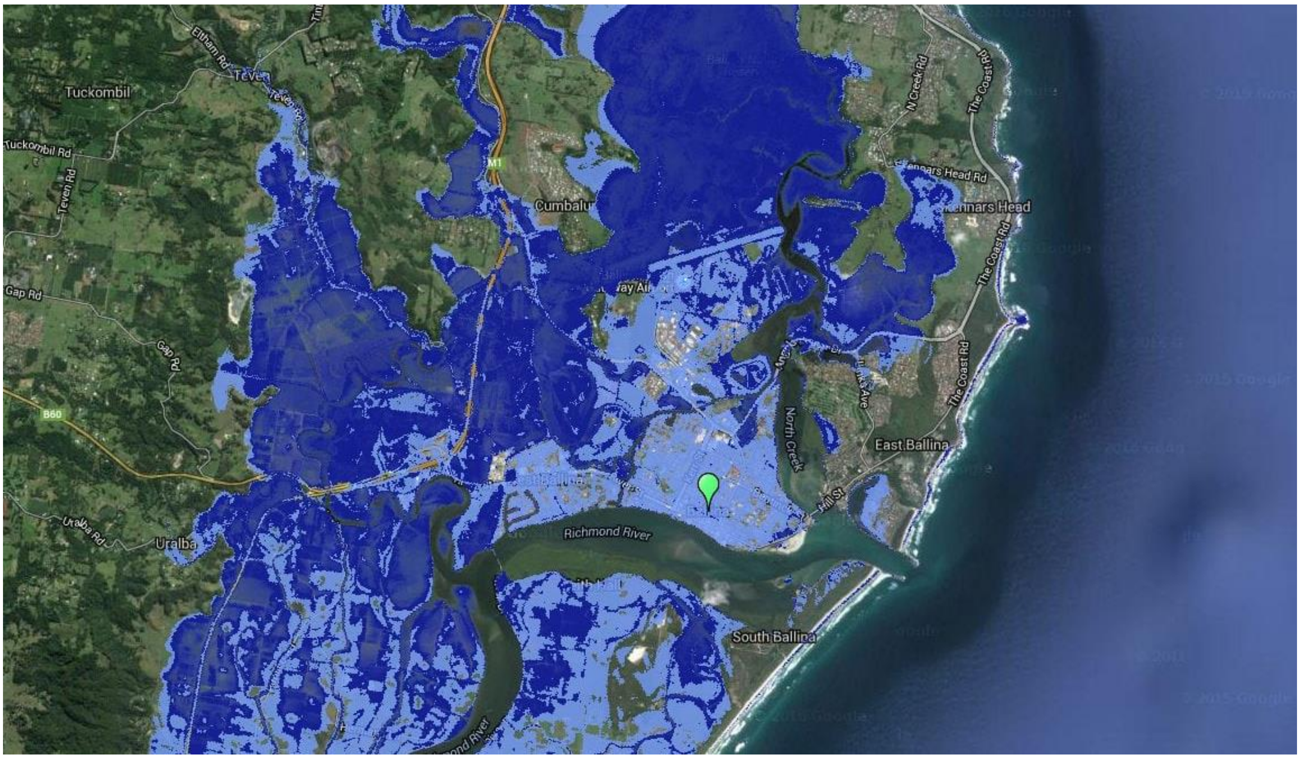


Figure 25 - Coastal Risk Australia 2100 Highest Tide Mapping – Ballina and Lennox Head

Opportunities	Risks and Constraints
• Large baseline population will put plant at primary location of demand. • South Ballina land would be cheaper than alternative locations identified in the report. • Proposed 5MLD SWRO plant (assuming 220L/EP/day and 10% NRW) would service the current population. Future expansions to the SWRO plant of up to 10 MLD would provide complete resilience to the townships of Ballina City, Skennars Head and Lennox Head.	• Additional expense to connect power and product water across Richmond River would add \$5.0 -\$10.00 MM[9] to cost if HDD is used for pipeline and power connection. • Anticipated population growth in Ballina City is fairly minimal, would require connection to the Lennox/Skennars Heads' reticulation network to justify upgrading plant capacity to 10 MLD. • South Ballina Location in flood zone and at risk of inundation and being isolated during floods. Site selection will need to be managed to ensure that the site is not located in a flood zone risk area. • Emigrant Creek WTP and new Knockrow Reservoir already provides more resilience to the area than other LGAs (including Byron Shire and Lismore City Councils). • Intake/outfall in area of high erodibility • WQ risk flood waters (estuary mouth) • Additional expense to ensure intake/outfall pipeline extends far past observed Richmond River sediment plume

7.3.2.2 Lennox Head and Skennars Head

Based on a projected 2036 population of approximately 4,437 and an estimated potable water use of 220 L/EP/day (plus an additional 10% for non-revenue water), the Lennox Head and Skennars Head areas will only require 1 MLD per day. While the growth in this region is set to grow faster than other townships in the Ballina LGA, there is no baseline population that would fully utilise the proposed 5 - 10 MLD SWRO plant. Therefore, if RCC were to consider this as a potential site location additional infrastructure is required to connect to the Ballina City water supply infrastructure which comes at additional expense which is likely prohibitive to adoption of this location.

[9] A more detailed cost assessment will need to be prepared upon confirmation of location, size and technology.

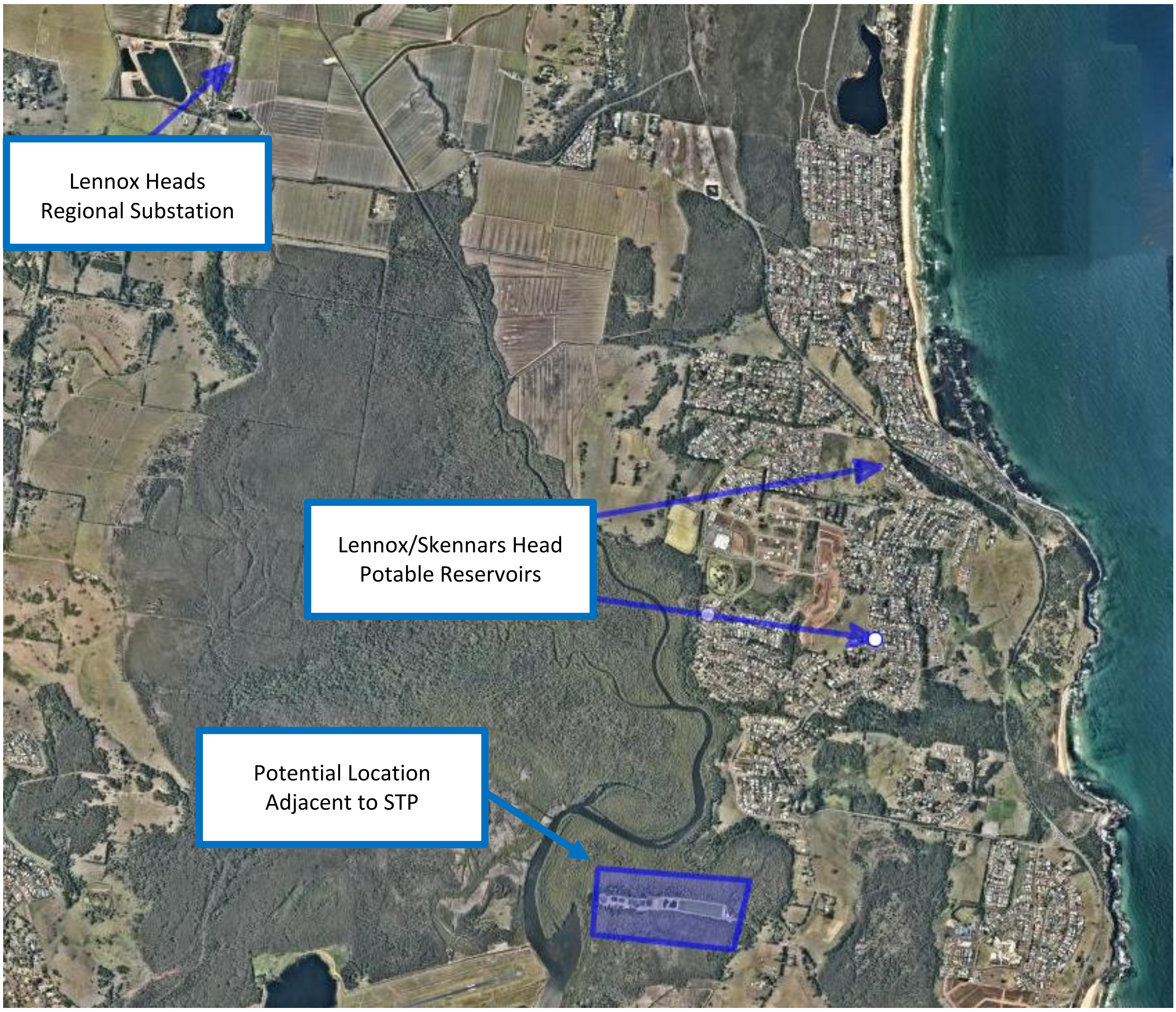


Table 38 - Opportunities, Risks and Constraints: Lennox Head/Skennar Head Site Location

Opportunities	Risks and Constraints
• Location of large population growth with potential to connect to both Lennox and Ballina City water reticulation networks. • Power would be simpler to connect than South Ballina option. • Likely good access to land adjacent to existing Sewage Treatment Plant • Co-location of existing wastewater ocean outfall (to be negotiated with Ballina Shire Council)	• Additional expense to connect intake underneath Skennars Head properties would add significant additional capital costs if considered. • Emigrant Creek WTP and new Knockrow Reservoir already provides more resilience to the area than other LGAs (including Byron Shire and Lismore City Councils). • Connection to East Ballina reservoirs would be required, as the current population does not warrant a new 5 – 10 MLD plant.

8. Multi-Criteria Analysis and Recommendation of Technologies

A multi-gated methodology was used to compare the identified desalination technologies and seawater intake technologies for an application within Council.

The methodology is as follows: -

Gate 1 Mandatory Requirements	Gate 2 Scoring	Gate 3 Value for Money
• The options must meet the following criteria: - Are water quality objectives met (ADWG)? - Is the option possible to implement? - Is the option practicable to implement? • Only options that can answer "yes" to all 3 progress to Gate 2.	• Multi-Criteria Analysis: - Whole of life costs - Proven technology - Resourcing - Support - Process Resilience • The top 3 options progress through to Gate 3	• NPV • The option wth the highest 80-year NPV to be chosen

If the option failed to pass the mandatory requirements in Gate 1, then it was not considered further. For the water quality objective, the technology had to achieve a minimum of 98.6% salt reduction, i.e. to be able to reduce TDS from a design influent of around 35,500 mg/L to < 500 mg/L.

In Gate 2, options were to be compared to each other using a multi-criteria analysis. The top three options were to be compared to each other for progression to Gate 3. [10]

In Gate 3, an NPV was conducted using a standard NPV spreadsheet. The highest NPV over 80 years would be the preferred option.

8.1 Comparison of Desalination Technologies

8.1.1 Gate 1: Mandatory Requirements

The tables below describe each technology and review their performance against the Gate 1 criteria. A detailed assessment has been provided for each of the assessed technologies.

Table 39. Summary Table Desalination Technology

[10] Note only one option made it through to Gate 2.

Technology	Will Meet Water Quality Objectives	Possible to implement in Rous County	Practical to implement in Rous County	Notes
Reverse Osmosis (Seawater)	**Yes**	**Yes**	**Yes**	**Likely preferred technology**
Electrodialysis Reversal	**Yes**	**Yes**	**No**	**Likely not suitable due to excessive cost**[11]
Nanofiltration	**No**	**Yes**	**Yes**	**Not suitable**[12]
Capacitive Deionisation and Membrane assisted Capacitive Deionisation	**No**	**No**	**No**	**Not suitable**
Ion Exchange	**No**	**Yes**	**No**	**Not suitable**
Distillation - Thermal	**Yes**	**No**	**No**	**Not suitable**
Distillation – Solar	**Yes**	**No**	**No**	**Not suitable**

8.1.2 Gate Two: Scoring Capability

The next step in the evaluation process was a shortlist of technology based on the MCA. The shortlist was to provide the top three technologies, but, as Reverse Osmosis was the only technology to pass through Gate 1, EDR (the next closest technology) was run through Gate 2 selection for comparison.

Each technology was scored against each criterion from one to ten. Where ten is best performance and one is worst performance. The individual scores have been determined by comparing the different technologies (RO and EDR) against each other, when the difference was pronounced this was expressed in the individual score (8- 4) when the difference was not pronounced the score was used to express this difference.

[11] Although EDR has been used on a large-scale groundwater desalination plant in the Canary Islands the main manufacturer Suez WTS does not recommend or offer it as a solution for seawater applications. Additional treatment modules are required to achieve the product water quality requirements with the high TDS of seawater.

[12] Does not meet the Water Quality Objectives, options around blending the water with other water sources have not been further considered as these are cumbersome and difficult to control with a high-risk profile attached.

Table 40. SWRO & EDR Comparison - Multi Criteria Analysis Results

Criteria	Reverse Osmosis (RO) polymeric Membranes	Weighted score (RO)	Electrodialysis Reversal (EDR) Membranes	Weighted score (EDR)
Whole of Life Cost (33%)	5	1.65	2.5	0.83
Proven Technology (23%)	10	2.3	5	1.65
Resourcing (7%)	8	0.56	4	0.28
Support (20%)	8	1.6	4	0.8
Process Resilience (17%)	8	1.36	5	0.85
Score	**39**	**7.47**	**20.5**	**4.41**

The score for this assessment placed SWRO first and EDR second. Although EDR did not qualify for Gate 2 rating it was judged to give an indication of the difference between first and second ranked technologies. EDR was not considered for Gate Three - Value for Money.

8.1.3 Gate Three: Value for Money

Gate Three was an assessment of the value for money of each technology. A detailed Net Present Value (NPV) [Cash inflows from investment, minus, cash outflows or costs of investment] assessment was undertaken to assess the best option financially for the proposed desalination plant and a summary of Strengths, Weaknesses, Capital Values, Operational Cost and NPV was provided for each of the options. Refer to Section 10 - NPV Seawater Reverse Osmosis Desalination Plant for the details on the NPV.

8.2 Comparison of Seawater Intake Technologies

8.2.1 Gate 1: Mandatory Criteria

The tables below describe each technology and review their performance against the Gate 1 criteria. A detailed assessment has been provided for each of the assessed technologies.

Table 41. Summary Table Desalination Intake Systems

Technology	Feedwater Quality & Quantity Objectives	Possible to implement on RCC Coastline	Practical to implement on RCC Coastline	Outcome
Onshore Open Intake	**Yes**	**Yes**	**No**	**Omitted (no deep-water open channel has been identified)**
Offshore Open Intake	**Yes**	**Yes**	**Yes**	**Passed gate 1**
Subsurface Vertical Beach Well	**Yes**	**Yes**	**No**	**Omitted**
Subsurface Angle wells	**Yes**	**No**	**No**	**Omitted**
Subsurface Horizontal wells	**Yes**	**Yes**	**No**	**Omitted**
Subsurface Ranney Collector Well	**Yes**	**Yes**	**Yes**	**Passed gate 1**
Subsurface Beach Gallery	**Yes**	**Yes**	**Yes**	**Omitted**

8.2.2 Gate Two Scoring Capability

The same multi criteria analysis (MCA) used to evaluate Desalination Technologies was applied to the Intake Technologies. For Process Resilience consideration was made for environmental changes such as beach erosion, salinity and turbidity resulting from rain and storms.

Table 42. Multi Criteria Analysis Results for Intake Technology

Criteria	Open Offshore Intake (OOI)	Weighted score (OOI)	Subsurface Radial Collector Well (SRCWI)	Weighted score (SRCW)
Whole of Life Cost (33%)	9	3	3	1
Proven Technology (23%)	10	2.3	4[13]	0.92
Resourcing (7%)	7	0.49	2	0.14
Support (20%)	8	1.6	2	0.4
Process Resilience (17%)	9	1.53	3	0.51
Score	**42**	**8.92**	**14**	**2.97**

The score for this assessment placed Open Offshore Intake first and Subsurface Radial Collector Well second. The MCA results for Intake Technology selection are somewhat subjective but they do provide a useful, indicative guide for comparison. For all significant desalination plants in Australia the choice of Intake System has been determined by the Environmental Management Plans following comprehensive Environmental Impact Assessments.

8.2.3 Gate Three Value for Money

Gate Three was an assessment of the value for money of each technology. A detailed Net Present Value (NPV) [Cash inflows from investment, minus, cash outflows or costs of investment] assessment was undertaken to assess the best option financially for a desalination plant and a summary of Strengths, Weaknesses, Capital Values, Operational Cost and NPV was provided for each of the options. Refer to Section 10 - NPV Seawater Reverse Osmosis Desalination Plant for the details on the NPV.

[13] Although SRCW is a proven technology in freshwater extraction, primarily from rivers, they are not widely used for seawater desalination and there are no known instances of use for any application in Australia. This also affects Resourcing and Support for this technology in Australia

8.3 Pre-treatment Filtration Recommendations

To determine the best pre-treatment filtration system, a cost analysis comparison was completed. Table 43 below (*from Vedavaen 2007)* gives a summary of the various costs comparing conventional and membrane pre-treatment systems.

Table 43. Cost analysis comparison of conventional and UF/MF pre-treatments

Parameter	Conventional pre-treatment	UF/MF pre-treatment	Benefits
Capital costs	Cost competitive with MF/UF	Slightly higher (~5%) than conventional pre-treatment. Costs continue to decline as developments are made	Capital costs of MF/UF could be 0–25% higher, whereas life cycle costs using either of the treatment schemes are comparable
Footprint	Larger footprint	Significantly smaller footprint (30-50% Lower)	Footprint of MF/UF could be 30-50% of conventional filters
Energy requirements	Less than conventional	Higher than conventional	MF/UF requires pumping of water through the membranes. This can vary depending on the type of membrane and water quality
Chemical costs	High due to coagulant and process chemicals needed for optimization	Chemical use is low, dependent on raw water quality	Less chemicals
RO capital cost	Higher than MF/UF since RO operates at lower flux	Higher flux is logically possible resulting in lower capital cost	Due to lower SDI values, RO can be operated at 20% higher flux if feasible, reducing RO capital costs
RO operating costs	Higher costs as fouling potential of RO feed water is high resulting in higher operating pressure. One experiences frequent cleaning of RO membrane	Lower RO operating costs are expected due to less fouling potential and longer membrane life	The NDP (net driving pressure) is likely to be lower if the feedwater is pre-treated by MF/UF. Membrane cleaning frequency is reduced by 10–100%, reducing system downtime and prolonged element life.

UF: ultrafiltration, MF: microfiltration, RO: reverse osmosis, SDI: silt density index.

Selecting the most suitable pre-treatment filtration process, particularly for open intake installations, is complicated because of many factors including diverse nature of foulants present in seawater, challenges associated the design and operation of pre-treatment technologies, and irreversible fouling on the SWRO surface due to inadequate pre-treatment particularly during periods of poor feedwater quality (rain induced increase in suspended solids & algae bloom periods).

With limited data provided on feedwater quality GANDEN provisionally recommends the use of ultrafiltration in preference to pressurised media filtration.

8.4 Remineralisation and Post Treatment Chemical Dosing Recommendations

Remineralisation of the RO permeate should be achieved by Council using direct dosing of a hydrated lime solution and carbon dioxide. The post-treatment system will be used to produce stabilised, chlorinated and (possibly) fluoridated water suitable for drinking from the RO permeate. The design of the post-treatment system shall be as installed using:

- Hydrated lime (powder) and carbon dioxide gas for stabilisation,
- Sodium hypochlorite for disinfection, and
- Fluoridation (likely sodium silicofluoride)[14].

Post treatment chemicals will be dosed into a dosing station between the RO Permeate Tank and final product (Drinking Water Tank). Where possible, equipment installation will be staged in alignment with the development of the plant. Chemical metering pumps will be digital, and flow paced to facilitate accurate control at all product flow rates. This will enable pumps sized for final product flow to be used at initial installed lower flow rates.

[14] Note that Byron is currently not fluoridating drinking water, selection of chemical to be undertaken during detailed design stage

9. SWRO Desalination Plant Preliminary Concept Design

9.1 Identification of Desalination Capabilities/Equipment

Many companies globally are involved in the provision of desalination plant. Figure 26 below shows the main players in the market over the last decade.

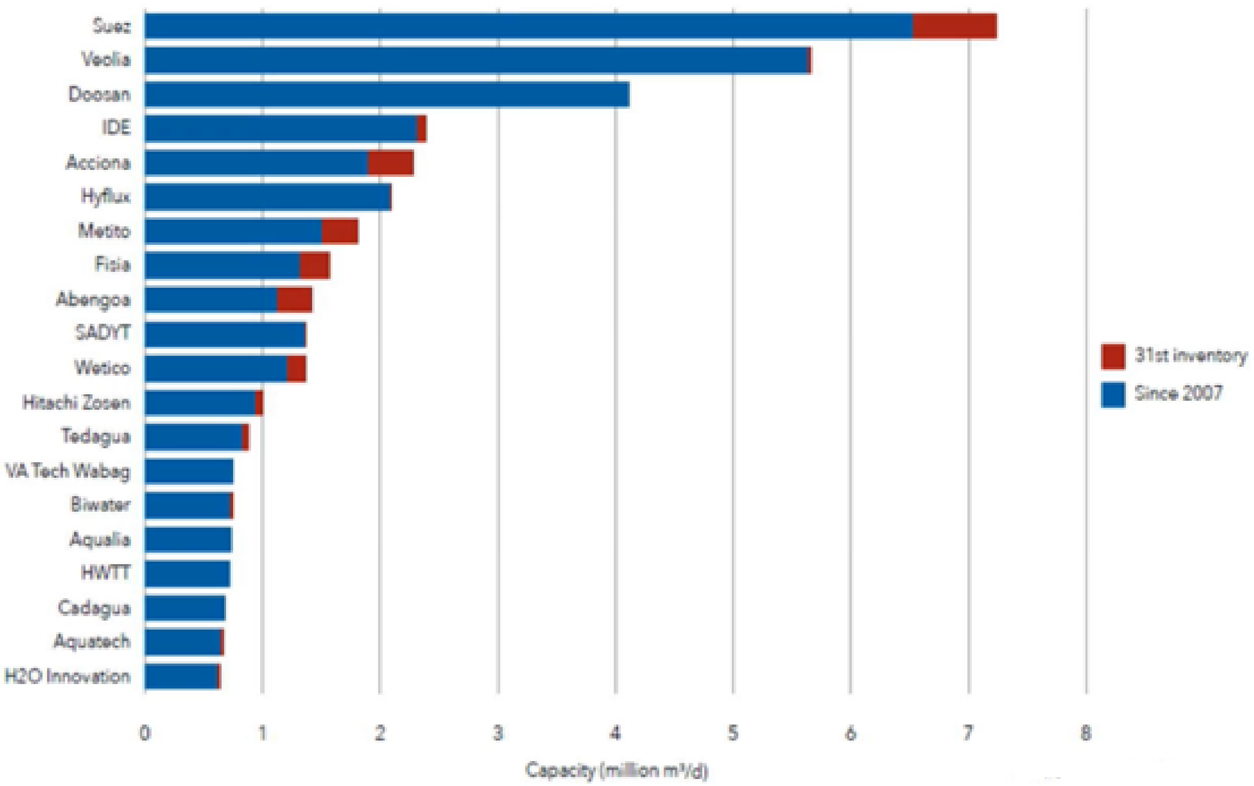


Figure 26: Top 20 plant suppliers by awarded capacity, 2007-2018 (From GWI desal Data/IDA)

To review the Australian market for the potential desalination options, contact was made with several reputable companies within the industry and experts in the field of desalination.

Companies approached were: -

1. Suez Water Technologies & Solutions (WTS);
2. Osmoflo;
3. Pall Filtration;
4. Mak Water;
5. Proxa Water; and
6. Trility Water Solutions.

GANDEN personnel have well established relationships with these companies through working together on different projects over the years. All the companies above offer RO desalination and have many reference sites with this technology, both within Australia and Internationally.

Suez Water Technologies & Solutions are the global technology leader in EDR but only have brackish water EDR sites as reference in Australia. Feedback for Suez was that EDR whilst able to deliver the required water quality for seawater desalination was not a competitive solution for SWRO desalination as the initial capital outlay on equipment would be too high to get the required product quality. Electro Dialysis Reversal was not offered as a solution by Suez WTS for seawater desalination.

9.2 Proposed Seawater Desalination Scheme

Section 9.3 of this report provides a Preliminary Concept Design of the preferred desalination option derived from the MCA. This concept design was produced to provide a basis for calculating capital and operational costs and development of the NPV.

Following the completion of this options analysis, the recommended desalination option will be progressed through: -

1. Feasibility-level proof of concept design, including pump stations, rising mains and site infrastructure associated with the scheme;
2. Workshops with key stakeholders; and
3. Concept design.

RCC may undertake the following if the proposed seawater desalination scheme is implemented: -

1. Detailed design; and,
2. Implementation.

In order to meet the required environmental requirements and drinking water standards the seawater desalination plant will need to have the following components: -

- Sea water intake system;
- Pre treatment screens;
- Chemical dosing;
- Pre treatment filtration;
- Reverse Osmosis trains including high pressure pumps, membrane pressure vessels and energy recovery devices;
- Post treatment systems, including pH adjustment and fluoridation requirements;
- Backwash wastewater settling tank, belt press and sludge disposal systems;
- Brine outfall systems; and
- Building and amenities.

The choice of final location will determine the requirement for the subcomponents.

A general arrangement has been developed by GANDEN, showing preliminary sizing for the minimum footprint required to install a 10MLD SWRO plant. This has been achieved through consultation with Suez who assisted with sizing of the system.

9.3 Preliminary Site Layout

GANDEN has produced a preliminary layout of the preferred option - a Suez SeaPAK SWRO system that is scalable in 2.5MLD increments. This system allows for SWRO scheme to be upgraded for increased demands in the future. See Appendix B - GANDEN Preliminary General Arrangement.

It is proposed to construct the desalination plan using proprietary skid based elements to reduce overall risk and to allow for easy expansion and phasing of the works based on demand. Alternatives around non skid based solutions have not been further assessed for this reason.

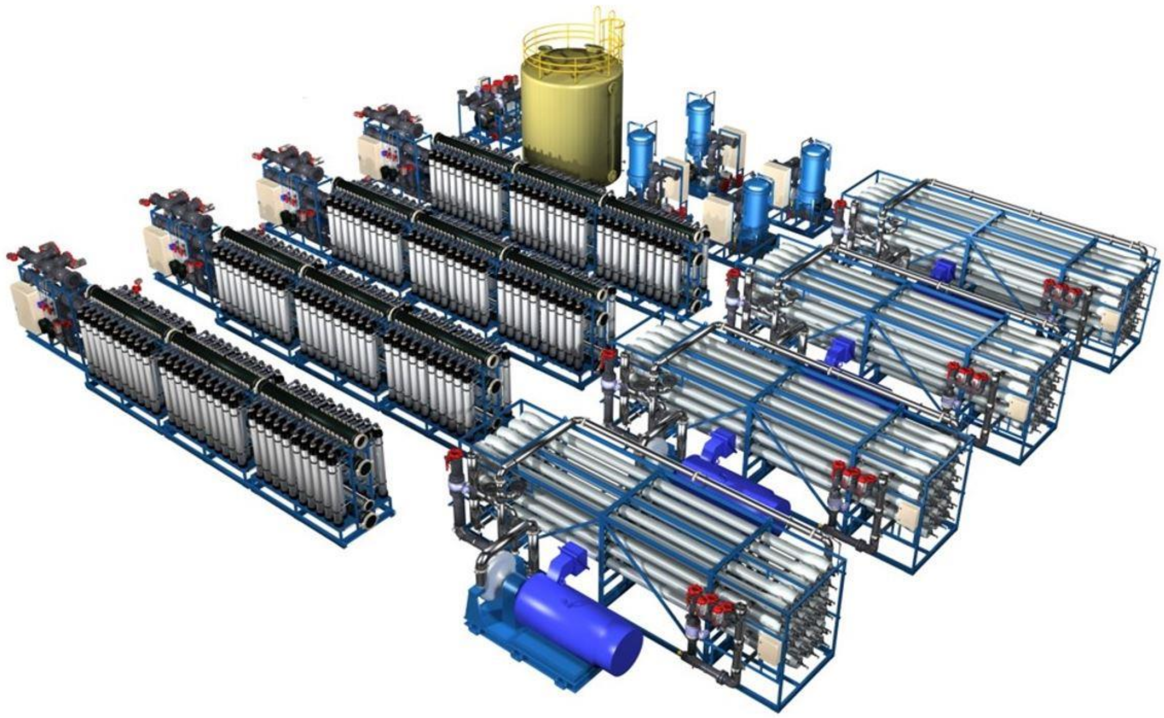


Figure 27 - Suez SeaPAK Scalable RO System (4 x 2.5 MLD Skids Shown)

9.3.1 Seawater Intake and Waste Outfall System

The preliminary layout does not include details on the seawater intake system as this will be site dependent. Likely the system will consist of a directionally drilled pipe with an intake structure and velocity cap. The pipeline would be installed via horizontal directional drilling rigs, which would ensure minimal environmental impacts and disruption to the community.

Laying of the intake pipe along the seabed is not recommended as this is only feasible if the intake structure is located in a low energy shore line where there is minimal exposure to beach erosion, heavy storms, typhoons, strong wave action or strong underwater currents. This would not be feasible in any of the identified locations.

Concentrate disposal for all proposed locations is anticipated to be achieved by depositing the reject brine water through the dual intake/outfall system. Treatment chemicals (antiscalant etc) is assumed to be selected to allow for discharge to the environment, this will need to be confirmed during the detailed environmental assessment and modelling.

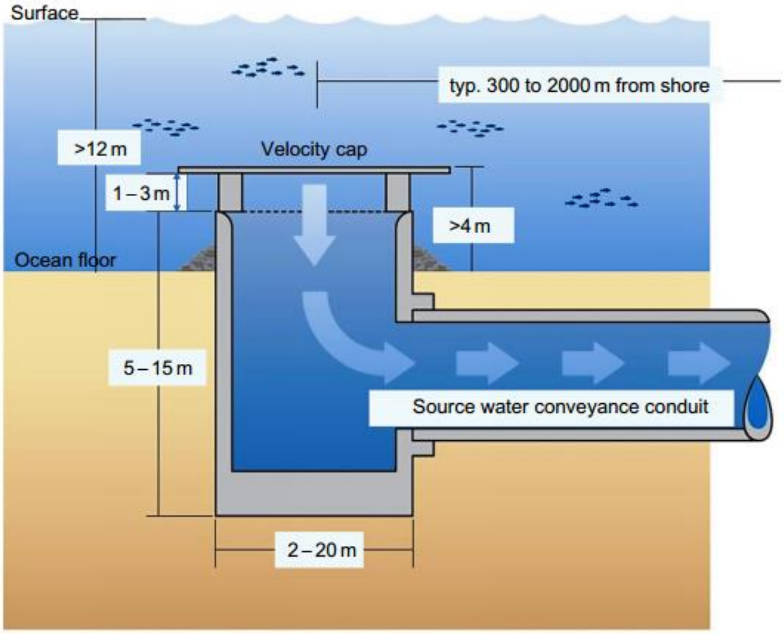


Figure 28: Intake Inlet Structure sizing

9.3.2 Pre-Filtration

Membrane ultrafiltration is preferred in lieu of media filtration. The preliminary general arrangement has selected ultrafiltration due to its considerably smaller footprint, reduced chemical consumption and the ability to provide a better barrier to fouling of the RO membrane surfaces due to inadequate pre-treatment.

9.3.3 Cartridge Filtration

Cartridge filters have been situated between the pre-filtration units and the RO membranes as a second line of defence in the event of UF filtration failure. The filters, similar to UF, capture any suspended solids in the feed water to prevent deposition on the RO membranes capturing any fugitive solids that may damage the membranes when under pressure.

Cartridge filters on desalination systems are normally a fiberglass reinforced plastic pressure vessel with of replaceable cartridges located inside the vessel.

Figure 29: Example of a Cartridge filter and housings

Cartridge filters with 1 to 5-micron cartridges are typically employed. Typically, the filter cartridges are consumables and will be replaced when the differential pressure across the filters goes over a pre-determined setpoint. This is normally an infrequent event with many cartridges needing changing only once a year if the upstream UF system is operating properly or between one and three months down stream of dual or multimedia sand filters. Figure 29: Example of a Cartridge filter and housings shows an example of a cartridge filter and cartridge filter housings.

9.3.4 Chemical Storages Area

Typically, the following chemicals are dosed into a SWRO plant: -

- Sodium hypochlorite used for disinfection and potentially to prevent growth of marine life in intake piping and pre-treatment filters;
- Antiscalant to prevent chemical fouling of SWRO (usually a proprietary product which will be required to be assessed against the Environmental Authority to allow for discharge to environment);
- Biocide to prevent biological fouling (usually a proprietary product and likely to be needed which will be required to be assessed against the Environmental Authority to allow for discharge to environment);
- Sodium Bisulphite – for preservation of the RO membranes if the system is put into shutdown and to remove any chlorine in the feed that may damage the membranes;
- Clean in Place (CIP) solution – for maintaining the permeability of the membranes (normally acid and/or alkali – a single system will be required). For smaller packages plants proprietary chemical are used but for larger trains over 2MLD Citric acid buffered with HCl is used for low pH cleans and caustic combined plus TSP or EDTA for high pH cleans; and
- Sulphuric Acid for pH control of the feed (subject to detail design);
- Direct dosing of chemicals for remineralisation and pH control on the RO permeate.

For a plant of this size, dosing directly from 20L drums, IBCs or small tanks will be most appropriate. The footprint of the dosing systems will be relatively small. The Rous Desalination Concept Plant Layout drawing provides an example of a typical chemical dosing skid (for eight IBCs or small tanks). It is recommended, given the location of the plant, that all chemical dosing equipment tanks and systems are located inside lockable structures or buildings.

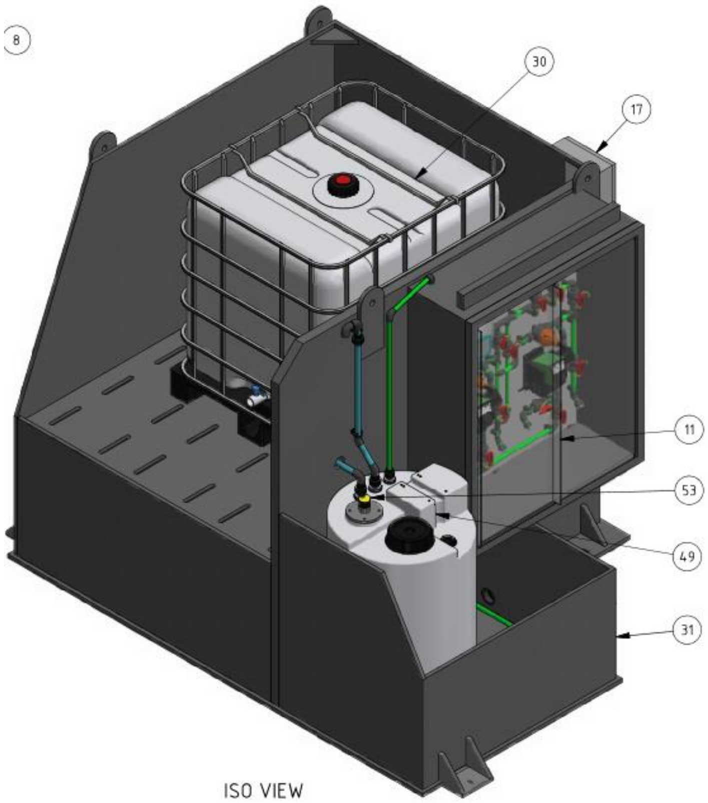


Figure 30 Typical chemical dosing Skid dosing from IBC

9.3.5 Disinfection

Historically, desalination plants continually or periodically chlorinate the intake seawater using sodium hypochlorite to prevent growth of marine organisms in the intake pipework and pre-treatment filters. Current practice is to not chlorinate or dose chemicals but to use fresh water flushes in combination with ice pigs (this will need to be further established during Environmental Assessment. Disinfection of the drinking water will be undertaken at the treated water reservoir/chlorine contact tank.

9.3.6 Sodium Bisulphite dosing

Free chlorine residual in the RO feed water causes irreparable oxidation damage of the membranes. Sodium bisulphite (SBS), an oxidation reducing agent, is dosed to remove any chlorine carry over from the filters. Monitoring for dechlorination can be performed using a Free Chlorine monitor, monitoring for a residual bisulphite concentration, or by an Oxidation-Reduction Potential (ORP) monitor. The feed to the SWRO system is equipped with an (ORP) meter. The feed water can then be continuously monitored for the presence of oxidant and the ORP meter reading should always be below 300mV.

SBS is available commercially in 10-25% solution as a commodity non-proprietary chemical. The SBS solution is not stable to air and reacts/degrades reducing its effectiveness. Theoretically, 1.47 mg/L of SBS will neutralize 1.0 mg/L of chlorine. Designers typically use a dosing rate of 1.8 to 3.0 ppm of SBS per 1.0 ppm chlorine so as to include an industrial safety factor for RO systems.

9.3.7 Antiscalant dosing

Antiscalants are used in membrane systems to inhibit the formation and precipitation of crystallized mineral salts that form scale. The use of antiscalants prevent the formation of a broad range of scale forming substances and keeps fouling material in suspension. Common foulants and scalants include calcium carbonate, calcium sulphate, barium sulphate, strontium sulphate, calcium fluoride, boron, iron, colloidal material, silica and other organic contaminants.

There are many chemical suppliers who supply a variety of proprietary antiscalants to improve the operation of RO systems. Antiscalants are selected specific to feed water chemistry. Typical dose rate of 2ppm in feedwater and dosing will need to be flow paced to SWRO feed flow.

9.3.8 SWRO Clean in Place chemicals

RO membrane manufacturers generally recommend the use of their own proprietary cleaning solutions. Across the board each cleaning situation is different and as a result specific cleaning recommendation are dependent on the foulant. Typically, proprietary CIP chemical can be expensive ($200-$300 per 20 litres pail). Larger desalination plant use bulk chemicals for RO membrane clean in place (CIP) which assists in keeping operating costs as low as possible. It is recommended to use non-proprietary, commodity chemicals for cleaning. For low pH cleaning it is best to use a 2% citric acid solution buffered to pH 1 and for high pH CIP use sodium hydroxide with a surfactant such as SLS (sodium lauryl sulphate) or detergent such a STPP (sodium tri-poly phosphate) at pH 13. CIP Will be optimised by use of a heater on the CIP system to raise CIP temperature to 35-40^{o}C. Expense of neutralising CIP solutions will be minimised by having a waste disposal system that is large enough to facilitate mixing of low and high pH CIP solutions so they neutralise each other with minimal addition pH correction. As mentioned previously CIP disposal is typically to outfall, if this allowed under the EA this will be at a significant additional operational cost to the project.

9.3.9 RO Membranes

Most of the major RO treatment plants in Australia, use RO membranes from suppliers such as Suez Water Technologies & Solutions, Hydranautics, Dow, Toray or Evoqua. The design of the membranes between these manufacturers are almost identical and membranes from different manufacturers are generally interchangeable.

Membranes are made of a several layers of semipermeable polyamide membranes cast to strengthening backing material. The layers are separated by spacers to allow the flow of permeate and concentrate. The layers are glued and then rolled into a tube shape, making a membrane, sometimes called a module or element.

Seawater RO membranes typically reject over 99.5 % of salt (nominally >98%) and have around 40% recovery (35-45%).

The membranes typically have a surface area of 370ft^2 -400ft^2 around 34.3 -37.140 m^2. Flux on the membranes is the rate of passage of water through the membrane. Typically, the design flux is around 12-19 L/m^2/hr.

For a permeate flow of 3 MLD, 252 of the 400ft^2 membranes are required. If the same train was loaded with 370ft^2 membranes the design flow would be reduced to 2.5 MLD. Care in selection will need to be balanced as the higher surface area membranes can be more prone to scaling and fouling and may need to be cleaned more frequently.

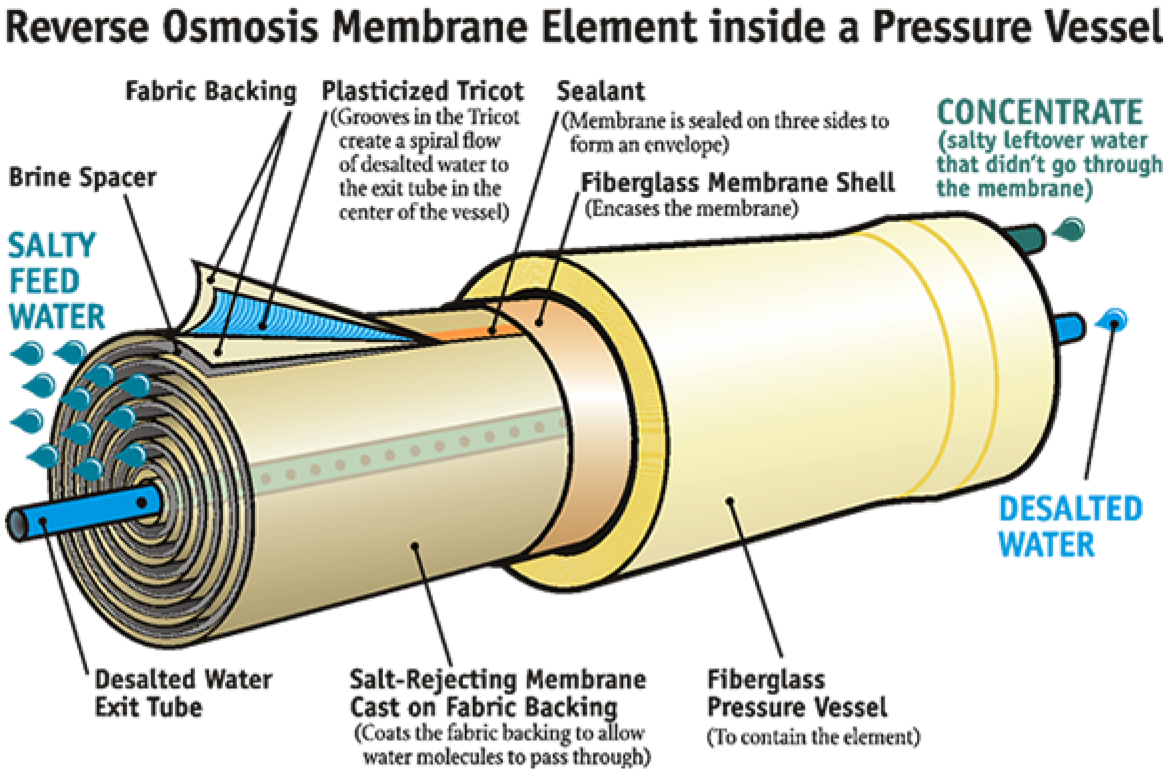


Figure 31 Typical RO membrane

9.3.10 Pressure Vessels

Pressure vessel manufactures are normally different companies to the membrane manufacturers. Normally between 5 and 7 membranes are inserted into a fibreglass reinforced plastic pressure vessel, though this can change due to space, energy and recovery requirements.

An end cap is placed at each end of the pressure vessel. The end cap is fixed using a proprietary clamping sytem designed to withstand the operating pressures.

The membranes are linked via a inner tube in the centre of the membrane that is used to transport the RO permeate away. The RO permeate tube normally protrudes through both of the end caps.

The concentrate usually leaves the pressure vessel from a port in the side of the pressure vessel, but sometimes from the end cap.

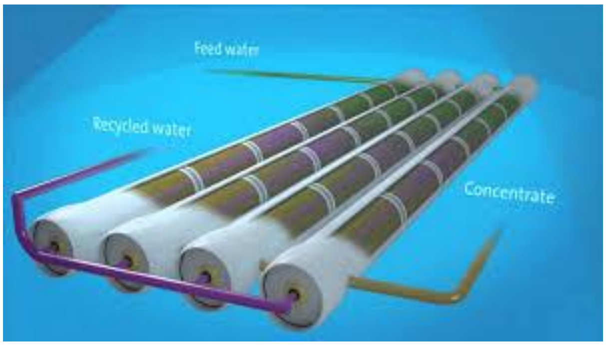


Figure 32 Membrane vessels

9.3.11 RO Arrays

Multiple pressure vessels are normally located on a rack, called arrays, sometimes called modules. The racks are normally made of painted mild steel or stainless steel. The RO permeate pipes and the concentrate pipes are normally manifolded together and linked to larger pipes that thansfer the RO permeate to Post Treatment and the concentrate to disposal.

For RCC a one-pass system with one stage is all that is required to achieve the required TDS. In some locations another pass is used where the first pass permeate is again passed through and additional array to increasethe rejection of boron. Recovery on this plant is likely to be between 35-45% (i.e approximately 40% RO permeate and 60% concentrate) and pumping pressures are low so there is not a strong argument for investment in a second pass.

To treat a staged incremental flow of between 2.5 and 3MLD, approximately 252 membranes will need to be provided. With seven membranes provided per pressure vessel then approximately 36 RO pressure vessels will be required. Typically on the smaller 1.0 MLD packade skid system 12 vessels each containing seven membraes are installed.

9.3.12 Pressure Pumps

The amount of pumping pressure required increases as the salinity (or TDS) of the feed water increases. RO requires approximately 0.7 bar of pressure for every 1,000 mg/L of TDS plus the pressure of the RO permeate.

The SWRO plant will require minimal pressure and 5-10 bar would be sufficient (note that the permeate will have a pressure of approximately 3 bar). The pressure required can be achieved using industry standard multistage pumps. For higher pressure, two stage pumping is required (i.e. booster pump on VSD and high-pressure pump on fixed speed), it is likely that only a booster pump on VSD is needed.

One duty high pressure feed pump and one low pressure high flow energy recovery device booster pump for each RO train is recommended. Type and size of pump will be incorporated in a vendor packaged plant design. Pump control using VFD's to minimise power consumption while optimising plant performance. This would require 2 pumps per RO train/array.45

Table 44 SWRO HP feed pumps and energy Recovery system booster pump operating pressure

RO Technology	Typical Feed Pump Operating Pressure (Bar)	Typical Energy Use (kWhr/m^3 Permeate Produced)
Energy recovery Booster Pump	2-3	0.5 – 2.0
Seawater RO HP Feed	50 - 90	3.5 – 6.0

Figure 33 SWRO feed pumps

9.3.13 Energy Recovery Devices

Energy recovery devices greatly reduce the energy required as they recycle high pressure to the feed side of the RO element. Energy recovery devices are found on most SWRO plants. There are two main types of energy recovery devices hydraulic or centrifugal turbo chargers and isobaric pressure Exchangers. There are positives for both. Generally, pressure exchangers have 2 pumps and are more complex but can recover more energy. Turbo chargers have one pump and the recovered energy is used to boost pressure of the high-pressure pumps.

9.3.14 Clean in Place

A manual Clean in Place (CIP) system is proposed where CIP fluid (normally a weak acid or base) is manually added to a tank and then recirculated for 1-10 hours through the RO array. Neutralised, spent CIP solution should be able to be blended with the desalination plant brine effluent and discharged to environment or alternatively pumped to the inlet works of the plant.

9.3.15 Electrical Demand

A total electrical demand of 4 kWh per KL has been used to assess energy consumption, until further detail is available on the design, location etc this is considered to be a reasonable assumption.

10. NPV Seawater Reverse Osmosis Desalination Plant

The overall CAPEX has been determined through benchmarking of comparably desalination plants. A CAPEX of **$54 MM** has been established. This capital estimate of $54MM was based on a 10 MLD SWRO system meeting typical ADWG specification, which was deemed likely to be adopted by Council and supplied as a turnkey permanent facility, fully commissioned. Refer to section 9 for details on the proposed concept.

Plants used as a benchmark include the $27 MM Agnes water desalination plant (1.5 MLD commissioned 2011 with intake and outfall structure scaled for 4.5MLD) and $87 MM for the proposed 15MLD augmentation.

GANDEN has undertaken a cost breakdown for each of these items. This cost estimate has been established as $47 MM with an overall construction contingency of 15%. This costing has been provided in the Appendix G - . This costing does not include an estimate for: -

- Project management by the principal;
- Cost associated with community consultation; and
- Approvals and investigations associated with obtaining approvals (EIS).

The cost estimates are based on the concept design layout, with several assumptions made in relation to the location, prices for obtaining land and the total length of the intake and outfall pipeline. With the assumption in mind, for the purposes of the NPV, a CAPEX of $54MM has been adopted.

10.1 Operational Cost

Costing has been estimated based on the information provided by RCC, industry-standard values provided by suppliers and assumptions made by GANDEN. This has been recorded in detail in Table 45 and has been used in the NPV calculations (available in Appendix E).

The cost for the replacement of membranes is likely to reduce over the life of the asset, due to advancements in the technology and the wider adaptation worldwide. Membrane life and efficiency is likely to increase over the life of the project due to membrane development. It is also assumed that supplier support can be decreased over the operational period as the knowledge base, experience and comfort with the equipment increases with operation staff.

Allowance has been made for 2 FTE treatment plant operators and 1.5 FTE for maintenance. These roles can be either filled through council staff or alternatively, outsourced to specialised contractors.

10.2 Net Present Value

Input and assumption details for the NPV are listed in Table 45, below with additional comments provided. Within the NPV no allowance has been made for access to finance capital.

Table 45. OPEX/NPV assumptions

Description	Assumption	Confidence +/- (%)	Comments
CAPEX	$54,000,000	Benchmarked	Final price of the project will depend greatly on specification, location and type of contract.
Power consumption SWRO system (kWh/kl)	4.0 kWh/kL	20%	Power consumption will vary based on location
CPI value	2% per annum	n/a	
Chemical consumption ($/kl) (inclusive of antiscalant, biocide and CIP Chemicals)	$0.12	25%	Average price supplied by industry, chemical consumption can diver between plants based on raw water quality and pricing variability within chemicals based on delivery location
Consumables ($/kL)	$0.03	10%	
Supplier support $/annum	$100,000 p.a. in 2020, $75,000 p.a. 2021-2022, $50,000 p.a. 2022-2100	10%	
Operator Labour (RCC) (salaried or contractor)	2 FTE $240,000 including overheads	10%	
Maintenance and Project Management (RCC) (salaried or contractor)	1.5 FTE $195,000 including overheads	10%	
Desalination water price per kL to consumer councils	$1.66	n/a	RCC current price (2019-2020), note that a price increase is likely required
Electrical cost (per kWh)	$0.10	10%	
Production volume based on plant ultimate capacity	80%	10%	Production rates will depend greatly on availability of alternative raw water sources, it is noted that desalinated water is more costly than raw water sourced from dams
RO Membrane replacement period UF Membrane replacement period	5 years 6 years	10% 10%	

Description	Assumption	Confidence +/- (%)	Comments
RO Membrane replacement cost (Full replacement cost inclusive of labour)	$710 USD per membrane, EX works. 182 membranes per 2.5MLD train $150 AUD per membrane, delivered and installed.	Based on quotation 2020	Pricing is greatly dependant on exchange rate and CPI
UF Membrane replacement cost (Full replacement cost inclusive of labour)	$2,500 USD per membrane, EX works. 120 membranes per 2.5MLD train. $150 AUD per membrane, delivered and installed.	Based on quotation 2020	Pricing is greatly dependant on exchange rate and CPI

Five NPV scenarios were developed based on the above assumptions. Scenarios 1, 2, and 3 have allowed for the construction of a 10MLD facility, staged initially for the provision of process equipment for 5MLD, with a second addition of 5MLD of process equipment in 2035, 2030 or 2025 respectively. Initial costs associated with land acquisition, construction of the intake/outfall system, and integration with existing services (water and power reticulation) have been calculated for the plant's ultimate capacity, as staging the construction of these non-process related assets is not economically viable. Non-process equipment has been valued as $7 MM in our assessment and has not been further detailed. These scenarios allow assessment of deferring the capital expenditure of 5MLD worth of process equipment.

Scenario 4 provides the NPV for construction of the 10MLD facility in a single stage and the final scenario provides details on the construction of a 5MLD process facility that is not in use.

For all scenarios (with the exception of scenario 5) a production rate of 80% was assessed.

Table 46 - NPV Scenario Results

Scenario	NPV of Cash Flow	IRR	Profitability Index
Scenario 1: 5MLD 2020, 10MLD 2035 80 year span	$34,830,334	4.0%	1.74
Scenario 2: 5MLD 2020, 10MLD 2030 80 year span	$39,859,351	4.2%	1.85
Scenario 3: 5MLD 2020, 10MLD 2025 80 year span	$45,307,916	4.5%	1.96
Scenario 4: 10MLD in 2020 80 year span	$50,931,192	4.8%	1.94
Scenario 5: 5MLD in 2020, mothballed 80 year span	-$81,775,805	n/a	- 0.74

Refer to Appendix H - for a detailed overview of NPV for each scenario and the input parameters and assumptions made.

10.3 NPV Discussion

The NPV that has been developed will allow detailed interrogation of the impact of CAPEX and assessment of OPEX over the life of the facility. The cost of a desalination plant is significant and the facility can only be justified from an economic sense when operated at close to full capacity.

Operation of desalination facility from a public perception point of view can only be justified when all other sources of drinking water supply have been exhausted (or are threatened to be exhausted). This is demonstrated throughout Australia where most desalination plants have been sat idle for extended periods of time, only to be turned on in times of need. For example, the Adelaide desalination plant has been turned on recently to reduce the impact on the Murray Darling Basin; and the Sydney desalination plant (with a doubling of capacity underway) has only been turned on recently as a response to the extended and unprecedented drought period. Both these plants have been heavily criticised as a very expensive waste of money in recent years but are now proofing invaluable to supply drinking water.

In this light the NPV assessment is more dependent on external conditions (mainly climate and population) which are very difficult to accurately predict. Figure 34 show current dam levels for Rocky Creek and Emigrant Creek dams and under these conditions, it would be difficult to gain community support to construct a desalination plant at significantly higher operating cost when compared to traditional filtration plants.

These climatic effects cannot be reliably incorporated as part of the NPV assessment. What the NPV shows is that when operated, safe and reliable drinking water can be supplied as an economically viable option.

The cost of staging of the capacity of the treatment plant has a minor impact on the overall NPV when percentage operation is taken into account.

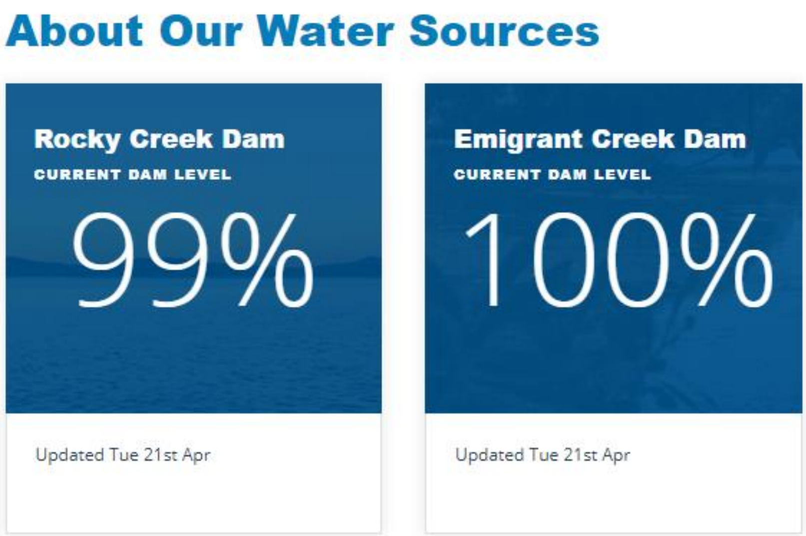


Figure 34 RCC dam levels 21-04-2020

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Appendix A - CoastAdapt Coastal Geology & Sediment Information

Coast Adapt General information

Coast Adapt Datasets Guidance 1

Coast Adapt NSW01.01.01 Byron to Tweed Coastal Sediment Compartment report

Coast Adapt NSW01.01.02 Cape Byron to Ballina Coastal Sediment Compartment report

Coast Adapt NSW01.01.03 Broadwater Coastal Sediment Compartment report

Tweed NSW01.01.01

Regional Setting

The dominant regional processes influencing coastal geomorphology in this region are the humid warm to cool temperate climate, micro-tides, south-easterly Tasman Sea swells, easterly seas, dominantly quartz (terrigenous) sediments with northerly longshore transport in the northern part, and the El Nino Southern Oscillation (driving beach erosion/accretion cycles, cyclone frequency).

Regional hazards or processes driving large scale rapid coastal changes include: East Coast Lows (extra-tropical cyclones), mid-latitude cyclones (depressions), and storm surges (<1m).

This compartment extends from Point Danger to Cape Byron.

Justification of sensitivity

Overall sensitivity rating is a 4. Within the compartment, several sections are already rated as 5, although if onshore sand supply is maintained for some sections, the sensitivity rating could be 3 for extended periods. The southern ends of several of these beaches are sensitive and undergoing erosion as a result of differential rates of littoral drift on adjacent beaches. Overwash from cyclonic storms has occurred in places where foredunes are low and narrow.

Other comments

This compartment comprises several tertiary compartments, characterised by northwards longshore drift, influenced by both tropical cyclones and East Coast lows (PWD, 1978; Helman, 2007).

It terminates to the north at the training walls of the Tweed River on Letitia Spit. Sand accumulation on the southern side of this training wall, following extension 1962-1965, deprived Gold Coast beaches to the north of sand. It also led to the installation of the Tweed River bypassing project, which pumps ~500,000 m^3 of sand a year (552,682 m^3 in 2015) from NSW to nourish Kirra and other beaches on the Gold Coast. See http://www.tweedsandbypass.nsw.gov.au/.

Patterson (2013) indicates that there is only a modest gradient in the longshore sand transport, increasing from about 200,000 m^3/yr at Ten Mile Beach, Iluka, to about 550,000m^3/yr at northern Stradbroke Island (Patterson, 2013, p. 82; see also Patterson et al., 2011).

The supply of river sand to the coast is limited on the section of coast to the south, and the source of sand to sustain northwards drift is inferred to be from onshore transport from the shelf (Boyd et al., 2008, Mariani et al., 2013). If maintained as sea level rises, it is possible that the shoreline position for long stretches of beaches facing generally east could be maintained as sea level rises (sensitivity 3) until an unknown threshold is reached (Cowell et al., 2000). However, there is likely to be some degree of short-term recession in the tertiary embayments during periods when sand feed from the south is restrained.

Sand moves around headlands, such as the basaltic Fingal Head, and Norries Head, as a slug (see example at Cudgen in Short, 1999, p244). Here, the training walls along Cudgen Creek create a permanent but variable sand shoal in the northern lee of Cudgen Headland, with associated erosion problems for Kingscliff. Tweed Council is developing a long-term strategy to manage the erosion threat at Kingscliff (see Coghlan et al., 2011, WRL report).

The southern ends of several of these beaches are undergoing periodic erosion as a result of differential rates of littoral drift on adjacent beaches. Cabarita Beach is experiencing ongoing shoreline recession due to by littoral drift imbalance (Mariani et al., 2013). Headlands at Norries and Cudgen both act like groynes protruding through the active surf zone. Sand tends to build up on their south (updrift) sides until bypassing occurs when the updrift areas are filled to capacity. During times of elevated wave action a pulse or slug of sediment can be moved around the headland (Figures 1 and 2), often partially depleting the updrift area, which has to re-fill before bypassing is again fully established (Short, 2007; Mariana et al., 2013). Cabarita

Beach appears to undergo an recession of 1m/year, when explained as a result of the differential of 110,000 m^3/y, as a consequence of the loss around Cudgen Head of 350,000 m^3/yr compared with a gain around Norries of only 240,000 m^3/yr. Unless this imbalance is offset by onshore drift as shown in Figures 3 and 4, the shoreline in this tertiary compartment will recede under climate change and cut into the foredune buffer built after mining operations ceased in the 1980s.

Cape Byron provides an obstacle at the southern end and only a limited quantity of sand makes it around the headland to contribute to the southern end of this compartment (PWD, 1978). A consequent drift differential can result in periodic erosion of the foreshore on the beaches north of Cape Byron. Some sand at Cape Byron can be lost to an offshore sand lobe (PWD, 1978; Patterson & Britton Partners, 2006) while there may be a component of cross embayment sand transport (Patterson, 2013, Figure 7-38). Various consulting reports prepared for Byron Shire Council, involving modelling of Byron Bay coastal erosion processes and hazards, have highlighted the vulnerability of this section of the coast, especially Belongil Spit, (for example BMT WBM , 2010). Hopley (1967, and PWD, 1978) also noted the impacts of overwash accompanying storm surges at the southern end of the compartment.

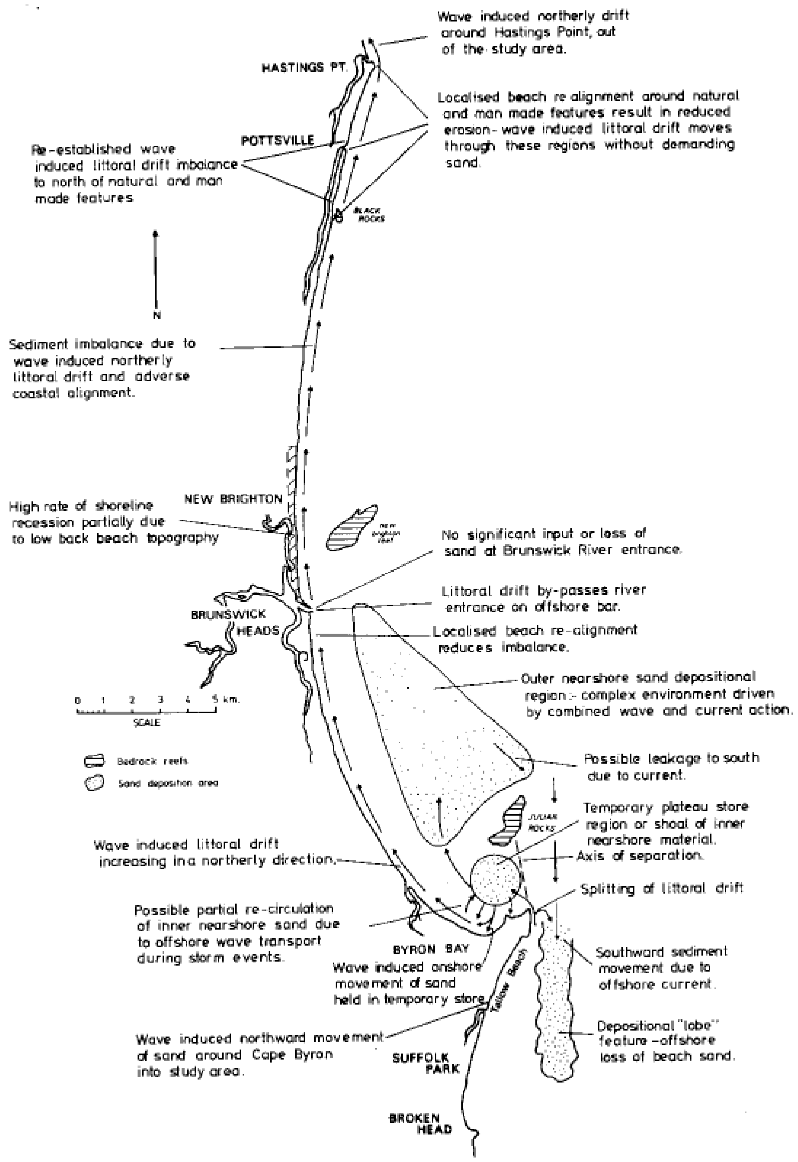
Several locations, such as Brunswick Heads, are sensitive where training walls have been built, with erosion becoming apparent downdrift after the storms in the 1970s. The Brunswick River is neither a source nor sink for sand (PWD, 1978). The settlement of Sheltering Palms to the north of the Brunswick River was severely eroded in the early 1970s and houses were abandoned and lost by 1977.

The area has been extensively explored and subjected to sand mining for heavy minerals (Gardner, 1955; Roy, 1999).

Figure 1. Erosion in front of surf club at Kingscliff (photo A. Short).

Figure 2. Sand slug moving around at Kingscliff (photo A. Short).

CoastAdapt



CONCEPTUAL MODEL OF SEDIMENT MOVEMENT

Figure 3. Conceptual model of Cape Byron (PWD, 1978)

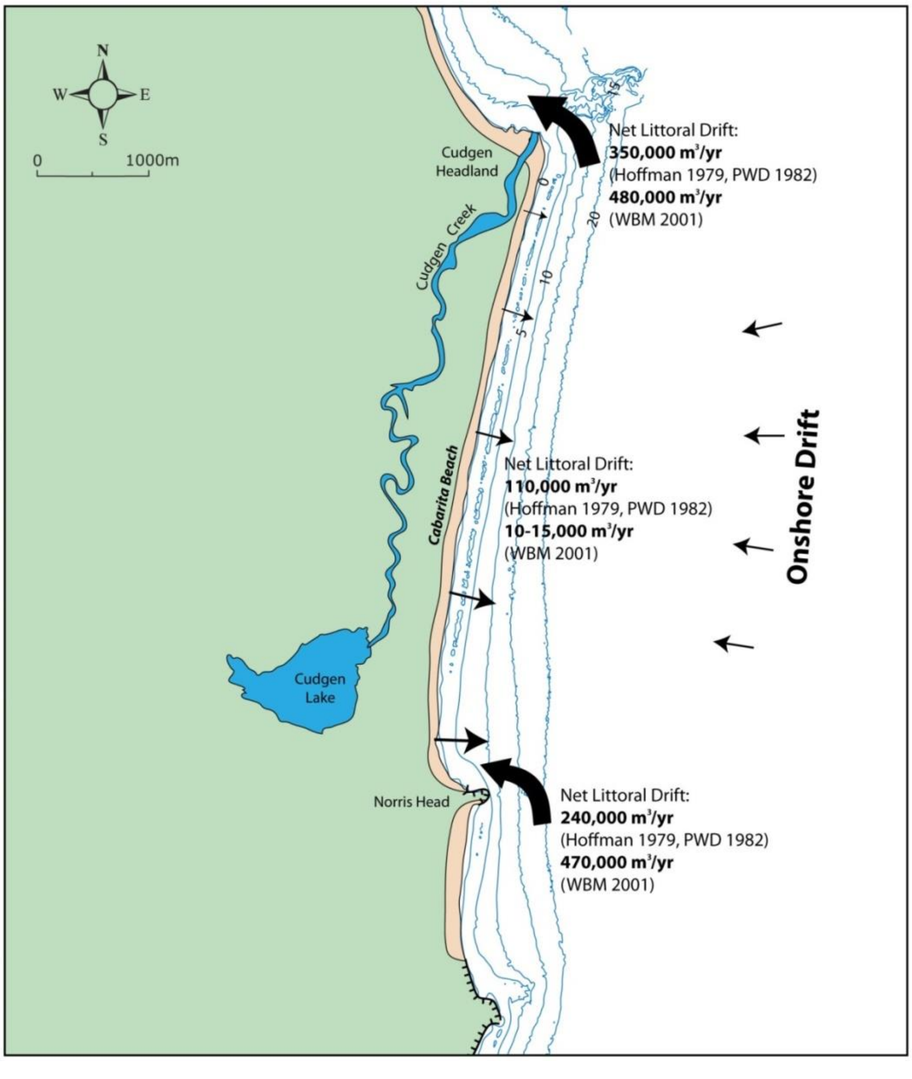


Figure 4, Conceptual sediment budget model (Fig 2.10 from Mariani et al., 2013)

Confidence in sources

High confidence: Longshore drift along the northern NSW coast has been the subject of numerous detailed studies, including several focused on erosion at Tweed Heads, Kingscliff, Cudgen and Byron Bay, especially Belongil Spit.

Additional information (links and references)

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Cape Byron to Ballina NSW01.01.02

Regional Setting

The dominant regional processes influencing coastal geomorphology in this region are the humid warm to cool temperate climate, micro-tides, south-easterly Tasman Sea swells, easterly seas, dominantly quartz (terrigenous) sediments with northerly longshore transport in the northern part, and the El Nino Southern Oscillation (driving beach erosion/accretion cycles, cyclone frequency).

Regional hazards or processes driving large scale rapid coastal changes include: East Coast Lows (extra-tropical cyclones), mid-latitude cyclones (depressions), and storm surges (<1m).

This compartment extends from Cape Byron to Richmond River.

Justification of sensitivity

Sensitivity rating is a 4. Parts of this compartment are sediment-starved; Holocene sand accumulation has been limited, with Pleistocene dune sands exposed in places on the coast and seawall construction at Lennox Head indicating that it is likely already earning a sensitivity rating of 5.

Other comments

This compartment comprises two log-spiral or zeta curve tertiary compartments to the north, and a more rocky section of coast to the south, near the mouth of the Richmond River. There has been past mining on many of these beaches.

Historically there has been an erosion problem at Seven Mile Beach, especially near Lennox Head at the southern end of a tertiary compartment. In places, there is narrow Holocene sand accumulation, and peat outcrops have been described in the beach - a sign of a receding barrier (Chapman et al., 1982). The exposed nearshore reef of peat has been radiocarbon dated around 3700 years BP, suggesting a recession rate of at least 0.05m/year (Geomarine, 1990). Patterson (2013) notes that the shoreline at Lennox Head and northward along Seven Mile Beach is eroding; from the earliest date of aerial photos in 1947, foredunes up to 10m high have been lost in places between 1947 and 1976.

As with other parts of the north coast on NSW, the shoreline has stabilised since 1980 to a large degree during a period of inter-decadal post storm recovery. However, this is a sediment starved area and highly sensitive to climate change. Historical and late Holocene breaching of the narrow barrier into Lake Ainsworth is another indication of the fragility of the coast in this area.

The southern part of this compartment faces southeast and contains several short straight beaches between basalt headlands; there are two boulder beaches.

Patterson (2009, 2013, p.268) has modelled the impact of the training walls of the Richmond River on sand transport. His study of the present-day wave climate and longshore sand transport regime for this compartment and that to the south of Ballina indicates that the net rate of transport at Ballina is highly sensitive to the subtle balance between deep water wave direction and shoreline orientation north and south of the Richmond River. The training walls have trapped a large quantity of sand, altering the alignment of the coastline to the south, but having possible long term erosion effects to the north toward Suffolk Park (southern end of Tallow Beach), including erosion of Seven Mile Beach and in the vicinity of Seven Mile Beach.

Low-lying plains flanking the lower Richmond River are likely to be subject to inundation, and continued sand accumulation and trapping in shoals of the flood tide delta. But it is not clear as to whether this delta will continue to serve as a sink for sand as sea level rises. The long-term behaviour of entrance shoals under climate change, such as at the Richmond, is most uncertain at this stage.

Confidence in sources

Medium confidence: Similar processes of longshore transport occur as further north, but they have studied in detail in the Lennox tertiary compartment and around the mouth of the river, the subject of recent (2016) Coastal Zone Management Plans by Ballina Shire Council.

Additional information (links and references)

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PWD (1978) Byron Bay – Hastings Point erosion study. NSW Dept. Public Works, Coastal Engineering Branch Report, PWD 78026

Broadwater NSW01.01.03

Regional Setting

The dominant regional processes influencing coastal geomorphology in this region are the humid warm to cool temperate climate, micro-tides, south-easterly Tasman Sea swells, easterly seas, dominantly quartz (terrigenous) sediments with northerly longshore transport in the northern part, and the El Nino Southern Oscillation (driving beach erosion/accretion cycles, cyclone frequency).

Regional hazards or processes driving large scale rapid coastal changes include: East Coast Lows (extra-tropical cyclones), mid-latitude cyclones (depressions), and storm surges (<1m).

This compartment extends from Richmond River to Evans Head.

Justification of sensitivity

Sensitivity rating is a 4, following Chapman et al. (1982), based on exposure of Pleistocene sediments.

Other comments

The Broadwater compartment contains a long beach (30 km from the southern training wall of the Richmond River to Evans Head). The beach fronts a mixed Pleistocene-Holocene sand barrier that separates the Richmond River from the sea (Figure 1). To the north is a narrow Holocene ridge, behind which are back barrier flats and a river flood plain that historically has been subject to overwash and dune instability, in places such as Patches Beach (Chapman et al., 1982). The Holocene barrier is anchored on a Pleistocene beach and dune ridge sequence that occurs at the southern end of the compartment. The Pleistocene sands are indurated with prominent coffee-rock outcrops on the beach as the waves erode the backshore. Mining of the Pleistocene sands has occurred.

Patterson (2009, 2013; see also work by WBM Oceanics Australia 2003) notes that little information is available for shoreline behaviour immediately north of Evans Head; however, regional modelling indicates shoreline recession of up to 0.4m/yr in that area. The local model shows that the Richmond River training walls have led to some shoreline accretion, suggesting a degree of long term stability of the shoreline for about 10km to the south of the mouth.

Figure 1. Pleistocene dune exposed and experiencing erosion, Broadwater (Photo A. Short).

Confidence in sources

Medium confidence: The synthesis by Chapman et al. (1982) provides some useful historical information, but more recent modelling indicates the need for more work to be undertaken on erosion rates of the coffee rock, and the impact of the Richmond River training walls.

Additional information (links and references)

Chapman, D.M., Geary, M., Roy, P.S., Thom, B.G., 1982. Coastal Evolution and Coastal Erosion in New South Wales. Coastal Council of New South Wales, Sydney.

Helman, P., 2007. Two hundred years of Coastline Change and Future Change, Fraser Island to Coffs Harbour, East Coast Australia. Unpublished PhD thesis, Southern Cross University.

Patterson, D.C. 2009. Modelling the shoreline impacts of the Richmond River training walls. 18th NSW Coastal Conference, Ballina, NSW.

Patterson, D.C., 2013. Modelling as an aid to understand the evolution of Australia's central east coast in response to late Pleistocene-Holocene and future sea-level change. Unpublished PhD thesis, University of Queensland.

Datasets Guidance 1: *Shoreline Explorer* Present-day coastal sensitivity to flooding and erosion

Table of Contents

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Introduction

There are three datasets in Shoreline Explorer:

- Sediment compartments (Section 1 in this document). This summarises the available information on physical (i.e., ocean currents, geomorphology etc.) coastal risks for each coastal compartment in Australia.
- Smartline (Section 2). This comes in a basic version and an advanced version. It is by far the most complex of the datasets in CoastAdapt, so you may wish to try the basic version first. It provides information on erodibility of the coastline based on geology.
- Water Observations from Space (Section 3). This provides information on present-day flood risk using satellite data.

Local government boundaries are also provided. You can look at more than one dataset at once. Each dataset has a horizontal slider bar below its name – this controls the transparency and opacity of the dataset. Sliding it to the left makes the data more transparent, and to the right more opaque.

All datasets in Shoreline Explorer are accessed from the same starting point, as follows:

1. From the home page of CoastAdapt click on Shoreline Explorer. This will take you to a page that provides short descriptions of available datasets in Shoreline Explorer.
2. Clicking on one of the Shoreline Explorer links from this page will take you to an interactive map of Australia. You can choose (top left-hand corner) to show this map as a satellite image, or as a national colour base map. We use two base maps because, although using the satellite base map is more visually appealing, features are not marked. The national colour base map show place names and roads, making it easier to pinpoint precise locations.
3. On the left-hand side of the screen, the available datasets are listed. You just have to tick the box(es) for the one(s) you want.

The first time you try to use Shoreline Explorer it may seem difficult, but with a little practice it will become a straightforward process.

1. Coastal sediment compartments

1.1 What is a sediment compartment?

It is possible to divide the coastline into discrete units within which there are broadly homogeneous features that may include geology, landform types, near-shore currents and sediment availability and movement. This can be done at different scales, and scientists have divided the Australian coastline into primary, secondary and tertiary compartments.

There are 359 secondary compartments (see Figure 1). A compartment might be, for example, a bay lying between two headlands. The scale of the secondary compartments makes them convenient units at which to consider present-day exposure and vulnerability to erosion from, for example, wave action and storm surge. Present-day exposure and vulnerability are, of course, good guides to where problems are likely to arise as a result of future sea-level rise and therefore where adaptation efforts may need to be concentrated.

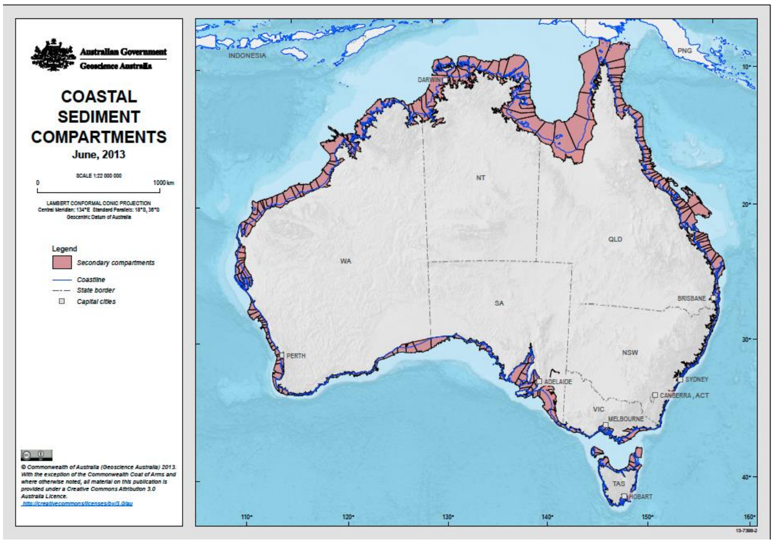

Figure 1: Australian coastal secondary sediment compartments. Source: Geoscience Australia http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_76502, accessed 29 June 2016.

Geomorphic data are available for primary and secondary compartments (http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_76502, accessed 29 June 2016). A project was carried out to build on what was known about each compartment, and to gather together the available information on coastal risk for each coastal compartment in Australia. Further information on the project is provided in Section 1.5. This information has been compiled into a dataset which is available through CoastAdapt.

1.2 How to access sediment compartment information

Once you have clicked the box in the Shoreline Explorer for the dataset you want (see the beginning of this document), proceed as follows:

1. You can find your area of interest either by typing the name of the place in the search box (top right hand corner of the map), or by zooming in using your mouse or the zoom slider.
2. Blue lines indicate the boundary of each compartment.
3. Click on the compartment of interest and an attribute table will appear in a pop-up box. The pop-up box contains a summary of the attributes for that sediment compartment. An example is shown in Table 1.
4. In the third row of each attribute table there is a link to a document. Select this link and a pdf with additional detail and information about the sediment compartment appears. An example of a pdf for the Tweed sediment compartment in New South Wales is provided in Appendix 1.

Table 1: Attribute table for the Tweed sediment compartment.

Sediment compartment name	**Tweed**
Included area	From Point Danger to Cape Byron
Further information	http://docs.coastadapt.com.au/sediment_compartments/NSW01.01.01.pdf
Geomorphology	Isolated rock headlands, zeta-form bays[1], sandy beaches, dunes and active blowouts (mixed Pleistocene-Holocene bay barriers infilling embayments), Tweed River mouth and estuary.
Sensitivity	Sensitivity rating is generally a 4, with several sections already 5. The southern end of several of these beaches is sensitive and undergoing periodic erosion and overwash

You will see in row 4 of the table that the compartment has been given a sensitivity rating. For the purposes of assessing future shoreline behaviour a sensitivity scale (1 to 5) was developed that could be applied in each of the 359 secondary compartments. The scale is as follows.

1. Shorelines that are presently accreting and are likely to continue or accelerate their accretion as sea-level rise continues (as a result of increased supply of sand from an alongshore source or from river/tidal channel sources).
2. Shorelines that are currently stable but are likely to start accreting as sea-level rise continues (includes shorelines that periodically grow seaward but may be subject to episodes of erosion).
3. Relatively stable shorelines which may be subject to periodic erosion followed by recovery (accretion), but no long-term recession expected in the next few decades since the sediment budget remains sufficiently balanced over time from offshore, alongshore or terrestrial sources.
4. Shorelines that currently do not show evidence of long-term recession but are likely to begin receding with continuing sea-level rise (based on sediment availability onshore and offshore).
5. Shoreline recession is occurring now (typically documented by historical shifts in shoreline position) and the shoreline is likely to continue to recede as sea level rises (possibly at a faster rate depending on local conditions).

Thus, in the case of the Tweed, the shoreline is expected to recede under sea-level rise (rating 4), with some sections already showing evidence of recession (rating 5). Action is likely to be necessary in the near future to address these risks.

Sometime the sediment compartment information provides a confidence rating, to provide users with an indication of the confidence of the experts in the sensitivity ranking they have provided (see Table 2).

[1] A zetaform bay *has a shoreline that in plan view is asymmetrical, with a decreasing radius of curvature toward one end.*

Table 2: Three categories of confidence were used to infer the sensitivity ranking.

Low	Limited or no information describing landforms or coastal landform change over the historical period is available.
Medium	Some information is available on changes to landforms, from multiple sources, which may include recent landform change from site descriptions and irregular aerial photographs over the past decade.
High	Detailed information is available identifying changes to coastal landforms spanning the historical period and includes regular remotely sensed information over the past 30 years or more.

1.3 How to use sediment compartment information in coastal management and adaptation

We suggest the following steps to use sediment compartments in coastal management and adaptation.

1. Start by looking at the sediment compartment information in CoastAdapt and identify the level of sensitivity for the compartments that relate to your local government area or location of interest. This is on a scale of 1 to 5, with higher numbers indicating a greater sensitivity to erosion, and lower numbers indicating a greater sensitivity to accretion. Generally, it is good practice to avoid locating infrastructure that could disrupt coastal processes in highly sensitive compartments.

2. If the sensitivity to change is medium to high, for example 4 or 5, it is important to get expert advice on the cause of the erosion risk to understand whether it is, for example, caused by high volumes of longshore sediment transport, or a deficient offshore sand supply. Limited offshore sources of sand are often revealed in beaches where recovery from storm erosion is slow or incomplete. A high level of sensitivity suggests that adjacent compartments may also need to be considered in coastal planning, thus helping to determine appropriate scales of action and whether collaboration and partnerships are required.

3. Consider the scale of planned development in the coastal compartments. If a large or high-value development is planned, for example a port or sewer facility, it is useful to consider the implications of that development at finer (tertiary, see Figure 2) compartment scales. Detailed impact modelling using local data will be needed for large developments or for critical infrastructure. For many smaller scale decisions, consideration of implications up to secondary compartments will be appropriate although local assessments at tertiary scale may also be needed.

4. If a planned development is near a compartment boundary, it is also important to consider the adjacent compartment in planning, assessment and decision-making.

Other sources of information will also be required for effective coastal planning and management, particularly where the compartment sensitivity rating is high. For example, understanding of the local sources and behaviour of sediments is needed to design effective coastal protection measures. In sediment deficient compartments, there may be few local sources of sand that can replenish eroding beaches. As a result, engineering solutions that depend on sediment accumulation may not work.

Guidance for consultants. In many cases, consultants do not collect new data and use whatever information is available. The information provided through this project can assist consultants to obtain relevant information, but can also help them to identify gaps and determine when new data are required. Similarly, users can use the information to help develop briefs for consultants.

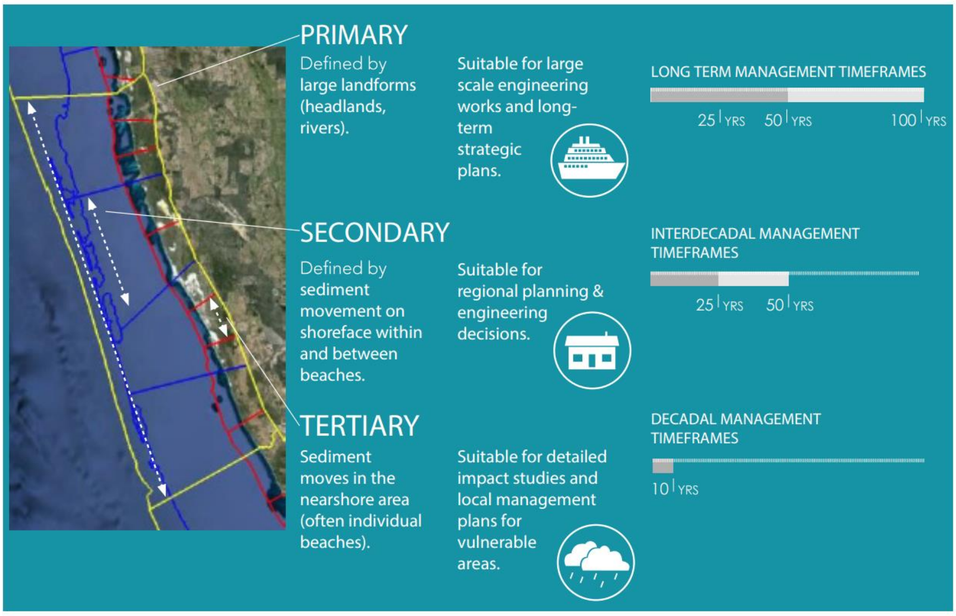

Figure 2: Coastal compartment scales, use and timeframes. (Source: Thom, B. Coastal Compartments Project Summary for Policy Makers, http://www.environment.gov.au/system/files/resources/4f288459-423f-43bb-8c20-87f91adc3e8e/files/coastal-compartments-project.pdf, accessed 12 April 2017.

1.4 Some thoughts on the sediment compartment database

Users of the information contained in the attribute tables (example in Table 1) and their pdf links (example in the Appendix) should note that no set climate change assumptions have been made other than those provided by CSIRO projections for sea-level rise, as described in Sea-level rise and you. For example, while tropical cyclones may increase in intensity, no assumption is made as to this, or to change in frequency or shift in location. Similarly, we have not assumed any changes to East Coast Lows in future decades, or any major changes in sediment outputs from rivers or tidal channels.

A major advantage of having information on secondary compartments is that it helps users to recognise that different compartments can, and most likely will, respond in different ways to climate change. The key is the link between landform type and sediment availability as expressed in the dynamics of the sediment budget within each secondary, and more locally tertiary, compartment. The project offers a basis for more informed consideration of sediment type, sources, pathways and sinks. It points to the need to go offshore and map sediment types and bottom conditions and to not make simple assumptions about directions and rate of shoreline movement over the time scales appropriate for coastal planning and management, and risk assessment.

1.5 The Coastal Sediment Compartments project in CoastAdapt

1.5.1 Overview

Aim

The aim of the sediment compartments project is to improve coastal risk assessments under conditions of climate change at regional scales. The compartment approach provides a spatial framework which integrates driving forces with landform type and sediment availability that best assists decision-makers involved in coastal land use planning and asset management (Thom 2015). This dataset is developed by Bruce Thom, Ian Eliot, Matt Eliot, Nick Harvey, Jo Mummery, David Rissik, Chris Sharples, Andrew Short and Colin Woodroffe.

Background

The approach involves the division of the Australian coast into discrete units based on sections where there are identifiable features that reflect sediment availability and fluxes, landform types or associations (see Information Manual 8: Coastal sediments for more details), and a potential ability to determine sediment (mostly sand) budgets. In the initial phase of the project, the coast was first divided into regions, which defined overall climatic and oceanographic process regimes (Figure 3). Regions can then be divided into primary, secondary and tertiary compartments or cells (Figure 2). It was agreed that the secondary compartments were most practical for regional planning and management decisions. The project involved descriptions of the characteristics of the 359 secondary compartments on a state-by-state basis.

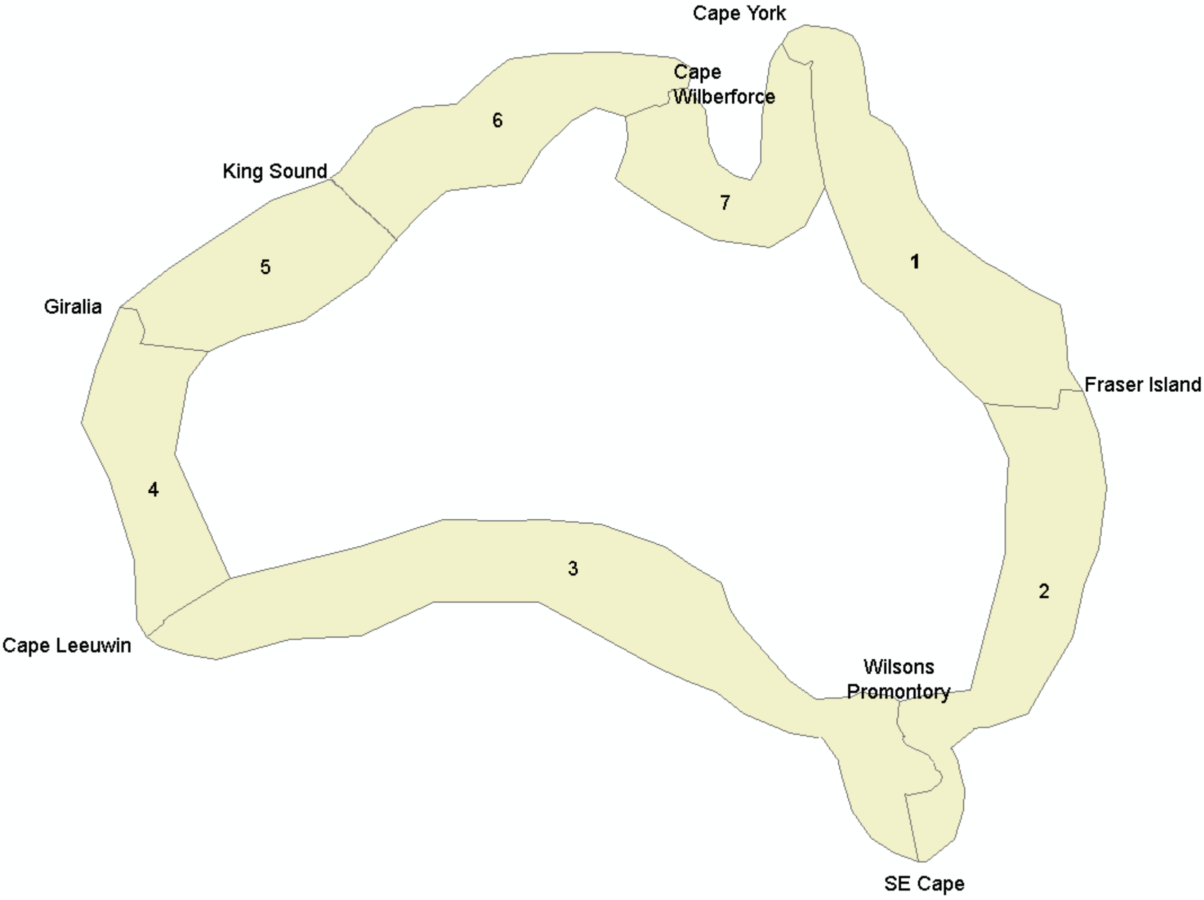

Figure 3: Regions which defined overall climatic and oceanographic process regimes.

Changes in shoreline condition within coastal compartments at the secondary scale can involve transport of sand in both cross-shore and alongshore directions, into and out of river and estuary entrances, and into dune fields. These transfers of sand can operate within these natural units regardless of administrative boundaries such as those of local government. It is then appropriate to highlight the way in which coastal processes and shoreline change should be investigated across such boundaries. The approach offers a consistent methodology determined by an understanding of the distinctive geomorphological characteristics of each compartment. This will include knowledge of existing sediment conditions; an interpretation of both recent geologic and historic trends in shoreline position; and, based on what is known about sediment budgets and shoreline behaviour of each compartment, an attempt to project the nature and degree of change into the future under the new climate era.

From a geomorphic perspective, shoreline behaviour in the future will depend on how sediment budgets will respond to the driving forces. For instance, we cannot simply assume a linear shift in shoreline position with sea-level rise if the sediment budget is in surplus or in deficit. Even in so-called equilibrium condition, we cannot assume that all sand will be permanently lost from the beachface to the shoreface as some component may be transported. It may move into an adjoining compartment to be captured by a control point such as a headland or rocky outcrop, or be lost into an estuary mouth that will then change the form and processes (morphodynamics) of estuaries (e.g. impact on tidal regime of the estuary or coastal lake). Understanding landform type and offshore sediment/rock condition can provide indications of which compartments are likely to respond earlier (fast responders) or later (slow responders) to sea-level rise and/or changes in wave climate. It is possible that the dynamics of sediment exchange and availability within a given compartment will allow shorelines within a compartment to remain stable for decades before any noticeable long term change is identified (resilient behaviour). Even within a secondary compartment it is possible for tertiary compartments or cells to differ in sensitivity to change compared to the overall condition at a larger scale; local investigations are required to determine these differences.

1.5.2 Assessing future shoreline behaviour

The process of assessment of shoreline behaviour now and into the future was based on expert judgement using an array of national, state, regional and local sources. Seven experts were assigned states and territories (Table 3). Of national importance were the original Geoscience Australia coastal maps, Smartline mapping undertaken for the former Department of Climate Change led by Chris Sharples, the national survey of beach types and sediments by Andy Short, sea-level projections by CSIRO, and various tools used to project inundation on Digital Elevation Models (DEMs) and Google Earth. At the state and regional scale, the experts used various published sources plus their own understanding of stretches of the Australian coast where they have undertaken fieldwork. In addition, they accessed many unpublished reports by academics and consultants and state and local agencies. Descriptions were standardised at a two day meeting attended by the team.

Table 3. Experts involved in the project and the areas they described.

Geographic Region	Expert
Far North Queensland	Nick Harvey/ Colin Woodroffe
North to South Queensland	Andy Short
New South Wales	Colin Woodroffe and Bruce Thom
Victoria	Chris Sharples
Tasmania	Chris Sharples
South Australia	Nick Harvey
West Australia	Ian Eliot and Matt Eliot
Northern Territory	Colin Woodroffe

References

Thom, B., 2015: Coastal Compartments Project Summary for Policy Makers. Accessed 29 June 2016. [Available online at www.environment.gov.au/system/files/resources/4f288459-423f-43bb-8c20-87f91adc3e8e/files/coastal-compartments-project.pdf].

2. Smartline

2.1 Overview

Aim
Smartline was developed to provide a single, consistent map of coastal landforms for the entire Australian coast. The aim is to provide information to help underpin coastal zone management, risk assessment prioritisation, and decision making. The project to develop Smartline was led by Chris Sharples.

What is Smartline?
The Smartline map divides the coastline into numerous distinct segments. Within each segment, multiple attributes describe the subtidal, intertidal and backshore coastal landforms and geology that dominate a coastal zone. The description extends (nominally) 500 m landward and seaward of the High Water Mark line. Each segment begins and ends where there is a significant change in any of the landform characteristics along the coastline, such as the beginning or end of a sandy beach (see Figures 4 and 5).

Background
The Smartline coastal geomorphic (landform) map of Australia was created during 2007 – 2009 in response to a need for a single detailed and consistently-classified map of coastal landforms for the entire Australian coast. Preparation of the map did not involve original mapping, but rather the extraction, reclassification and combining of relevant details from over 200 pre-existing, but differently purposed, scaled and classified coastal map datasets into a single nationally-consistent map. The format of representing detailed descriptive coastal landform information as multiple attributes within a simple digital (GIS) line map was chosen over the more traditional two-dimensional or polygon map format. The reason being, firstly, this provided a practical method of compiling a new national dataset within a limited time frame and, secondly, the essentially linear nature of coastlines makes the GIS line map a particularly efficient format in which to capture, represent and extract many types of useful coastal information. Although some types of coastal information do require polygon maps and digital elevation models, the ease with which a simple line map can efficiently capture and display many types of useful coastal information has led to it being referred to as the 'Smartline' format.

The landform and geological information provided in the Smartline dataset is as accurate as the base datasets from which it has been compiled. However owing to the varied nature and detail of these, there are known to be some data gaps and generalisations present within the Smartline; particularly in regions for which less detailed existing geomorphic mapping was available such as parts of the Northern Territory and Gulf of Carpentaria. It is hoped that future work will enable the level of detail of the Smartline data for areas such as these to be improved.

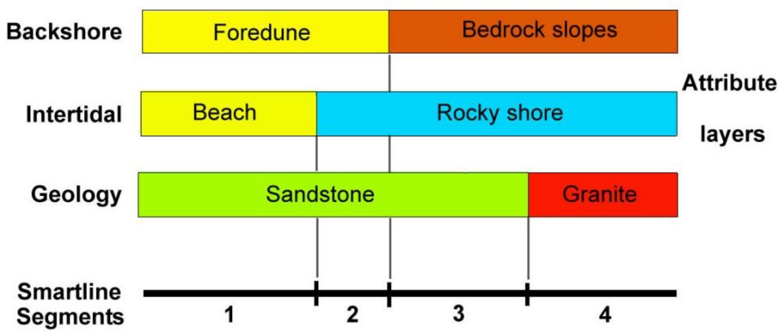

Figure 4: Illustration of how multiple layers of information about the coastal zone can be attributed to a single digital line map representing the coastline, with the correct alongshore extent of each attribute being preserved by segmenting the line wherever any one of the attributes change.

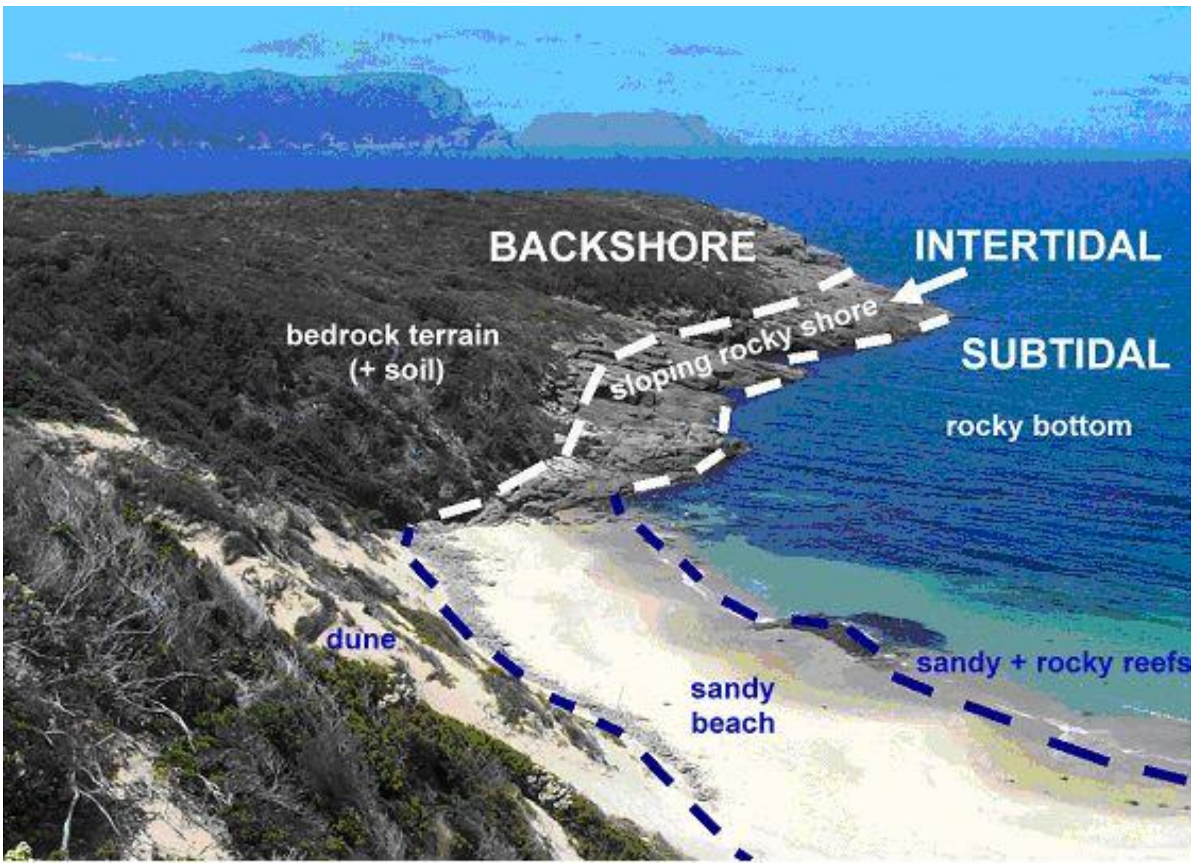

Figure 5: In its more detailed attributes, Smartline describes the landforms of the coastal zone in terms of three shore-parallel tidally-defined zones as indicated in this figure. Landforms within each of these zones are described using two descriptive attribute fields plus another field describing the overall zone profile or slope. The two simpler levels of detail provided in Shoreline Explorer within the CoastAdapt tool do not display these attributes separately, but rather amalgamate them into simpler characterisations of the coastal zone. For example, the two main coastal segments in this figure would be characterised as 'Sloping hard rock shore backed by bedrock' and 'Sandy beach backed by dunes over bedrock'.

The Smartline format permits very detailed information about coastal landforms (or other coastal attributes) to be recorded in multiple attributes, however it also allows this information to be 'distilled' down into simpler, broader landform categories represented by just a few or even just a single map attribute or layer. Two such simpler layers are provided in the Coast Adapt Tool: Smartline Basic and Smartline Advanced.

2.2 Smartline within CoastAdapt

Shoreline Explorer provides two Smartline layers with different levels of detail.

- At the simplest level, a single map layer called 'Smartline Basic' can be used to display the coast classified into just four landform categories based on very broad differences in the composition and erodibility of coastal landforms.
- At the second level of detail, called 'Smartline Advanced', separate layers can be displayed showing the location and extent of more differentiated but still quite broadly-defined coastal landform types or groups, such as hard rocky shores (of several types e.g. cliffed and sloping), sandy beaches (e.g. backed by bedrock or by soft sediment terrain), soft-rock shores of several types, and others.

2.3 How can I use Smartline information?

The value of Smartline lies first and foremost in its provision of a single detailed nationally-consistent map identifying the location and distribution of a wide variety of coastal landform types around the entire Australian coast. At present, no other coast of comparable length anywhere in the world has been consistently mapped and classified to the level of landform mapping detail provided by Smartline.

This information has been used to map the regional and national distribution of shores having broadly different levels or modes of sensitivity to sea-level rise and coastal erosion or recession at the two levels of detail (basic and advanced) provided within CoastAdapt. The advanced level of detail provided allows differentiation between broadly defined categories such as erodible sandy beaches exposed to or sheltered from swell-wave action, resilient sloping hard rock shores, slump-prone 'soft-rock' shores, and other susceptibilities. Note however that Smartline cannot provide estimates of likely rates or magnitudes of shoreline responses (such as recession or slumping) to sea-level rise at specific locations, as this requires additional modelling of coastal processes.

Smartline information can be used in conjunction with sediment compartment descriptions (see Section 1) to extend assessment of sensitivity of beaches to short, medium and long-term change and help to prioritise action.

Smartline information can be used as a basis for undertaking foreshore related climate adaptation planning and as a useful starting point for research projects on foreshore stability.

Together with other datasets relating to the shoreline, Smartline can help understanding of coastal and estuarine foreshore processes.

In addition, the Smartline provides a useful format to which a wide variety of other coastal data can be attached as new attribute layers become available. This functionality is not available through CoastAdapt, but requires importing the Smartline base data into the users' GIS environment.

2.4 How to access Smartline

A. Smartline Advanced

Once you have clicked the box in the Shoreline Explorer for the dataset you want (in this case, Smartline Advanced, see the beginning of this document), proceed as follows:

Step 1: In the drop-down box, select one of the ten geomorphic types you are interested in (Figure 6). For each geomorphic type you select, a key will appear below showing the colour scheme for various geomorphic attributes. An example of the legend for a sandy classification is shown in Figure 7.

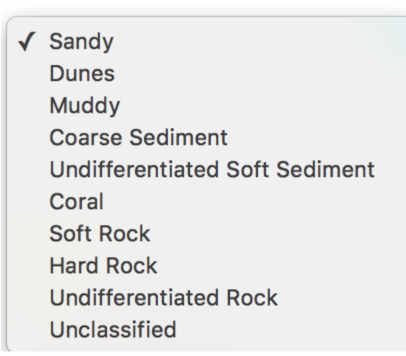

Figure 6: Geomorphic types in SmartLine.

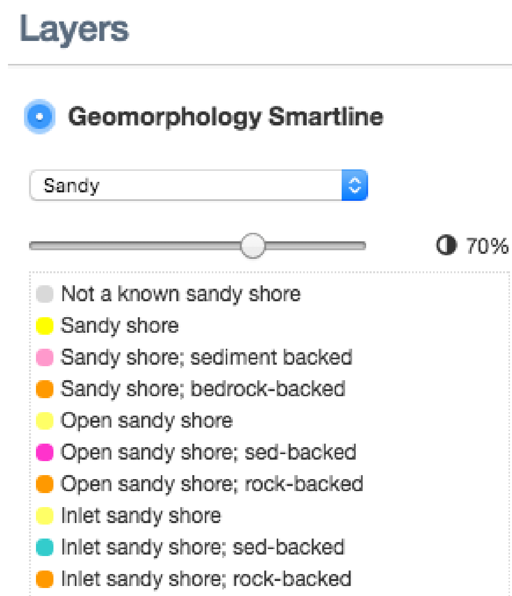

Figure 7: Legends for sandy classification.

Step 2: Find your area of interest either by typing the name of the place in the search box (top right hand corner of the map), or by zooming in using your mouse or the zoom slider. A coloured line will appear showing the extent of the geomorphic characteristic selected.

Step 3: If you are interested in any particular place or point, you can click directly on the coloured line at that place of interest. This will bring up an attribute table that will show information about the ten geomorphic attributes (Figure 8).

Muddy	Not identified as a muddy shore
Sandy	Sandy shore backed by soft sediment deposits to below sea-level
Dunes	Dune-field undiff exposed to wave attack at seaward side
Coarse Sediment	Not identified as a coarse sediment shore
Undifferentiated Soft Sediment	Not identified as an undifferentiated soft sediment shore
Soft Rock	Not identified as a soft rock shore
Hard Rock	Not identified as a hard rock shore
Undifferentiated Rock	Not identified as an undifferentiated rock shore
Coral	Not identified as a coral coast
Unclassified	Shoreline stability classified

Figure 8: Example attribute table for SmartLine.

B. Smartline Basic

Step 1: Once you have clicked the box in the Shoreline Explorer for the dataset you want (in this case, Smartline Basic, see the beginning of this document), a legend will appear below showing six categories of erodibility (Figure 9).

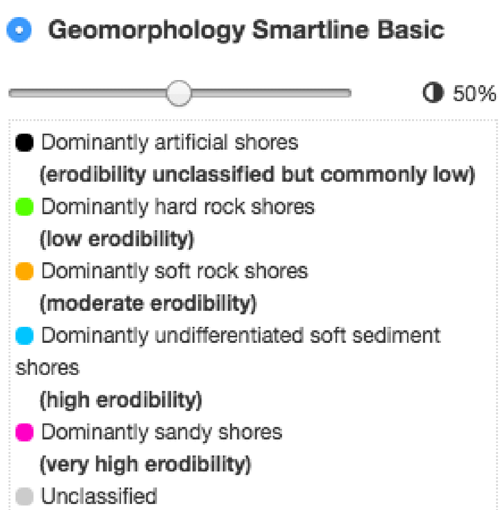

Figure 9: Smartline Basic key.

Step 2: Find your area of interest either by typing the name of the place in the search box (top right hand corner of the map), or by zooming in using your mouse or the zoom slider. A coloured line will appear showing the extent of the erodibility characteristic selected.

Step 3: If you are interested in any particular place or point, you can click directly on the coloured line at that place of interest. This will bring up an attribute table that will indicate the erodibility at that point (Figure 10).

Erodibility	Dominantly sandy shores (very high erodibility)

Figure 10: Example attribute table of Smartline Basic.

2.5 Further information

Smartline can also be used at an even more detailed level than the two described above, using further attributes that classify coastal landform attributes in greater detail. To use Smartline effectively at this higher level of detail it is necessary to have some experience using the dataset and to be familiar with both GIS techniques generally and the Smartline Data Model specifically. Further information on Smartline and its potential uses can be found at the OzCoasts website http://www.ozcoasts.gov.au/coastal/index.jsp; this allows users to interact online with Smartline data, and provides a useful extended introduction to the structure and use of Smartline (at http://www.ozcoasts.gov.au/coastal/introduction.jsp). In addition, a detailed 'Smartline Manual and Data Dictionary' providing full technical details can be downloaded from the same OzCoasts website.

smartline
coastal data segmentation

3. Water Observations from Space (WOfS)

3.1 Introduction

Water Observations from Space (WOfS) is a dataset developed by Geoscience Australia (GA). The project was commissioned by the Australian Government following extreme flooding in eastern Australia in 2011. It aims to map the extent of surface water across Australia using the multi-decadal archive of Landsat satellite imagery. WOfS provides information on historical surface water observations derived from satellite imagery for all of Australia for the period 1987 to 2014. Close to 200 000 images from 27 years of observations from Landsat 5 and Landsat 7 were analysed using a water detection algorithm to show where surface water was usually observed, occasionally observed and rarely observed by satellite.

Water detection methods are based on the absorption of longer wavelengths of light in water. Using an automated water detection algorithm, the number of times that water was detected in a location is compared to the number of clear observations of that location (i.e. observations not affected by cloud, shadow or other quality issues). Each location is a cell in a 25 m by 25 m grid across Australia. The resulting information indicates how often water was observed at each location. The approach enables identification of areas with episodic inundation such as flooding (lower calculated values) and those with water bodies such as lakes and dams (higher calculated values).

3.2 The information

For each grid cell in the map, WOfS in CoastAdapt contains two datasets:

- Dataset 1 Water summary (filtered): the percentage of clear (no cloud, shadowing etc.) observations in which water was detected from 1987 to 2014 (i.e. the number of occasions water was detected divided by the number of clear satellite observations).
- Dataset 2 Confidence: the confidence (or probability) that the percentage value displayed in Dataset 1 is correct at a location. This is expressed as a percentage, based on a number of factors including the slope of the land and the existence of other corroborative evidence.

Dataset 1 is labelled as filtered because information is only shown where the confidence is at least 1%.

3.3 How to access WOfS

Once you have clicked the box in the Shoreline Explorer for WOfS (see the beginning of this document), proceed as follows:

1. If you want to see where the local government boundaries are, click on this dataset also.
2. You can find your area of interest either by typing the name of the place in the search box (top right hand corner of the map), or by zooming in using your mouse or the zoom slider.
3. Immediately below the tick box for WOfS, you have to choose between two datasets: the actual data (‘water summary filtered’) and the confidence in that data (‘confidence’). You will want to look at the water summary before you look at the confidence.

4. Use the horizontal slidebar to set your transparency/opacity for the displayed data.

In the context of climate change, information from WOfS can be used to understand existing flood and inundation risk at a location. Specifically, when conducting a risk assessment, it is useful to identify any existing risk of flooding or inundation in the coastal area. In the absence of any local studies, WOfS can give a broad understanding of the previous flood and inundation history.

Dataset 1 Water summary (filtered)

When you select this dataset, you will see a coloured map in which different colours show the percentage of clear observations when water was detected. The key on the left shows the interpretation of colours (Figure 11). As an example, red colour at a location indicates that only 1% of the observations identified water at that location. This means the location does not have a regular presence of water but may have flooded in the past (1%, if all observations are clear, is 3-4 days per year). On the other hand, blue colour suggests 80% of observations identified water at that location, indicating that the location is a semi-permanent water body.

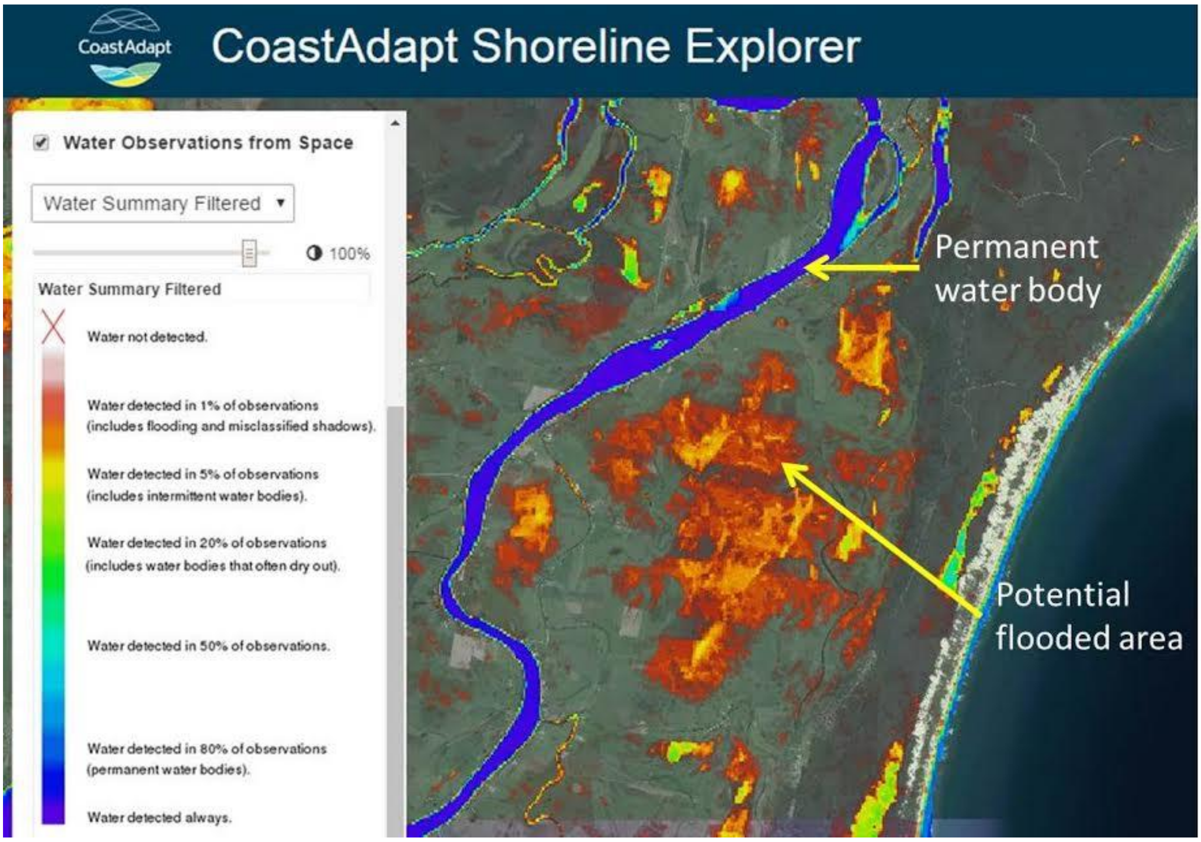

Figure 11: Example of Dataset 1 Water summary filtered in CoastAdapt WOfS.

Some of the limitations of WOfS are (Geoscience Australia 2015a):

- The Landsat satellites, which provide data for WOfS, view a 185 km-wide strip of Australia once every 16 days, and the observations show only what was visible on the day of the satellite pass. Therefore not all historical floods will have been observed.
- Although the water detection algorithm has an overall accuracy of 97%, it is designed to detect large areas of water and may miss small water bodies.
- Errors occur along rivers, small waterbodies and swamps where the presence of both water and vegetation within the pixel leads to a failure to detect water. This leads to an underestimation of the extent of water in locations with mixed water and vegetation pixels.
- Some densely urbanised or steep areas are sometimes misclassified as water.

Dataset 2 Confidence

To account for the limitations mentioned above, WOfS provides a second dataset showing the confidence in the water summary information at each location. Red indicates low confidence (less than 2%) and green suggest high (75%) to very high (100%) confidence in the information (Figure 12).

These two datasets can build understanding of past flooding extent at a location. As an example, if a location shows red in the Water summary dataset, and green in the Confidence dataset, you can be confident that this indicates a past history of flooding.

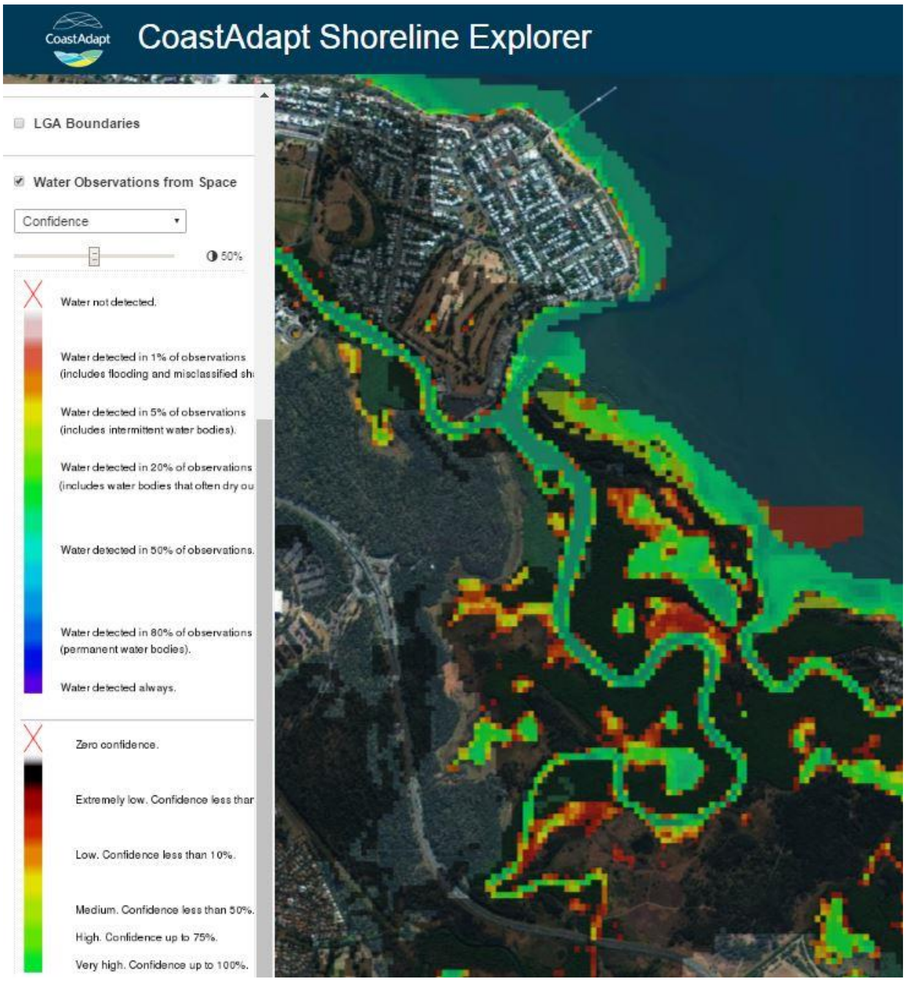

Figure 12: Example of Dataset 2 Confidence in CoastAdapt WOfS.

3.4 Things to keep in mind (Geoscience Australia 2015a)

1. The absence of water observations in WOfS at a particular location does not provide certainty that flooding will never occur in the future.
2. The probability of surface water appearing at a particular location may vary over time due to anthropogenic changes, for example dam building. WOfS in CoastAdapt cannot reflect these changing probabilities. Where such changes have occurred, Dataset 1 may no longer give a true picture of the probability of surface water being observed.

Further details on WOfS are available in the product description.

References and further information

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Appendix

Example of pages from sediment compartment data (see https://coastadapt.com.au/sites/default/files/docs/sediment_compartments/NSW01.01.01.pdf).

Tweed NSW01.01.01

Regional Setting

The dominant regional processes influencing coastal geomorphology in this region are the humid warm to cool temperate climate, micro-tides, south-easterly Tasman Sea swells, easterly seas, dominantly quartz (terrigenous) sediments with northerly longshore transport in the northern part, and the El Nino Southern Oscillation (driving beach erosion/accretion cycles, cyclone frequency).

Regional hazards or processes driving large scale rapid coastal changes include: East Coast Lows (extra-tropical cyclones), mid-latitude cyclones (depressions), and storm surges (<1 m).

This compartment extends from Point Danger to Cape Byron.

Justification of sensitivity

Overall sensitivity rating is a 4. Within the compartment, several sections are already rated as 5, although if onshore sand supply is maintained for some sections, the sensitivity rating could be 3 for extended periods. The southern ends of several of these beaches are sensitive and undergoing erosion as a result of differential rates of littoral drift on adjacent beaches. Overwash from cyclonic storms has occurred in places where foredunes are low and narrow.

Other comments

This compartment comprises several tertiary compartments, characterised by northwards longshore drift, influenced by both tropical cyclones and East Coast lows (PWD, 1978; Helman, 2007).

It terminates to the north at the training walls of the Tweed River on Letitia Spit. Sand accumulation on the southern side of this training wall, following extension 1962-1965, deprived Gold Coast beaches to the north of sand. It also led to the installation of the Tweed River bypassing project, which pumps ~500,000 m^3 of sand a year (552,682 m^3 in 2015) from NSW to nourish Kirra and other beaches on the Gold Coast. See http://www.tweedsandbypass.nsw.gov.au/.

Patterson (2013) indicates that there is only a modest gradient in the longshore sand transport, increasing from about 200,000 m^3/yr at Ten Mile Beach, Iluka, to about 550,000 m^3/yr at northern Stradbroke Island (Patterson, 2013, p. 82; see also Patterson et al., 2011).

The supply of river sand to the coast is limited on the section of coast to the south, and the source of sand to sustain northwards drift is inferred to be from onshore transport from the shelf (Boyd et al., 2008, Mariani et al., 2013). If maintained as sea level rises, it is possible that the shoreline position for long stretches of beaches facing generally east could be maintained as sea level rises (sensitivity 3) until an unknown threshold is reached (Cowell et al., 2000). However, there is likely to be some degree of short-term recession in the tertiary embayments during periods when sand feed from the south is restrained.

Sand moves around headlands, such as the basaltic Fingal Head, and Norries Head, as a slug (see example at Cudgen in Short, 1999, p244). Here, the training walls along Cudgen Creek create a permanent but variable sand shoal in the northern lee of Cudgen Headland, with associated erosion problems for Kingscliff. Tweed Council is developing a long-term strategy to manage the erosion threat at Kingscliff (see Coghlan et al., 2011, WRL report).

The southern ends of several of these beaches are undergoing periodic erosion as a result of differential rates of littoral drift on adjacent beaches. Cabarita Beach is experiencing ongoing shoreline recession due to by littoral drift imbalance (Mariani et al., 2013). Headlands at Norries and Cudgen both act like groynes protruding through the active surf zone. Sand tends to build up on their south (updrift) sides until bypassing occurs when the updrift areas are filled to capacity. During times of elevated wave action a pulse or slug of sediment can be moved around the headland (Figures 1 and 2), often partially depleting the updrift area, which has to re-fill before bypassing is again fully established (Short, 2007; Mariana et al., 2013). Cabarita

Beach appears to undergo an recession of 1 m/year, when explained as a result of the differential of 110,000 m^3/y, as a consequence of the loss around Cudgen Head of 350,000 m^3/yr compared with a gain around Norries of only 240,000 m^3/yr. Unless this imbalance is offset by onshore drift as shown in Figures 3 and 4, the shoreline in this tertiary compartment will recede under climate change and cut into the foredune buffer built after mining operations ceased in the 1980s.

Cape Byron provides an obstacle at the southern end and only a limited quantity of sand makes it around the headland to contribute to the southern end of this compartment (PWD, 1978). A consequent drift differential can result in periodic erosion of the foreshore on the beaches north of Cape Byron. Some sand at Cape Byron can be lost to an offshore sand lobe (PWD, 1978; Patterson & Britton Partners, 2006) while there may be a component of cross embayment sand transport (Patterson, 2013, Figure 7-38). Various consulting reports prepared for Byron Shire Council, involving modelling of Byron Bay coastal erosion processes and hazards, have highlighted the vulnerability of this section of the coast, especially Belongil Spit, (for example BMT WBM , 2010). Hopley (1967, and PWD, 1978) also noted the impacts of overwash accompanying storm surges at the southern end of the compartment.

Several locations, such as Brunswick Heads, are sensitive where training walls have been built, with erosion becoming apparent downdrift after the storms in the 1970s. The Brunswick River is neither a source nor sink for sand (PWD, 1978). The settlement of Sheltering Palms to the north of the Brunswick River was severely eroded in the early 1970s and houses were abandoned and lost by 1977.

The area has been extensively explored and subjected to sand mining for heavy minerals (Gardner, 1955; Roy, 1999).

Figure 1: Erosion in front of surf club at Kingscliff (photo A. Short).

Figure 2: Sand slug moving around at Kingscliff (photo A. Short).

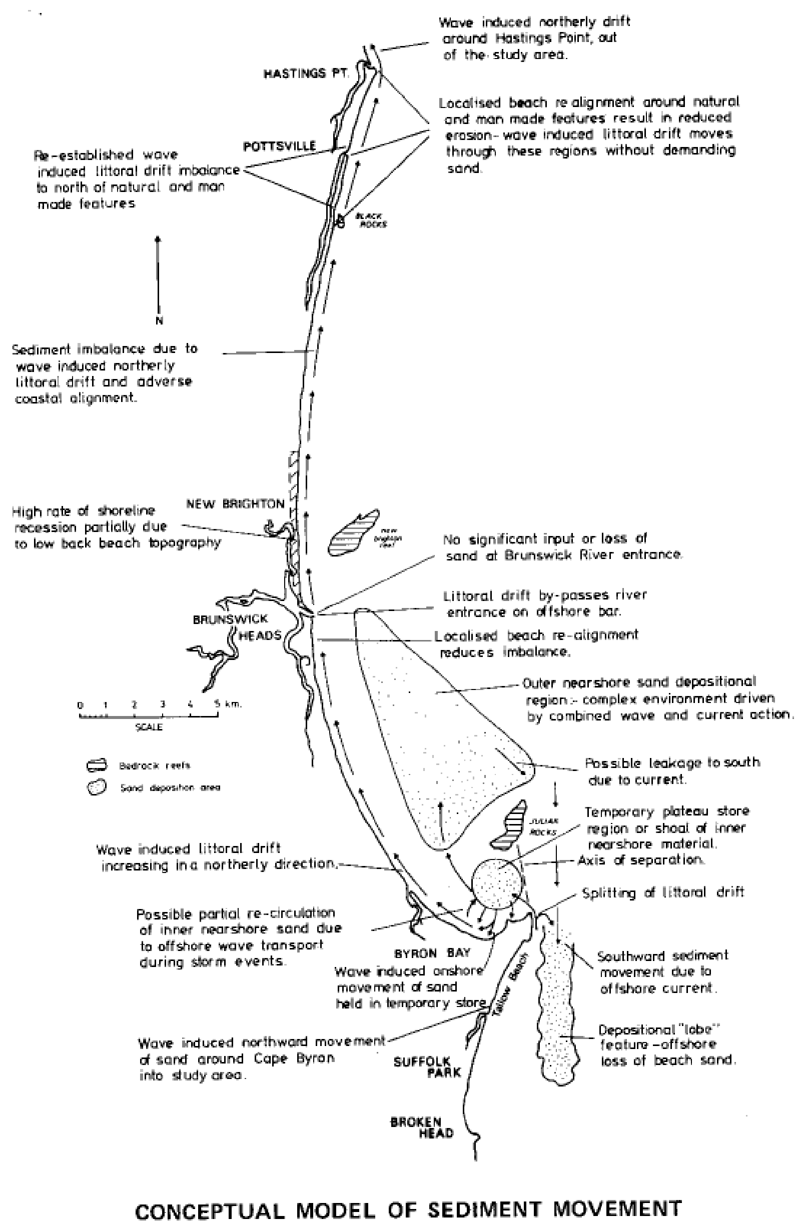

Figure 3: Conceptual model of Cape Byron (PWD, 1978)

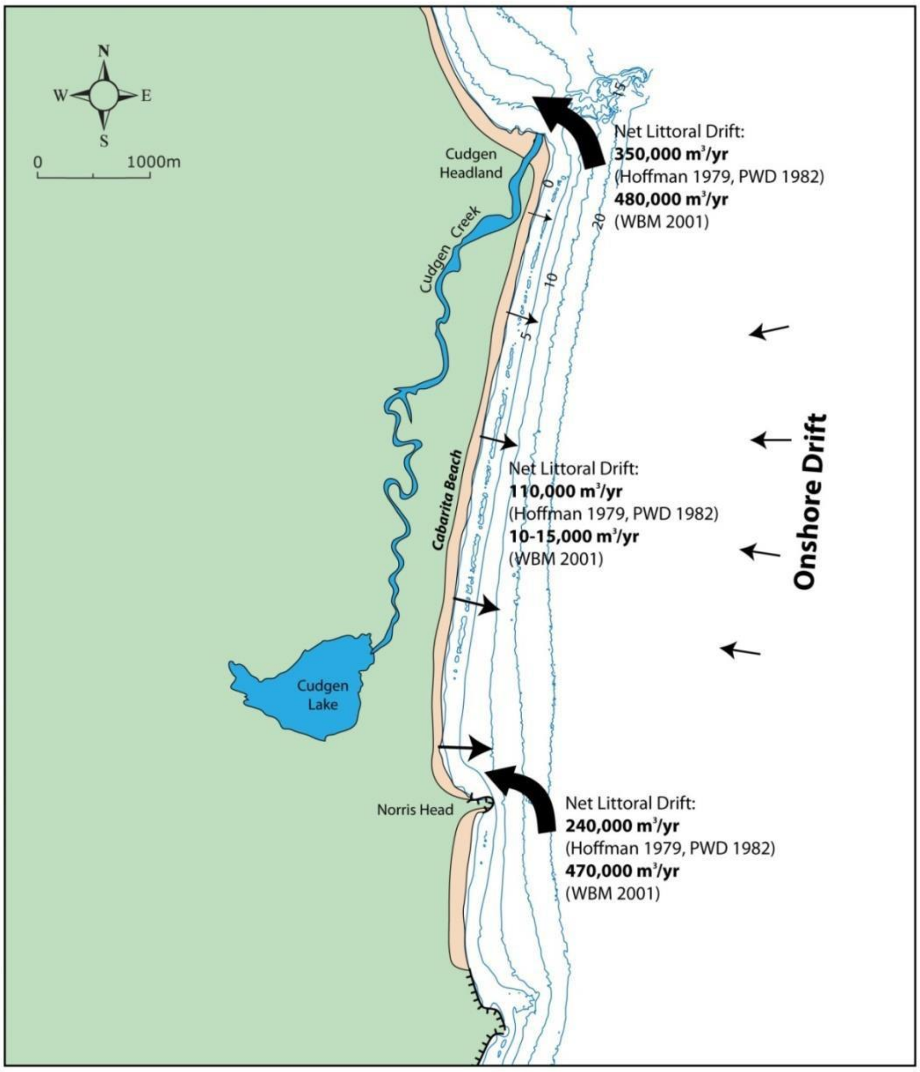

Figure 4: Conceptual sediment budget model (Fig 2.10 from Mariani et al., 2013)

Confidence in sources

High confidence: Longshore drift along the northern NSW coast has been the subject of numerous detailed studies, including several focused on erosion at Tweed Heads, Kingscliff, Cudgen and Byron Bay, especially Belongil Spit.

Additional information (links and references)

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NCCARF
National
Climate Change Adaptation
Research Facility

Australian Government

Department of the Environment and Energy

WHAT?
CoastAdapt is a new online tool that provides information, maps and resources to plan for and adapt to coastal climate impacts.

WHO & FUNDING:
CoastAdapt was developed by the team at the National Climate Change Adaptation Research Facility (NCCARF) with input from government, community, industry and business. NCCARF was established in 2008 and is currently funded by the Australian Government until the end of June 2017.

BACKGROUND:
NCCARF was commissioned by the Australian Government through the (then) Department of the Environment to build a coastal climate risk management tool that, according to the Funding Agreement, should:

- be national in scope, but recognise variations in climate, and regulatory and planning systems
- be appropriate for new developments and areas where substantial assets are already at some risk from coastal climate hazards
- provide users with access to the best available science and advice on coastal climate risks and regional sea-level rise projections
- incorporate the views of end users, regarding its design, content, delivery and dissemination
- be communicated in plain English
- be illustrated with practical case studies.

NCCARF took the approach that CoastAdapt needed to make life easier for decision makers and should provide the information that was needed. We undertook considerable stakeholder engagement and testing throughout the development to make sure the website was attractive, functional and easy to use.

WHAT WILL I FIND ON COASTADAPT?
CoastAdapt contains information, maps and data and a framework for planning to help users understand their climate risk, plan how to reduce it and even take advantage of changes.

There are also projections of how the climate might change for council regions around Australia. This includes sea-level rise, temperature and rainfall.

CoastAdapt includes information on a wide range of topics related to the coast, climate change and adaptation (e.g. what is climate changes, impacts of climate change, what is adaptation etc.). The information is delivered in a variety of formats including factsheets, case studies, technical information manuals, tools, worked examples, methodology elements and information elements.

There is a set of over 60 case studies of what councils and businesses are doing to address climate change. Most case studies are a short factsheet, but we also have a number of videos.

Central to CoastAdapt is the decision-making framework C-CADS. This can be used to step through a planning process and help councils and businesses develop and adaptation plan.

HOW WILL THIS HELP THE OYSTER INDUSTRY:
The oyster industry is exposed to climate change and in some areas may already be feeling the impact. Key risks include:

- Sea level rise
- Increases in air and water temperature
- Changes in rainfall patterns
- Changes in salinity
- Increases in wind speed, storm surges, waves
- Increases in ocean acidity
- Increased harmful algal blooms, pests, biofouling and disease.

CoastAdapt provides a number of resources that can help the industry learn more about the risks and guidance on how to start to thinking and planning.

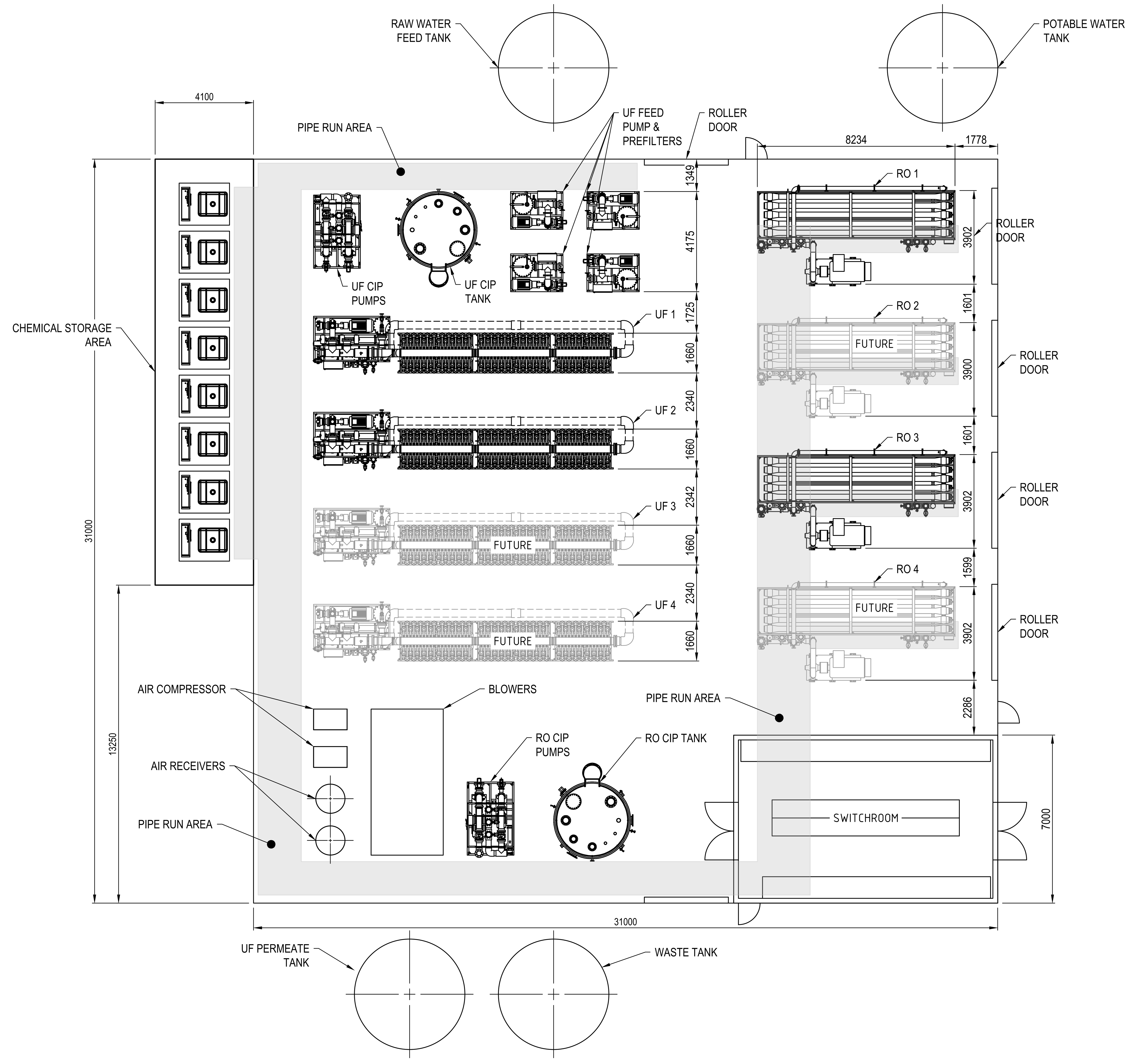
1. Information:
CoastAdapt includes information on how the climate has already changed (https://coastadapt.com.au/climate-change-and-sea-level-rise-based-observed-data) and how it might change in the future (https://coastadapt.com.au/climate-change-and-sea-level-rise-australian-region). Impacts that are relevant to oyster farmers including information about ocean acidification (https://coastadapt.com.au/ocean-acidification-and-its-effects), estuaries and climate change (https://coastadapt.com.au/sites/default/files/factsheets/T3I6_Estuaries_and_climate_change_0.pdf), impacts on fisheries and aquaculture (https://coastadapt.com.au/sites/default/files/factsheets/T312_8_Fisheries%20and%20aquaculture.pdf). Information on adaptation (https://coastadapt.com.au/overview-of-adaptation) and ways of planning and thinking about the future (https://coastadapt.com.au/pathways-approach).

2. Maps and data:
You can look at how much the seas may rise in your region and look at maps that show the areas at risk of inundation in the future using the Sea Level Rise and You tool (https://coastadapt.com.au/tools/coastadapt-datasets#future-datasets). This also includes information about how much temperatures may rise and how rainfall may change.

3. Ask an expert:
CoastAdapt includes an online forum for posing and asking questions of other practitioners, but also from a panel of experts. Visit CoastExchange to pose your question (https://connect.coastadapt.com.au/).

FURTHER INFORMATION:
Visit the CoastAdapt website at www.coastadapt.com.au or email s.boulter@griffith.edu.au

Appendix B - GANDEN Preliminary General Arrangement



PLAN

SCALE 1:100

GANDEN
ENGINEERS AND PROJECT MANAGERS

HEAD OFFICE - GOLD COAST
Suite 106, 20 Lake Orr Drive,
Varsity Lakes, QLD 4227
T 07 5589 1457
E enquiries@ganden.com.au

SCALES — 100mm ON ORIGINAL DRAWING

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1 : 100

ORIG.SIZE A1

REV	DESCRIPTION	DATE	DWN	APP
A	PRELIMINARY ISSUE	17.01.20	PAC	JH

REVISIONS

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NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	
FOR CONSTRUCTION	REV.
NAME:	
DATE:	
SIGNATURE:	
RPEQ No.	

ROUS COUNTY COUNCIL

DRAWING STATUS: PRELIMINARY

TITLE

ROUS DESALINATION
CONCEPT PLANT
5-10MLD CAPACITY

DRAWING NUMBER: 1364-DWG-GEN-001

REVISION: A

Appendix C - Suez SeaTECH SWRO 2.5 MLD Train

PART NUMBER	DESCRIPTION
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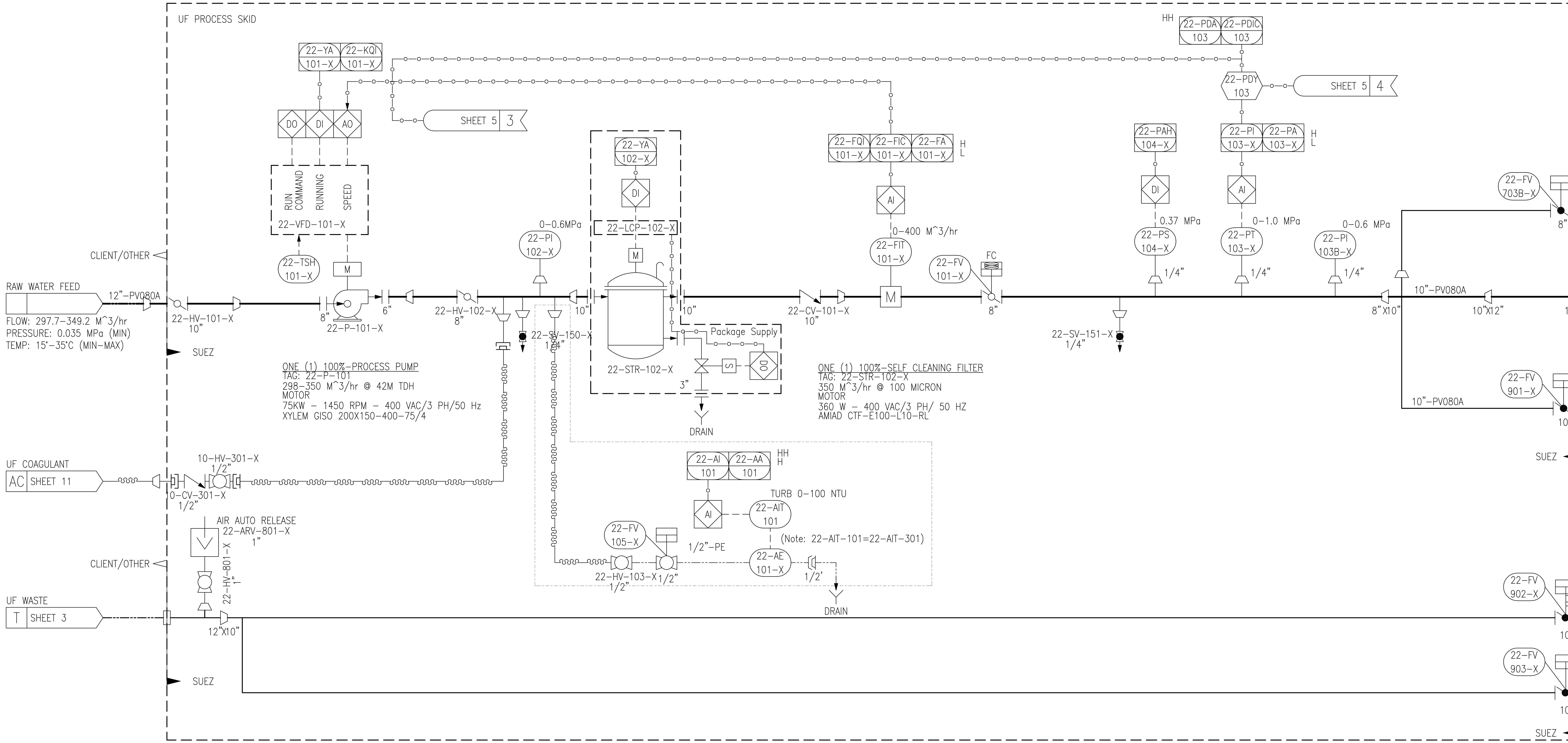
3056292	SEAPAK-2500,50HZ,THREE-TRAIN
3056293	SEAPAK-2500,50HZ,FOUR-TRAIN

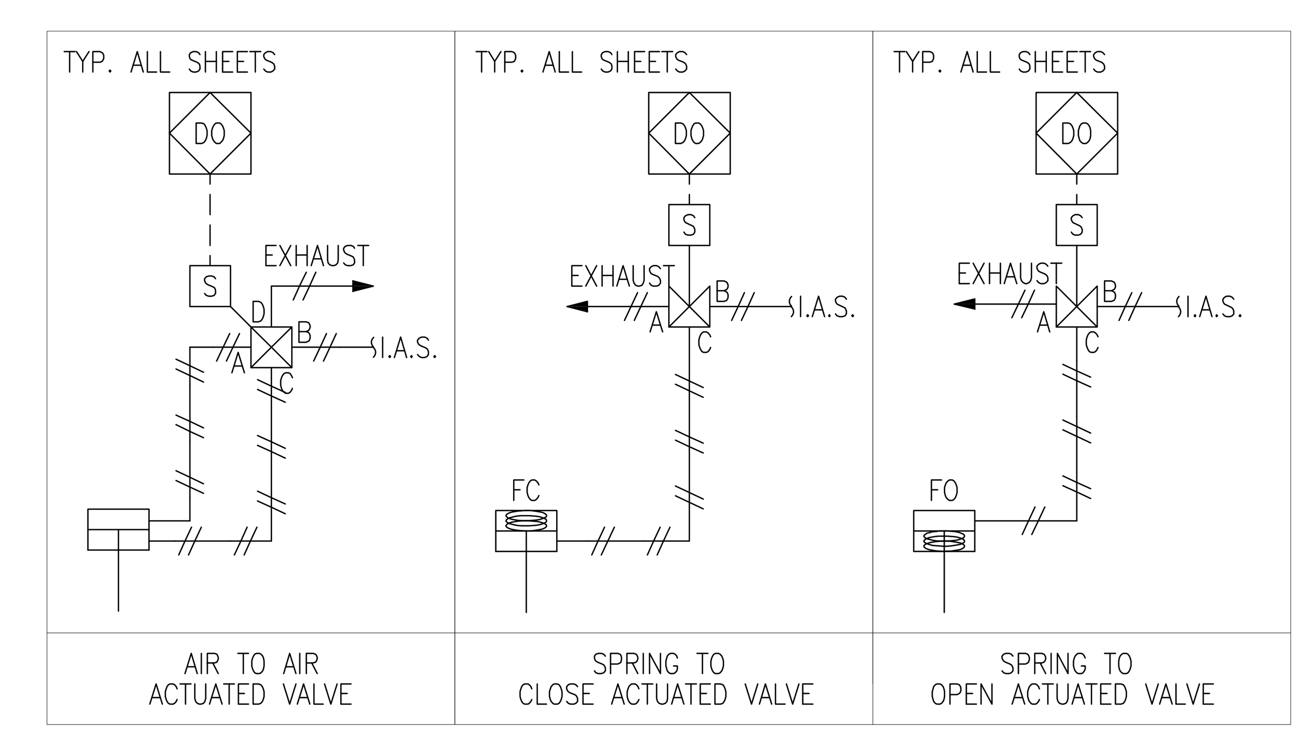


NOTES:

1. REFERENCE TO P&ID LEGEND SHEETS 1303984RCP02.
2. ALL VFD OPTIONAL SUEZ SUPPLY, OUT OF STANDARD SEAPAK SUEZ SUPPLY SCOPE.

OPTIONAL SUEZ SUPPLY

CLIENT/OTHER



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E	TRANSPOSITION DOSING AND CV AFTER PUMP	17223	LL	WMD	DHX	17JUN16
D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
DECIMALS .X .XX .XXX — ANGLES — FRAC

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CUSTOMER INFORMATION

P&ID,MULTI-TRAIN,
SEAPAK-2500,400/3/50

DRAWING NUMBER	REVISION
1308826	F

REF.: - DOC. OWNER:

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
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D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
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CUSTOMER INFORMATION

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NOTES:

1. THE CLIENT NEED TO ENSURE THE TEMPERATURE OF AIR ENTERING THE UF HEADER NO MORE THAN 50°.
2. THE VALVE 22-FV-902B-X IS SUPPLIED BY SUEZ.

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
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D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
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C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
DECIMALS .X .XX .XXX — ANGLES — FRAC

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DRAWING NUMBER	REVISION
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ONE (1) 100%-BREAK/BP TANK
TAG: 22-TK-601
WORKING CAPACITY: 200000 L
MATERIAL: CONCRETE

NOTES:

1. Some pipeline's size need to be checked according to different quantity of trains.

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C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
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CUSTOMER INFORMATION

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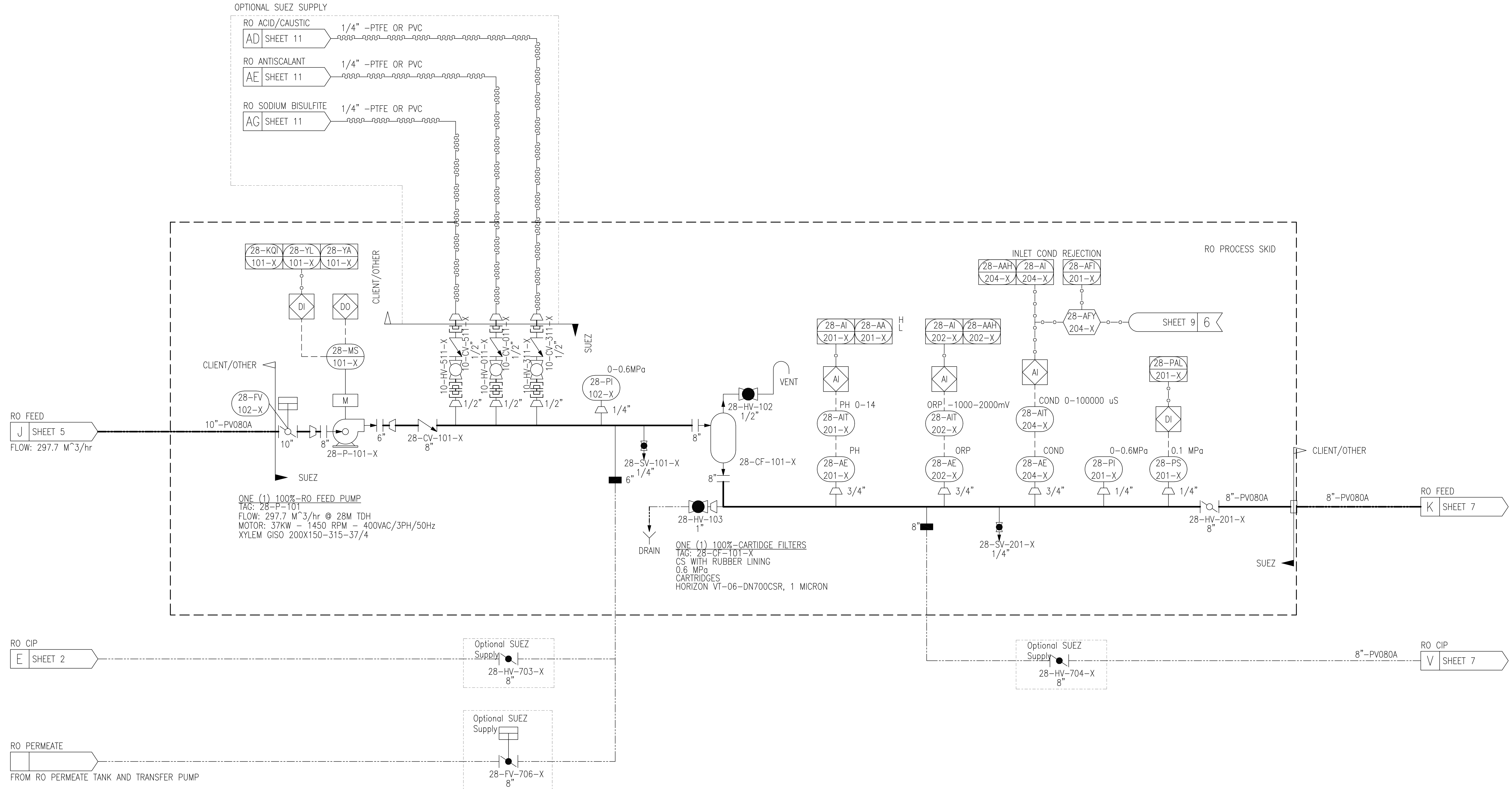

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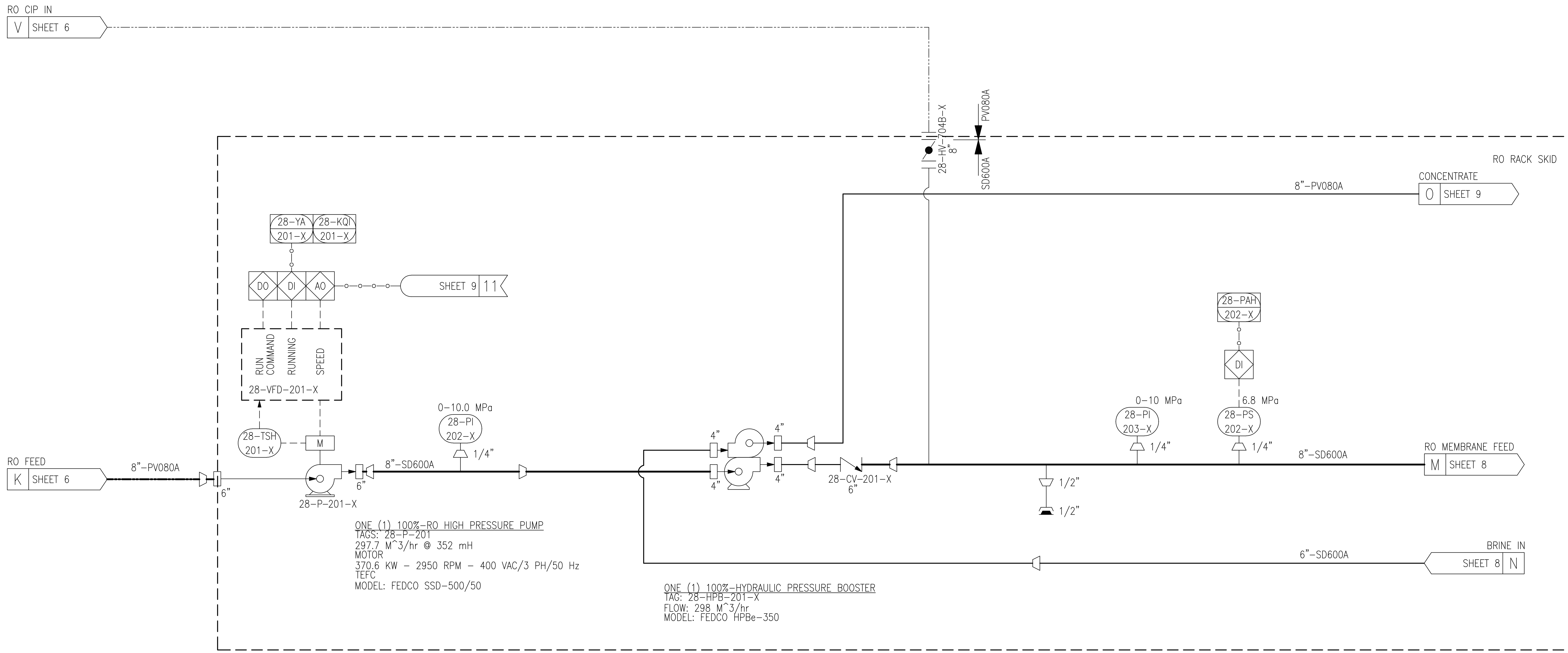

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C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12
REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE

TOLERANCES UNLESS NOTED
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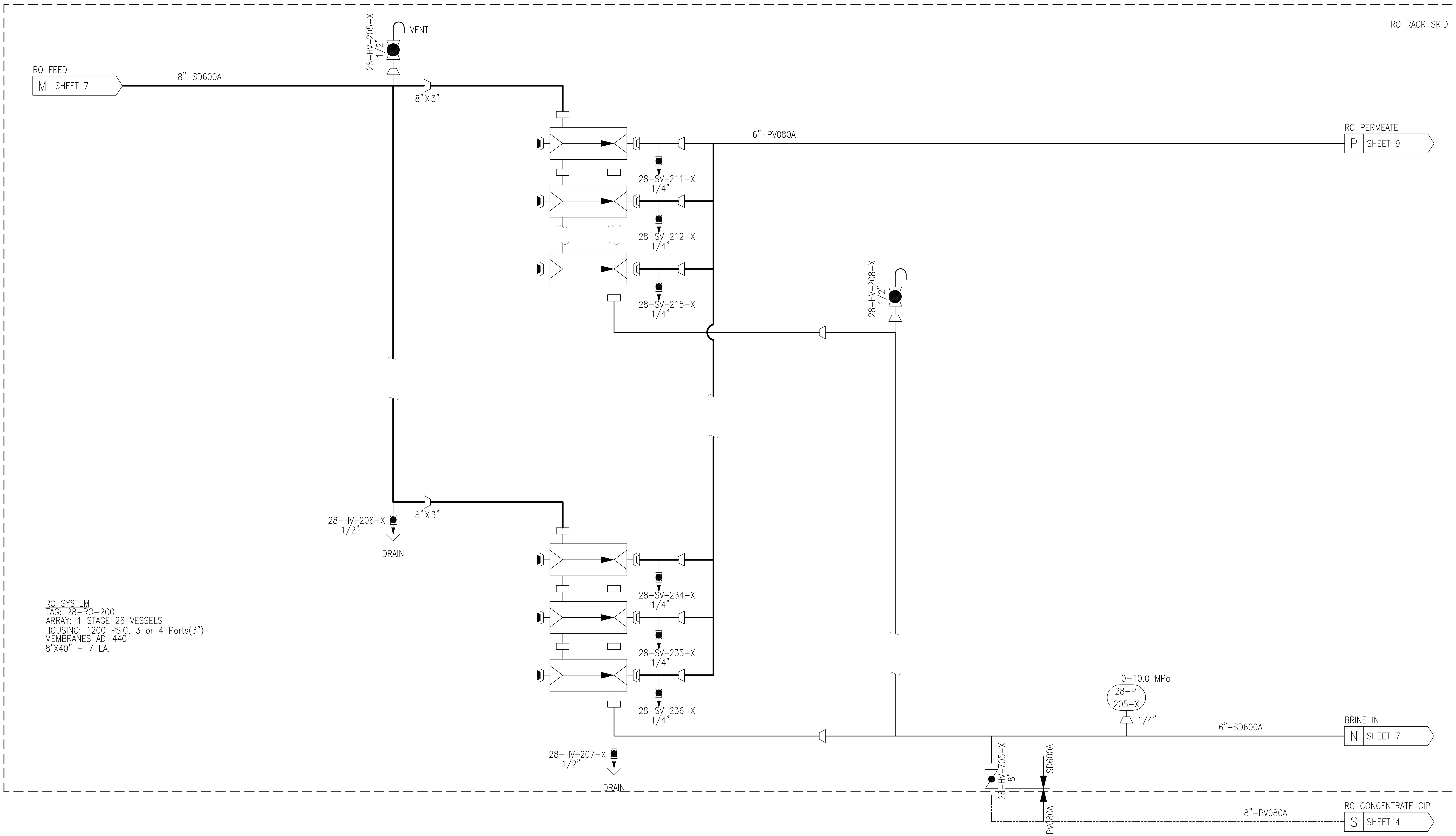

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F	SUEZ REBRANDING	132678	SW	SR	CJ	13FEB19
E	TRANSPOSITION DOSING AND CV AFTER PUMP	17223	LL	WMD	DHX	17JUN16
D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

P&ID,MULTI-TRAIN,
SEAPAK-2500,400/3/50

DRAWING NUMBER				REVISION
1308826				F
REF.: -	DOC. OWNER: -			
PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
	SEE BOM	NONE	D	08 OF 11

LAST SAVED: Wednesday, January 30, 2019 8:04:24 PM

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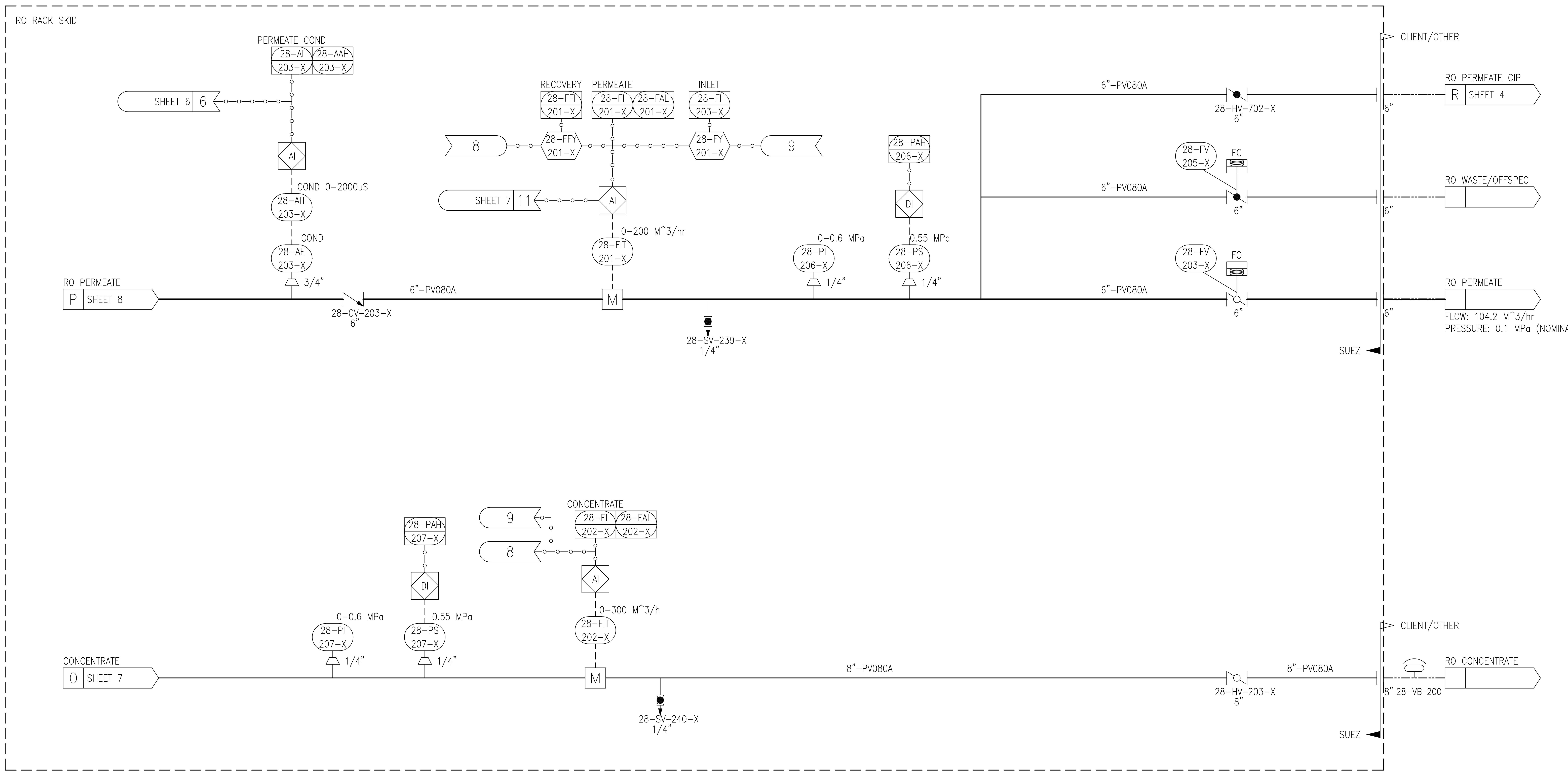

NOTES:

1. VACUUM BREAKER [BY CUSTOMERS] SHOULD BE INSTALLED AT HIGH POINT OF RO CONCENTRATE PIPE IF THE CONCENTRAT DRAIN TO TRENCH DIRECTLY.
2. THERE MAY REMAIN CHEMICAL SOLUTION IN CONCENTRATE PIPELINE AFTER RO CIP. A PIPELINE FOR RO CONCENTRATE TO NEUTRALIZATION IS PREFERED.

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
F	SUEZ REBRANDING	132678	SW	SR	CJ	13FEB19
E	TRANSPOSITION DOSING AND CV AFTER PUMP	17223	LL	WMD	DHX	17JUN16
D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
.XX FRAC
.XXX

CUSTOMER INFORMATION

P&ID,MULTI-TRAIN,

SEAPAK-2500,400/3/50

DRAWING NUMBER					REVISION
1308826					F
REF.: -		DOC. OWNER: -			
PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET	
	SEE BOM	NONE	D	09 OF 11	

LAST SAVED: Wednesday, January 30, 2019 8:04:24 PM

NOTES:

1. LISTED INFORMATION FOR DOSING SYSTEM IS FOR REFERENCE ONLY, NEED CHECK PER SPECIFIC PROJECT.
2. CHEMICAL INJECTION EQUIPMENT IS OPTIONAL SUEZ SUPPLY FOR INSTALLATION BY OTHERS.
3. NEED A PORTABLE WATER LINE FOR GETTING CHEMICAL SOLUTIONS.
4. ADD RO CIP CHEMICAL USING UF CIP DOSING SYSTEM OR OTHER DOSING EQUIPMENT OFFERED BY CLIENT.

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
F	SUEZ REBRANDING	132678	SW	SR	CJ	13FEB19
E	TRANSPOSITION DOSING AND CV AFTER PUMP	17223	LL	WMD	DHX	17JUN16
D	INCREASE VACUUM BREAKER	16916	SZ	WMD	DHX	10DEC15
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B	REV PER ECO	15370	JH	DHX	LXZ	24OCT12

TOLERANCES UNLESS NOTED
DECIMALS .X .XX .XXX
ANGLES
FRAC

CUSTOMER INFORMATION

P&ID,MULTI-TRAIN,
SEAPAK-2500,400/3/50

DRAWING NUMBER	REVISION
1308826	F
REF.: - DOC. OWNER: -	

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
	SEE BOM	NONE	D	10 OF 11

LAST SAVED: Wednesday, January 30, 2019 8:04:24 PM
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NOTES:
1. CHEMICAL INJECTION EQUIPMENT IS OPTIONAL SUEZ SUPPLY FOR INSTALLATION BY OTHERS.
2. NEED A PORTABLE WATER LINE FOR GETTING CHEMICAL SOLUTIONS.

REV	DESCRIPTION	ECO	DWN	APPR	APPR	DATE
F	SUEZ REBRANDING	132678	SW	SR	CJ	13FEB19
E	TRANSPOSITION DOSING AND CV AFTER PUMP	17223	LL	WMD	DHX	17JUN16
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C	UPDATE PER UF MODULE UPDATED	15799	JH	DHX	LXZ	23JUL13
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TOLERANCES UNLESS NOTED
DECIMALS ANGLES
.X
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suez

CUSTOMER INFORMATION

P&ID,MULTI-TRAIN,
SEAPAK-2500,400/3/50

DRAWING NUMBER	REVISION
1308826	F

REF.: - DOC. OWNER: -

PROJECT NO.	PART/MATERIAL NO.	SCALE	SIZE	SHEET
	SEE BOM	NONE	D	11 OF 11

LAST SAVED: Wednesday, January 30, 2019 8:04:24 PM

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Appendix D - Fluence NiroBox (Seawater) Product Sheets

SW
SEAWATER

NIROBOX™ SW

A modular, scalable & highly-efficient
seawater desalination solution

fluence

NIROBOX SW

A New Generation Decentralized Water Treatment Solution

Leading the way in water, wastewater and reuse solutions, Fluence believes that everyone, everywhere deserves access to clean water. The NIROBOX™ family of containerized water treatment solutions challenges convention by providing advanced treatment technologies in an affordable and compact package. Nirobox offers the industry's smallest overall footprint, which makes the units ideal for the industrial, municipal, and commercial markets.

NIROBOX SW is a modular, high-output and highly-efficient **seawater desalination** solution that offers pre-treatment, reverse osmosis and energy recovery device (ERD) – all housed in a single, self-contained 40 foot shipping container. The use of superior components ensures the production of high quality product water under continuous heavy-duty conditions with minimal O&M.

Offering unrivalled capacity, a single compact NIROBOX SW container can produce up to 1,500 cubic meters per day of clean water, making it the most compact plant-in-a-box with an extremely small overall footprint.

Technically Advanced, Sustainable SWRO Desalination System

NIROBOX SW offers recovery rates of up to 50%, the lowest chemical and energy consumption in the market, reducing overall enviromental impact.

NIROBOX SW's patent-pending process includes a cleaning process for the ultrafiltration membranes that inhibits microorganism growth and scaling. This natural disinfecting process reduces energy and chemical requirements, and minimizes the plant's ecological footprint. Moreover, Nirobox SW features a work-exchanger energy recovery device with the lowest energy consumption in the industry.

Key Advantages

- **Cost-effective**: pre-assembled, housed in a standard ISO shipping container. Engineered for fast deployment, simple operation and maintenance.
- **Sustainable**: low energy consumption and chemical usage reduces the enviro nmental impact. The unique patent pending design provides a **high recovery** rate which means less waste discharge.
- **Compact**: small footprint minimizes site impact, lowers the cost of site development, and ensures easy expansion.
- **Flexibility and scalability**: intended for large-scale water needs, with smart pre-engineering and design to suit any site requirements, facilitating fast delivery, integration, commissioning and operation.

NIROBOX SW modular desalination solutions are ideal for:

- Municipalities and growing communities
- Construction sites
- Housing developments
- Commercial establishments
- Resorts, hotels & golf clubs
- Remote oil and gas facilities
- Power plants
- Mining camps & operations

Smart Operations

Fully automated, remotely monitored and operated systems

- Keeps ongoing equipment, operation and maintenance expenses in check.
- PLC based HMI with remote monitoring.
- Data and reports easily accessible from anywhere on any platform.
- Real-time alerts for system malfunctions or abnormal performance.

Modular and Scalable

NIROBOX building blocks are modular and can be adapted to your requirements, providing an independent solution on virtually any scale, from single, self-contained units to large water treatment plants.

Main Advantages:

- **Modular**
- **Fast delivery and deployment**
- **Lower CAPEX**
- **Lower Operation and Maintenance costs**

NIROPLANT™

- Niroplant uses the boxes as stand-alone units with a centralized control unit and optional post-treatment. This allows the plant to be scaled up or down without losing the individual operability of each box.
- Niroplants can handle up to 20,000 m³/d.
- Units can be easily removed and relocated according to changing requirements.

NIROSITE™

As an end-to-end solution, Nirosite achieves greater operating and maintenance efficiencies for larger capacity plants.

- Nirosite installations feature centralized peripheral functions, including control, air compression, chemical flushing, and clean-in-place (CIP).
- Expandable through the addition of operating clusters.

Specifications

	Model		
	NIROBOX SW-M	NIROBOX SW-XL	NIROBOX SW-MEGA
Operating Parameters			
Permeate rate	500 m^3/d (92 gpm)	1,000 m^3/d (183 gpm)	1,500 m^3/d (275 gpm)
Feed rate	42 m^3/h	84 m^3/h	125 m^3/h
Recovery	50%	50%	50%
Population served	2,500	5,000	7,500
Energy consumption (kWh/m^3)	2.45	2.45	2.2
Turbidity	< 20 NTU		
Oil and grease	< 1.5 mg/l		
TDS (Total Dissolved Solids)	15,000 - 45,000 mg/l		
Temperature	from 5° to 35° C (41° to 95° F)		
Number of containers	1x40'	1x40'	1x40'
Container weight	11.5T	14T	16.5 T

* Production based on 36,000 ppm and 25°C feed water

Options	
Pretreatment	• Dissolved air flotation (DAF) • Multimedia filtration • Activated carbon filters • Clarification
Post-treatment	• Remineralization • pH adjustment • Ultraviolet / chlorine disinfection

* Additional pre or post-treatment options are available to tailor the standard unit to your requirements, as well as other process configuration options

Fluence profile

Formed in 2017 following the consolidation of independent water treatment solution providers Emefcy and RWL Water, Fluence Corporation was established with the vision of becoming the leading global provider of fast-to-deploy smart decentralized and packaged water and wastewater treatment solutions. With some 300 highly-trained water professionals with experience operating in 70 countries, Fluence provides local and sustainable treatment and reuse solutions while empowering businesses and communities worldwide to make the most of their water resources.

With core operations in North America, South America, the Middle East, Europe and China, Fluence offers an integrated range of solutions across the entire water cycle - from early stage evaluation, through design and delivery, to ongoing support, optimization of water-related assets, operations and financing.

NIROBOX-SW_4PB0001_ENG 8.2017

Appendix E - Mak Water Desalination Equipment

PRODUCT DATA SHEET

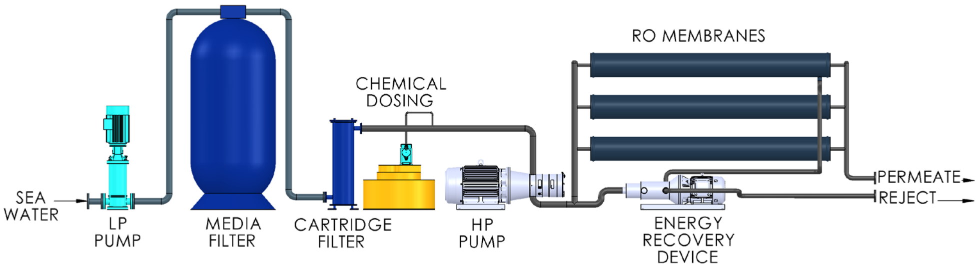
Sea Water Reverse Osmosis (SWRO) Desalination

water | wastewater | sewage

OVERVIEW

MAK Water's Sea Water Reverse Osmosis (SWRO) plants are designed to treat sea water, or high salinity ground water, with < 40,000 mg/L of dissolved solids (TDS) and < 30 mg/L of suspended solids (TSS), to achieve potable water quality. The standard treatment process involves pre filtration (auto backwashing multimedia filters and cartridge filters), anti-scalant dosing to prevent membrane scaling, RO desalination and auto flushing and CIP systems for membrane cleaning. Additional pre-RO and post-RO treatment steps may be added as required to suit feed water conditions and/or treated water quality requirements. The MAK SWRO plants are available as skid mounted or containerised systems.

ADDITIONAL FLOW RATES AND CUSTOMISED SOLUTIONS ARE AVAILABLE. JUST ASK US.



STANDARD SPECIFICATIONS

Parameter		Units	SWRO-50	SWRO-100	SWRO-150	SWRO-250	SWRO-500	SWRO-1000
Permeate Flow Rate		m³/day	50	100	150	250	500	1000
Permeate Recovery Rate		%	40 (typical)					
Permeate TDS		mg/L	<500 (typical)					
Raw Water TDS		mg/L	<40,000					
Raw Water TSS		mg/L	<30					
Raw Water Temperature		°C	15 ~ 35					
Ambient Design Temperature		°C	5 ~ 45 (-15 ~ 50 for insulated containerized system)					
Feed Water Inlet Pressure		kPa	>15 (flooded suction)					
Permeate Discharge Pressure		kPa	~40 (higher discharge pressures available on request)					
Brine Discharge Pressure		kPa	~40 (higher discharge pressures available on request)					
Power Supply		-	AC 380~450 V, 3 Phase, 50/60 Hz					
Power Consumption	Standard	kW	20	25	35.5	52.5	105	190
	High Efficiency		-	-	26	43	71	142
No. Containers (Optional)		-	1 x 20'	1 x 20'	1 x 40'	1 x 40'	2 x 40'	2 x 40'

STANDARD INCLUSIONS + OPTIONS

✓= Standard Supply, o = Optional Supply, - = Not Applicable

Equipment		SWRO-50	SWRO-100	SWRO-150	SWRO-250	SWRO-500	SWRO-1000
Skid Mounted Plant & Equipment		✓	✓	✓	✓	✓	✓
Low Pressure Feed Pump		✓	✓	✓	✓	✓	✓
High Pressure RO Pump (c/w ERD)	Std Efficiency	✓	✓	✓	✓	✓	✓
	High Efficiency	-	-	o	o	o	o
Pre-filtration	Multimedia	o	✓	✓	✓	o	o
	Ultra Filtration	o	o	o	o	✓	✓
	Cartridge Filters	✓	✓	✓	✓	✓	✓
Anti Scalant Dosing System		✓	✓	✓	✓	✓	✓
Membrane CIP & Auto Flush System		✓	✓	✓	✓	✓	✓
PLC Control System with HMI		✓	✓	✓	✓	✓	✓
Containerised system, c/w A/C & Lights		o	o	o	o	o	o
Container Insulation (walls & ceiling)		o	o	o	o	o	o
Container non-slip floor coverings		o	o	o	o	o	o
Container Side Access Door		o	o	✓	✓	✓	✓
Additional Pre-RO Treatment		o	o	o	o	o	o
Additional Post-RO Treatment		o	o	o	o	o	o
Premium Instrumentation Package		o	o	o	o	✓	✓
Permeate Distribution Pump Set		o	o	o	o	o	o

Instrumentation	Standard Package	Premium Package
Pressure Gauges	✓	✓
Pressure Transmitters (4-20 mA)	-	✓
HP RO Pump Inlet Low Pressure Switch	✓	✓
Flow Gauges (Rotameters)	✓	-
Flow Transmitters (4-20 mA)	-	✓
Conductivity Transmitter (4-20 mA)	✓	✓
Float Switches (Feed/Permeate, Chemical Dosing & CIP Tanks)	✓	✓
Remote Monitoring & Control Capabilities	-	✓

MODEL SELECTION

0050 50 m³/day - permeate flow
0100 100 m³/day - permeate flow
0150 150 m³/day - permeate flow
0250 250 m³/day - permeate flow
0500 500 m³/day - permeate flow
1000 1000 m³/day - permeate flow
XXXX Custom permeate flow

- **XX** Skid mounted
- **CX** Containerised - standard
- **CF** Containerised - with floor coatings
- **CP** Containerised - with floor coatings & insulation

- **X** Pre RO treatment - standard
- **C** Pre RO treatment - custom

- **X** Post RO treatment - standard
- **C** Post RO treatment - custom

- **X** Standard instrument package
- **P** Premium instrument package, c/w remote monitoring
- **C** Custom instrument package

- **F** Standard efficiency RO pump
- **D** High efficiency RO pump

Permeate distribution pump set
- **X** Without
- **C** Custom

SWRO _ _ _ _ _ _ _ _ _ _ _

NEED A QUOTE?

COMPLETE THIS TABLE AND EMAIL TO...

sales@makwater.com.au

Disclaimer: MAK Water is continuously updating and improving its products and services, so please contact us for more detailed information or to confirm specifications. MAK Water takes no responsibility for any errors resulting from the use of information contained within this document .

Appendix F - Proprietary Equipment Supplier Desalination Product Sheets

Innovation by Chemistry

Standard SWRO

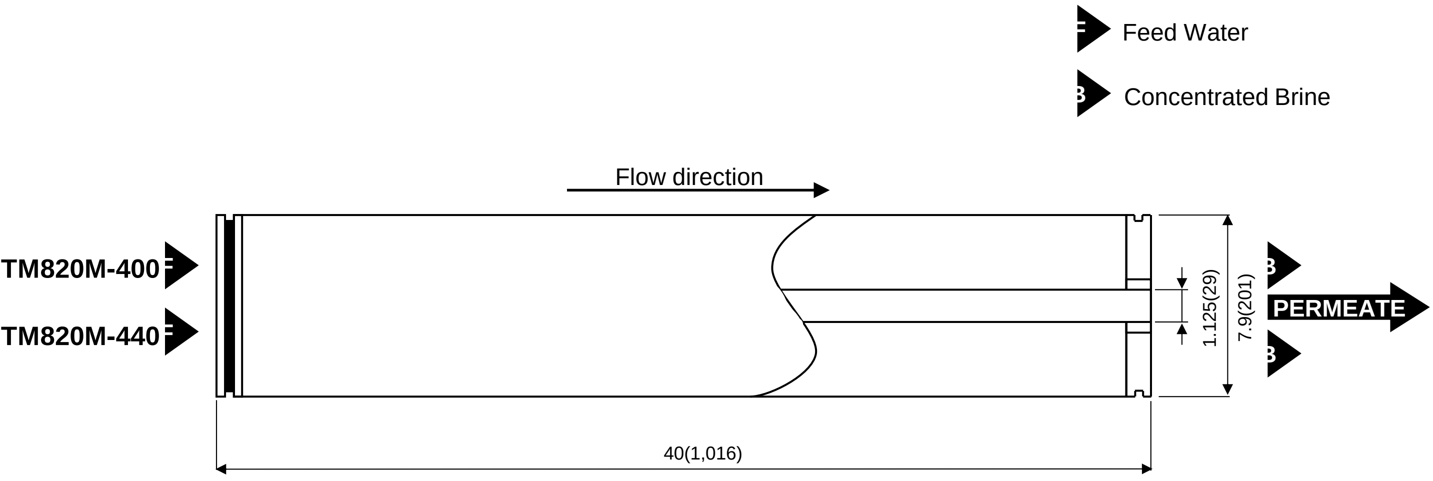
TM800M

Type	Diameter Inch	Membrane Area ft²(m²)	Salt Rejection %	Product Flow Rate gpd(m³ / d)	Feed Spacer Thickness mil
TM820M-400	8”	400(37)	99.8	7,000(26.5)	34
TM820M-440	8”	440(41)	99.8	7,700(29.2)	28

1. Membrane Type		Cross Linked Fully Aromatic Polyamide Composite
2. Test Conditions	Feed Water Pressure Feed Water Temperature Feed Water Concentration Recovery Rate Feed Water pH	800 psi(5.52MPa) 77° F(25℃) 32,000 mg/l NaCl 8% 7
3. Minimum Salt Rejection		99.5%
4. Minimum Product Flow Rate		5,600gpd(21.2m³/d)(TM820M-400) 6,200gpd(23.5m³/d)(TM820M-440)
5. Boron Rejection (typical value)		95% at pH 8 (5mg/l Boron added to Feed water)

Dimensions

All dimensions shown in Inches (millimeter).



Operating Limits

Maximum Operating Pressure	1200psi (8.3 MPa)
Maximum Feed Water Temperature	113° F (45℃)
Maximum Feed Water SDI_{15}	5
Feed Water Chlorine Concentration	Not detectable
Feed Water pH Range, Continuous Operation	2-11
Feed Water pH Range, Chemical Cleaning	1-12
Maximum Pressure Drop per Element	15 psi (0.10 MPa)
Maximum Pressure Drop per Vessel	50 psi (0.34 MPa)

Operating Information

1. For the recommended design range, please consult the latest Toray technical bulletin, design guidelines,computer design program, and/ or call an application specialist. If the operating limits given in this Product Information Bulletin are not strictly followed, the Limited Warranty will be null and void.
2. All elements are wet tested, treated with tested feed water solution, and then vacuum packed in oxygen barrier bags with deoxidant inside. To prevent biological growth during system shutdown, it is recommended to perform 30-60 minutes flushing of Toray elements with seawater once in every two days.
3. The presence of free chlorine and other oxidizing agents under certain conditions, such as heavy metals which acts as oxidation catalyst in the feed water will cause unexpected oxidation of the membrane. It is strongly recommended to remove these oxidizing agents contained in feed water before operating RO system.
4. Permeate from the first hour of operation shall be discarded.
5. The customer is fully responsible for the effects of chemicals that are incompatible with the elements. Their use will void the element Limited Warranty.

Notice

1. Toray accepts no responsibility for results obtained by the application of this information or the safety or suitability of Toray's products, either alone or in combination with other products. Users are advised to make their own tests to determine the safety and suitability of each product combination for their own purposes.
2. All data may change without prior notice, due to technical modifications or production changes.

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Fax: +86 10 80485217

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Toray Membrane Middle East LLC.

PO Box 20279, Al Khobar 31952,
Kingdom of Saudi Arabia

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JUN.2019

Appendix G - GANDEN Cost Estimate (Bottom Up)

RCC Desalination: Ultrafiltration & Reverse Osmosis base on Suez WTS technology					
Capital Cost Estimate (exclusive GST)					
Item	Description	Units	Rate	Quantity	Amount ($)
	Project Management (10%) (subtotal)				$4,267,518.73
	Design Stages (subtotal)				$3,382,487.33
2.1	Concept Design (subtotal)				$678,760.00
2.1.1	Detailed Design 30%	Allowance	n/a	n/a	$135,752.00
2.1.2	Detailed Design 60%	Allowance	n/a	n/a	$271,504.00
2.1.3	Detailed Design 90%	Allowance	n/a	n/a	$203,628.00
2.1.4	Detailed Design IFC	Allowance	n/a	n/a	$67,876.00
2.2	Process Design (subtotal)				$848,450.00
2.2.1	Detailed Design 30%	Allowance	n/a	n/a	$169,690.00
2.2.2	Detailed Design 60%	Allowance	n/a	n/a	$339,380.00
2.2.3	Detailed Design 90%	Allowance	n/a	n/a	$254,535.00
2.2.4	Detailed Design IFC	Allowance	n/a	n/a	$84,845.00
2.3	Mechanical Design (subtotal)				$565,633.33
2.3.1	Detailed Design 30%	Allowance	n/a	n/a	$113,126.67
2.3.2	Detailed Design 60%	Allowance	n/a	n/a	$226,253.33
2.3.3	Detailed Design 90%	Allowance	n/a	n/a	$169,690.00
2.3.4	Detailed Design IFC	Allowance	n/a	n/a	$56,563.33
2.4	Electrical & SCADA design (subtotal)				$848,450.00
2.4.1	Detailed Design 30%	Allowance	n/a	n/a	$169,690.00
2.4.2	Detailed Design 60%	Allowance	n/a	n/a	$339,380.00
2.4.3	Detailed Design 90%	Allowance	n/a	n/a	$254,535.00
2.4.4	Detailed Design IFC	Allowance	n/a	n/a	$84,845.00

2.5	Structural Design (subtotal)				$441,194.00
2.5.1	Detailed Design 30%	Allowance	n/a	n/a	$88,238.80
2.5.2	Detailed Design 60%	Allowance	n/a	n/a	$176,477.60
2.5.3	Detailed Design 90%	Allowance	n/a	n/a	$132,358.20
2.5.4	Detailed Design IFC	Allowance	n/a	n/a	$44,119.40
2.6	Construction stage (subtotal)				$33,938,000.00
2.6.1	Construction management (10%)	Allowance	n/a	n/a	$2,570,500.00
2.6.2	Site Establishment	Allowance	n/a	n/a	$25,000.00
2.6.3	Plant Land *	m^2	$670	4250	$2,847,500.00
2.6.4	Building (assume portal frame)	m^2	$2,000	850	$1,700,000.00
2.6.5	Process Equipment (4 Trains SeaPAK UFRO includes Prescreen, Process, Control & Backpulse Tank skid	Allowance	n/a	n/a	$10,900,000.00
2.6.6	Blowers (2)	Allowance	n/a	n/a	$15,000.00
2.6.7	Compressor	Allowance	n/a	n/a	$15,000.00
2.6.11	Beach Well	Allowance			$3,000,000.00
2.6.12	Inlet & Outlet HDD pipe installation	Allowance			$6,500,000.00
2.6.13	Chemical Tanks & Bunds	Allowance	n/a	n/a	$200,000.00
2.6.14	Chemical dosing Systems	Allowance	n/a	n/a	$25,000.00
2.6.15	Sludge Press & Dewatering system	Allowance	n/a	n/a	$350,000.00
2.6.16	Water Tanks 2.0 ML **FEED**	Allowance	n/a	n/a	$1,000,000.00
2.6.17	Water Tanks 2.0 ML x 2	Allowance	n/a	n/a	$2,000,000.00
2.6.18	Pipework, valves & Fittings	Allowance	n/a	n/a	$200,000.00
2.6.19	Electrical works	Allowance	n/a	n/a	$1,750,000.00
2.6.20	Mechanical works	Allowance	n/a	n/a	$500,000.00
2.6.21	SCADA works	Allowance	n/a	n/a	$100,000.00
2.6.22	Earthworks, Roads & drainage	Allowance	n/a	n/a	$200,000.00
2.6.23	Fencing	Allowance	n/a	n/a	$25,000.00

2.6.24	Landscaping	Allowance	n/a	n/a	$15,000.00
2.7	Construction Contingencies (15%)	Allowance	n/a	n/a	$5,090,700.00
2.8	Testing and Commissioning (subtotal)				$135,000.00
2.8.1	Commissioning documentation	Allowance			$25,000.00
2.8.2	Dry Commissioning	Allowance			$30,000.00
2.8.3	Wet Commissioning	Allowance			$50,000.00
2.8.4	Process Commissioning	Allowance			$20,000.00
2.8.5	Process optimisation	Allowance			$10,000.00
2.9	Operations and Maintenance (subtotal)				$129,000.00
2.9.1	O&M Documentation (Manual, Standard Operation Procedures)				$18,000.00
2.9.2	O&M Training				$21,000.00
2.9.3	O&M Support (12 months)				$90,000.00
	Total Capital Cost				$46,942,706.07

Appendix H - NPV

SCENARIO 1: 5ML INSTALL, ADDITIONAL 5ML IN 2035

Net Cash Flow

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Net Capital Costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Capital Cost - SeaPak 2500	-47,000,000.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replacement of UF Modules every 6 years	$0	$0	$0	$0	$0	$0	$990,000	$0	$0	$0	$0	$0	$990,000
Replacement of RO Modules every 5 years	$0	$0	$0	$0	$0	$465,520	$0	$0	$0	$0	$465,520	$0	$0
Total Capital	**-$47,000,000**	**$0**	**$0**	**$0**	**$0**	**$465,520**	**$990,000**	**$0**	**$0**	**$0**	**$465,520**	**$0**	**$990,000**
Operating and Maintenance Costs													
Electricity		-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00
Membrane Replacement (included in capital expenditure)													
Chemical consumption (based on Reverse Osmosis)		-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00
Consumables		-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00
Labour (Operation)		-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
Labour (Maintenance & Management)		-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
Product support		-$100,000.00	-$75,000.00	-$50,000.00	-$25,000.00	-$25,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
Environmental Monitoring		-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
Water Quality Monitoring		-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
Escalation of Costs (CPI Adjusted)		-$22,391.60	-$44,221.03	-$65,466.85	-$86,106.99	-$108,720.73	-$129,894.30	-$153,083.79	-$176,737.07	-$200,863.41	-$225,472.27	-$250,573.32	-$276,176.39
Total Costs	**$ -**	**-$1,196,971.60**	**-$1,193,801.03**	**-$1,190,046.85**	**-$1,185,686.99**	**-$1,208,300.73**	**-$1,214,474.30**	**-$1,237,663.79**	**-$1,261,317.07**	**-$1,285,443.41**	**-$1,310,052.27**	**-$1,335,153.32**	**-$1,360,756.39**
Revenue and Operating Benefits													
New Revenue (CPI Adjusted)		$ 2,423,600	$ 2,472,072	$ 2,520,544	$ 2,569,016	$ 2,617,488	$ 2,665,960	$ 2,714,432	$ 2,762,904	$ 2,811,376	$ 2,859,848	$ 2,908,320	$ 2,956,792
Total Benefits and Revenue	**$ -**	**$ 2,423,600**	**$ 2,472,072**	**$ 2,520,544**	**$ 2,569,016**	**$ 2,617,488**	**$ 2,665,960**	**$ 2,714,432**	**$ 2,762,904**	**$ 2,811,376**	**$ 2,859,848**	**$ 2,908,320**	**$ 2,956,792**
Cash Flow Before Taxes	**-$47,000,000**	**$1,226,628**	**$1,278,271**	**$1,330,497**	**$1,383,329**	**$1,874,707**	**$2,441,486**	**$1,476,768**	**$1,501,587**	**$1,525,933**	**$2,015,315**	**$1,573,167**	**$2,586,036**
Income Tax Calculation													
Depreciation Expense		4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	0.00	0.00
Operating Cost		-1,196,971.60	-1,193,801.03	-1,190,046.85	-1,185,686.99	-1,208,300.73	-1,214,474.30	-1,237,663.79	-1,261,317.07	-1,285,443.41	-1,310,052.27	-1,335,153.32	-1,360,756.39
Operating Benefits		2,423,600.00	2,472,072.00	2,520,544.00	2,569,016.00	2,617,488.00	2,665,960.00	2,714,432.00	2,762,904.00	2,811,376.00	2,859,848.00	2,908,320.00	2,956,792.00
Net Income Taxes	**$ -**	**-1,777,988.52**	**-1,793,481.29**	**-1,809,149.14**	**-1,824,998.70**	**-1,832,756.18**	**-1,845,445.71**	**-1,853,030.46**	**-1,860,476.08**	**-1,867,779.78**	**-1,874,938.72**	**-471,950.00**	**-478,810.68**
Cash Flow After Taxes	**-47,000,000.00**	**-551,360.12**	**-515,210.32**	**-478,652.00**	**-441,669.69**	**41,950.69**	**596,039.99**	**-376,262.25**	**-358,889.15**	**-341,847.18**	**140,376.61**	**1,101,216.68**	**2,107,224.93**
Discounted Cash Flow (After Tax)	**-47,000,000.00**	**-537,650.04**	**-489,906.53**	**-443,826.14**	**-399,351.15**	**36,988.00**	**512,461.69**	**-315,457.60**	**-293,410.06**	**-272,527.93**	**109,128.48**	**834,796.21**	**1,557,696.77**
Cumulative Cash Flow	**-47,000,000.00**	**-47,537,650.04**	**-48,027,556.57**	**-48,471,382.72**	**-48,870,733.86**	**-48,833,745.87**	**-48,321,284.17**	**-48,636,741.77**	**-48,930,151.84**	**-49,202,679.77**	**-49,093,551.30**	**-48,258,755.09**	**-46,701,058.32**

Business Case Results:

NPV of Cash Flow	**$34,830,334**
IRR	**4.0%**
Profitability Index	**1.74**

Assumptions:		**Source**
CPI Rate	2.00%	GANDEN estimate
Benefit Escalation Factor	10.00%	GANDEN estimate
Income Tax Rate	30.00%	GANDEN estimate
Discounted cash flow Rate	2.55%	Provided by Council
Electrical cost (per kWh)	$0.10	Provided by Council
Operator / Maintainer Hourly Rate (includes 72.5% oncosts)	$69.00	Provided by Council
Water price per kl	$1.66	Provided by Rous
Peaking factor	80%	GANDEN estimate
Membrane Replacement		
Membrane UF Life	6.00	Years, SUEZ Example
Membrane UF Replacement Cost	$ 495,000.00	Per train (2.5MLD), including delivery and installation (Suez email)
Membrane RO Life	5.00	Years, SUEZ Example
Membrane RO Replacement Cost	$ 232,759.80	Per train (2.5MLD), including delivery and installation (Suez email)
USD to AUD conversion rate	$1.59	AUD to USD. Accessed 21/04/2020

Operating costs

Fixed costs	Operation Annual Salary + OH x 2	$ 240,000.00
	Maintenance Annual Salary + OH x 1	$ 120,000.00
	Management Annual Salary	$ 75,000.00
Montly variable costs	Chemicals ($/kl)	$0.12
	Consumables ($/kl	$0.03
	Power (kwh/kl)	4

Energy Usage per Annum	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant Ultimate Capacity (kL per day)	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00
Adjusted at 80% production volume	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**
Water price (per kL)	$1.66	$1.69	$1.73	$1.76	$1.79	$1.83	$1.86	$1.89	$1.93	$1.96	$1.99	$2.03	$2.06
Average estimated permeate production per annum kl	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.37

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2033	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
$0	$0	-$7,000,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039
$0	**$0**	**-$6,068,961**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**
-$584,000.00	-$584,000.00	-$584,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$480.00	-$480.00	-$480.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$100.00	-$100.00	-$100.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$302,291.51	-$328,928.94	-$356,099.12	-$601,735.77	-$646,053.69	-$691,257.96	-$737,366.32	-$784,396.85	-$832,367.99	-$881,298.55	-$931,207.72	-$982,115.07	-$1,034,040.57	-$1,087,004.58	-$1,141,027.88	-$1,196,131.63	-$1,252,337.47	-$1,309,667.41
-$1,386,871.51	**-$1,413,508.94**	**-$1,440,679.12**	**-$2,270,895.77**	**-$2,315,213.69**	**-$2,360,417.96**	**-$2,406,526.32**	**-$2,453,556.85**	**-$2,501,527.99**	**-$2,550,458.55**	**-$2,600,367.72**	**-$2,651,275.07**	**-$2,703,200.57**	**-$2,756,164.58**	**-$2,810,187.88**	**-$2,865,291.63**	**-$2,921,497.47**	**-$2,978,827.41**
$ 3,005,264	$ 3,053,736	$ 3,102,208	$ 6,301,360	$ 6,398,304	$ 6,495,248	$ 6,592,192	$ 6,689,136	$ 6,786,080	$ 6,883,024	$ 6,979,968	$ 7,076,912	$ 7,173,856	$ 7,270,800	$ 7,367,744	$ 7,464,688	$ 7,561,632	$ 7,658,576
$ 3,005,264	**$ 3,053,736**	**$ 3,102,208**	**$ 6,301,360**	**$ 6,398,304**	**$ 6,495,248**	**$ 6,592,192**	**$ 6,689,136**	**$ 6,786,080**	**$ 6,883,024**	**$ 6,979,968**	**$ 7,076,912**	**$ 7,173,856**	**$ 7,270,800**	**$ 7,367,744**	**$ 7,464,688**	**$ 7,561,632**	**$ 7,658,576**
$1,618,392	**$1,640,227**	**-$4,407,432**	**$4,030,464**	**$4,083,090**	**$6,114,830**	**$4,185,666**	**$5,166,618**	**$4,284,552**	**$4,332,565**	**$4,379,600**	**$6,405,637**	**$5,401,695**	**$4,514,635**	**$4,557,556**	**$4,599,396**	**$4,640,135**	**$7,590,788**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-1,386,871.51	-1,413,508.94	-1,440,679.12	-2,270,895.77	-2,315,213.69	-2,360,417.96	-2,406,526.32	-2,453,556.85	-2,501,527.99	-2,550,458.55	-2,600,367.72	-2,651,275.07	-2,703,200.57	-2,756,164.58	-2,810,187.88	-2,865,291.63	-2,921,497.47	-2,978,827.41
3,005,264.00	3,053,736.00	3,102,208.00	6,301,360.00	6,398,304.00	6,495,248.00	6,592,192.00	6,689,136.00	6,786,080.00	6,883,024.00	6,979,968.00	7,076,912.00	7,173,856.00	7,270,800.00	7,367,744.00	7,464,688.00	7,561,632.00	7,658,576.00
-485,517.75	**-492,068.12**	**-498,458.66**	**-1,209,139.27**	**-1,224,927.09**	**-1,240,449.01**	**-1,255,699.70**	**-1,270,673.75**	**-1,285,365.60**	**-1,299,769.64**	**-1,313,880.09**	**-1,327,691.08**	**-1,341,196.63**	**-1,354,390.62**	**-1,367,266.84**	**-1,379,818.91**	**-1,392,040.36**	**-1,403,924.58**
1,132,874.74	**1,148,158.94**	**-4,905,890.59**	**2,821,324.96**	**2,858,163.22**	**4,874,381.03**	**2,929,965.97**	**3,895,944.61**	**2,999,186.41**	**3,032,795.82**	**3,065,720.20**	**5,077,945.85**	**4,060,498.00**	**3,160,244.79**	**3,190,289.29**	**3,219,577.46**	**3,248,094.17**	**6,186,863.21**
816,616.69	**807,054.21**	**-3,362,659.46**	**1,885,742.88**	**1,862,862.18**	**3,097,972.15**	**1,815,870.81**	**2,354,504.25**	**1,767,479.97**	**1,742,844.13**	**1,717,956.75**	**2,774,802.73**	**2,163,653.36**	**1,642,076.71**	**1,616,468.03**	**1,590,743.90**	**1,564,927.91**	**2,906,702.42**
-45,884,441.63	**-45,077,387.42**	**-48,440,046.88**	**-46,554,304.00**	**-44,691,441.82**	**-41,593,469.67**	**-39,777,598.86**	**-37,423,094.61**	**-35,655,614.64**	**-33,912,770.50**	**-32,194,813.75**	**-29,420,011.02**	**-27,256,357.66**	**-25,614,280.95**	**-23,997,812.93**	**-22,407,069.03**	**-20,842,141.12**	**-17,935,438.69**

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
5000.00	5000.00	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
4000.00	**4000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.09	$2.12	$2.16	$2.19	$2.22	$2.26	$2.29	$2.32	$2.36	$2.39	$2.42	$2.46	$2.49	$2.52	$2.56	$2.59	$2.62	$2.66
1.39	1.42	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73	1.75	1.77

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
2051	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$1,368,143.96	-$1,427,790.04	-$1,488,629.04	-$1,550,684.82	-$1,613,981.72	-$1,678,544.55	-$1,744,398.65	-$1,811,569.82	-$1,880,084.42	-$1,949,969.30	-$2,021,251.89	-$2,093,960.13	-$2,168,122.53	-$2,243,768.18	-$2,320,926.74	-$2,399,628.48	-$2,479,904.25	-$2,561,785.53
-$3,037,303.96	**-$3,096,950.04**	**-$3,157,789.04**	**-$3,219,844.82**	**-$3,283,141.72**	**-$3,347,704.55**	**-$3,413,558.65**	**-$3,480,729.82**	**-$3,549,244.42**	**-$3,619,129.30**	**-$3,690,411.89**	**-$3,763,120.13**	**-$3,837,282.53**	**-$3,912,928.18**	**-$3,990,086.74**	**-$4,068,788.48**	**-$4,149,064.25**	**-$4,230,945.53**
$ 7,755,520	$ 7,852,464	$ 7,949,408	$ 8,046,352	$ 8,143,296	$ 8,240,240	$ 8,337,184	$ 8,434,128	$ 8,531,072	$ 8,628,016	$ 8,724,960	$ 8,821,904	$ 8,918,848	$ 9,015,792	$ 9,112,736	$ 9,209,680	$ 9,306,624	$ 9,403,568
$ 7,755,520	**$ 7,852,464**	**$ 7,949,408**	**$ 8,046,352**	**$ 8,143,296**	**$ 8,240,240**	**$ 8,337,184**	**$ 8,434,128**	**$ 8,531,072**	**$ 8,628,016**	**$ 8,724,960**	**$ 8,821,904**	**$ 8,918,848**	**$ 9,015,792**	**$ 9,112,736**	**$ 9,209,680**	**$ 9,306,624**	**$ 9,403,568**
$4,718,216	**$4,755,514**	**$4,791,619**	**$4,826,507**	**$5,791,193**	**$6,872,535**	**$4,923,625**	**$4,953,398**	**$4,981,828**	**$5,939,926**	**$5,034,548**	**$7,038,784**	**$5,081,565**	**$5,102,864**	**$6,053,688**	**$5,140,892**	**$5,157,560**	**$7,152,622**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3,037,303.96	-3,096,950.04	-3,157,789.04	-3,219,844.82	-3,283,141.72	-3,347,704.55	-3,413,558.65	-3,480,729.82	-3,549,244.42	-3,619,129.30	-3,690,411.89	-3,763,120.13	-3,837,282.53	-3,912,928.18	-3,990,086.74	-4,068,788.48	-4,149,064.25	-4,230,945.53
7,755,520.00	7,852,464.00	7,949,408.00	8,046,352.00	8,143,296.00	8,240,240.00	8,337,184.00	8,434,128.00	8,531,072.00	8,628,016.00	8,724,960.00	8,821,904.00	8,918,848.00	9,015,792.00	9,112,736.00	9,209,680.00	9,306,624.00	9,403,568.00
-1,415,464.81	**-1,426,654.19**	**-1,437,485.69**	**-1,447,952.15**	**-1,458,046.28**	**-1,467,760.63**	**-1,477,087.61**	**-1,486,019.45**	**-1,494,548.28**	**-1,502,666.01**	**-1,510,364.43**	**-1,517,635.16**	**-1,524,469.64**	**-1,530,859.15**	**-1,536,794.78**	**-1,542,267.46**	**-1,547,267.93**	**-1,551,786.74**
3,302,751.23	**3,328,859.77**	**3,354,133.27**	**3,378,555.02**	**4,333,147.20**	**5,404,774.81**	**3,446,537.75**	**3,467,378.73**	**3,487,279.31**	**4,437,259.89**	**3,524,183.68**	**5,521,148.71**	**3,557,095.83**	**3,572,004.67**	**4,516,893.68**	**3,598,624.06**	**3,610,291.83**	**5,600,835.73**
1,513,109.15	**1,487,148.13**	**1,461,178.86**	**1,435,219.73**	**1,794,961.66**	**2,183,200.76**	**1,357,573.79**	**1,331,821.50**	**1,306,158.29**	**1,620,646.43**	**1,255,151.88**	**1,917,483.02**	**1,204,653.05**	**1,179,621.75**	**1,454,571.11**	**1,130,045.43**	**1,105,518.63**	**1,672,402.97**
-16,422,329.55	**-14,935,181.41**	**-13,474,002.56**	**-12,038,782.83**	**-10,243,821.16**	**-8,060,620.40**	**-6,703,046.61**	**-5,371,225.11**	**-4,065,066.82**	**-2,444,420.39**	**-1,189,268.50**	**728,214.52**	**1,932,867.57**	**3,112,489.32**	**4,567,060.42**	**5,697,105.85**	**6,802,624.48**	**8,475,027.45**

2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.69	$2.72	$2.76	$2.79	$2.82	$2.86	$2.89	$2.92	$2.95	$2.99	$3.02	$3.05	$3.09	$3.12	$3.15	$3.19	$3.22	$3.25
1.79	1.81	1.84	1.86	1.88	1.90	1.93	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.12	2.15	2.17

49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
2069	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**	**2077**	**2078**	**2079**	**2080**	**2081**	**2082**	**2083**	**2084**	**2085**	**2086**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0
$0	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**	**$0**	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$2,645,304.44	-$2,730,493.73	-$2,817,386.81	-$2,906,017.74	-$2,996,421.30	-$3,088,632.92	-$3,182,688.78	-$3,278,625.76	-$3,376,481.47	-$3,476,294.30	-$3,578,103.39	-$3,681,948.66	-$3,787,870.83	-$3,895,911.45	-$4,006,112.88	-$4,118,518.33	-$4,233,171.90	-$4,350,118.54
-$4,314,464.44	**-$4,399,653.73**	**-$4,486,546.81**	**-$4,575,177.74**	**-$4,665,581.30**	**-$4,757,792.92**	**-$4,851,848.78**	**-$4,947,785.76**	**-$5,045,641.47**	**-$5,145,454.30**	**-$5,247,263.39**	**-$5,351,108.66**	**-$5,457,030.83**	**-$5,565,071.45**	**-$5,675,272.88**	**-$5,787,678.33**	**-$5,902,331.90**	**-$6,019,278.54**
$ 9,500,512	$ 9,597,456	$ 9,694,400	$ 9,791,344	$ 9,888,288	$ 9,985,232	$ 10,082,176	$ 10,179,120	$ 10,276,064	$ 10,373,008	$ 10,469,952	$ 10,566,896	$ 10,663,840	$ 10,760,784	$ 10,857,728	$ 10,954,672	$ 11,051,616	$ 11,148,560
$ 9,500,512	**$ 9,597,456**	**$ 9,694,400**	**$ 9,791,344**	**$ 9,888,288**	**$ 9,985,232**	**$ 10,082,176**	**$ 10,179,120**	**$ 10,276,064**	**$ 10,373,008**	**$ 10,469,952**	**$ 10,566,896**	**$ 10,663,840**	**$ 10,760,784**	**$ 10,857,728**	**$ 10,954,672**	**$ 11,051,616**	**$ 11,148,560**
$5,186,048	**$6,128,841**	**$5,207,853**	**$5,216,166**	**$5,222,707**	**$7,207,439**	**$6,161,366**	**$5,231,334**	**$5,230,423**	**$5,227,554**	**$5,222,689**	**$8,126,827**	**$5,206,809**	**$5,195,713**	**$5,182,455**	**$5,166,994**	**$6,080,323**	**$7,109,281**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-4,314,464.44	-4,399,653.73	-4,486,546.81	-4,575,177.74	-4,665,581.30	-4,757,792.92	-4,851,848.78	-4,947,785.76	-5,045,641.47	-5,145,454.30	-5,247,263.39	-5,351,108.66	-5,457,030.83	-5,565,071.45	-5,675,272.88	-5,787,678.33	-5,902,331.90	-6,019,278.54
9,500,512.00	9,597,456.00	9,694,400.00	9,791,344.00	9,888,288.00	9,985,232.00	10,082,176.00	10,179,120.00	10,276,064.00	10,373,008.00	10,469,952.00	10,566,896.00	10,663,840.00	10,760,784.00	10,857,728.00	10,954,672.00	11,051,616.00	11,148,560.00
-1,555,814.27	**-1,559,340.68**	**-1,562,355.96**	**-1,564,849.88**	**-1,566,812.01**	**-1,568,231.72**	**-1,569,098.17**	**-1,569,400.27**	**-1,569,126.76**	**-1,568,266.11**	**-1,566,806.58**	**-1,564,736.20**	**-1,562,042.75**	**-1,558,713.77**	**-1,554,736.54**	**-1,550,098.10**	**-1,544,785.23**	**-1,538,784.44**
3,630,233.29	**4,569,500.79**	**3,645,497.23**	**3,651,316.38**	**3,655,894.69**	**5,639,207.35**	**4,592,268.25**	**3,661,933.97**	**3,661,295.77**	**3,659,287.59**	**3,655,882.03**	**6,562,090.34**	**3,644,766.42**	**3,636,998.79**	**3,627,718.59**	**3,616,895.57**	**4,535,538.07**	**5,570,497.02**
1,057,029.15	**1,297,434.74**	**1,009,340.90**	**985,813.82**	**962,506.01**	**1,447,745.32**	**1,149,650.12**	**893,950.12**	**871,569.30**	**849,430.77**	**827,538.02**	**1,448,446.05**	**784,502.18**	**763,364.47**	**742,483.34**	**721,860.75**	**882,694.89**	**1,057,158.43**
9,532,056.60	**10,829,491.34**	**11,838,832.24**	**12,824,646.06**	**13,787,152.06**	**15,234,897.38**	**16,384,547.51**	**17,278,497.62**	**18,150,066.93**	**18,999,497.70**	**19,827,035.72**	**21,275,481.76**	**22,059,983.94**	**22,823,348.42**	**23,565,831.76**	**24,287,692.51**	**25,170,387.39**	**26,227,545.82**

2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.29	$3.32	$3.35	$3.39	$3.42	$3.45	$3.49	$3.52	$3.55	$3.59	$3.62	$3.65	$3.69	$3.72	$3.75	$3.78	$3.82	$3.85
2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.37	2.39	2.41	2.43	2.46	2.48	2.50	2.52	2.55	2.57

67	68	69	70	71	72	73	74	75	76	77	78	79	80	Totals
2087	**2088**	**2089**	**2090**	**2091**	**2092**	**2093**	**2094**	**2095**	**2096**	**2097**	**2098**	**2099**	**2100**	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-$54,000,000
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$23,760,000
$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$13,965,588
$0	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**-$16,274,412**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	**$ (84,680,000)**
														$ -
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	**$ (69,600)**
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	**$ (14,500)**
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	**$ (19,200,000)**
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	**$ (15,600,000)**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	**$ (1,025,000)**
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	**$ (2,800,000)**
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	**$ (1,600,000)**
-$4,469,404.11	-$4,591,075.39	-$4,715,180.10	-$4,841,766.90	-$4,970,885.44	-$5,102,586.35	-$5,236,921.27	-$5,373,942.90	-$5,513,704.96	-$5,656,262.26	-$5,801,670.70	-$5,949,987.32	-$6,101,270.26	-$6,255,578.87	**$ (188,368,521)**
-$6,138,564.11	**-$6,260,235.39**	**-$6,384,340.10**	**-$6,510,926.90**	**-$6,640,045.44**	**-$6,771,746.35**	**-$6,906,081.27**	**-$7,043,102.90**	**-$7,182,864.96**	**-$7,325,422.26**	**-$7,470,830.70**	**-$7,619,147.32**	**-$7,770,430.26**	**-$7,924,738.87**	**$ (313,357,621)**
$ 11,245,504	$ 11,342,448	$ 11,439,392	$ 11,536,336	$ 11,633,280	$ 11,730,224	$ 11,827,168	$ 11,924,112	$ 12,021,056	$ 12,118,000	$ 12,214,944	$ 12,311,888	$ 12,408,832	$ 12,505,776	$ 652,675,480
$ 11,245,504	**$ 11,342,448**	**$ 11,439,392**	**$ 11,536,336**	**$ 11,633,280**	**$ 11,730,224**	**$ 11,827,168**	**$ 11,924,112**	**$ 12,021,056**	**$ 12,118,000**	**$ 12,214,944**	**$ 12,311,888**	**$ 12,408,832**	**$ 12,505,776**	**$ 652,675,480**
$5,106,940	**$5,082,213**	**$5,055,052**	**$5,956,448**	**$4,993,235**	**$6,938,478**	**$4,921,087**	**$4,881,009**	**$5,769,230**	**$4,792,578**	**$4,744,113**	**$6,672,741**	**$4,638,402**	**$5,512,076**	**$ 323,043,447**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47,000,000.00
-6,138,564.11	-6,260,235.39	-6,384,340.10	-6,510,926.90	-6,640,045.44	-6,771,746.35	-6,906,081.27	-7,043,102.90	-7,182,864.96	-7,325,422.26	-7,470,830.70	-7,619,147.32	-7,770,430.26	-7,924,738.87	-313,357,620.92
11,245,504.00	11,342,448.00	11,439,392.00	11,536,336.00	11,633,280.00	11,730,224.00	11,827,168.00	11,924,112.00	12,021,056.00	12,118,000.00	12,214,944.00	12,311,888.00	12,408,832.00	12,505,776.00	652,675,480.00
-1,532,081.97	**-1,524,663.78**	**-1,516,515.57**	**-1,507,622.73**	**-1,497,970.37**	**-1,487,543.30**	**-1,476,326.02**	**-1,464,302.73**	**-1,451,457.31**	**-1,437,773.32**	**-1,423,233.99**	**-1,407,822.21**	**-1,391,520.52**	**-1,374,311.14**	**-115,895,357.72**
3,574,857.92	**3,557,548.83**	**3,538,536.33**	**4,448,825.57**	**3,495,264.19**	**5,450,934.36**	**3,444,760.71**	**3,416,706.37**	**4,317,772.93**	**3,354,804.42**	**3,320,879.31**	**5,264,918.48**	**3,246,881.22**	**4,137,765.19**	**207,148,089.36**
661,560.02	**641,986.17**	**622,676.96**	**763,394.19**	**584,854.47**	**889,412.22**	**548,094.62**	**530,113.02**	**653,258.31**	**494,944.71**	**477,756.84**	**738,600.85**	**444,169.66**	**551,966.43**	**34,830,334.28**
26,889,105.84	**27,531,092.00**	**28,153,768.96**	**28,917,163.15**	**29,502,017.62**	**30,391,429.84**	**30,939,524.46**	**31,469,637.47**	**32,122,895.79**	**32,617,840.50**	**33,095,597.34**	**33,834,198.19**	**34,278,367.85**	**34,830,334.28**	

2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.88	$3.92	$3.95	$3.98	$4.02	$4.05	$4.08	$4.12	$4.15	$4.18	$4.22	$4.25	$4.28	$4.32
2.59	2.61	2.63	2.66	2.68	2.70	2.72	2.74	2.77	2.79	2.81	2.83	2.86	2.88

GANDEN
ENGINEERS AND PROJECT MANAGERS

SCENARIO 2: 5ML INSTALL, ADDITIONAL 5ML IN 2030

Net Cash Flow

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Net Capital Costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Capital Cost - SeaPak 2500	-47,000,000.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	-$7,000,000	$0	$0
Replacement of UF Modules every 6 years	$0	$0	$0	$0	$0	$0	$990,000	$0	$0	$0	$0	$0	$990,000
Replacement of RO Modules every 5 years	$0	$0	$0	$0	$0	$465,520	$0	$0	$0	$0	$465,520	$0	$0
Total Capital	**-$47,000,000**	**$0**	**$0**	**$0**	**$0**	**$465,520**	**$990,000**	**$0**	**$0**	**$0**	**-$6,534,480**	**$0**	**$990,000**
Operating and Maintenance Costs													
Electricity		-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$1,168,000.00	-$1,168,000.00
Membrane Replacement (included in capital expenditure)													
Chemical consumption (based on Reverse Osmosis)		-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$960.00	-$960.00
Consumables		-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$200.00	-$200.00
Labour (Operation)		-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
Labour (Maintenance & Management)		-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
Product support		-$100,000.00	-$75,000.00	-$50,000.00	-$25,000.00	-$25,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
Environmental Monitoring		-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
Water Quality Monitoring		-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
Escalation of Costs (CPI Adjusted)		-$22,391.60	-$44,221.03	-$65,466.85	-$86,106.99	-$108,720.73	-$129,894.30	-$153,083.79	-$176,737.07	-$200,863.41	-$225,472.27	-$392,845.07	-$432,985.18
Total Costs	**$ -**	**-$1,196,971.60**	**-$1,193,801.03**	**-$1,190,046.85**	**-$1,185,686.99**	**-$1,208,300.73**	**-$1,214,474.30**	**-$1,237,663.79**	**-$1,261,317.07**	**-$1,285,443.41**	**-$1,310,052.27**	**-$2,062,005.07**	**-$2,102,145.18**
Revenue and Operating Benefits													
New Revenue (CPI Adjusted)		$ 2,423,600	$ 2,472,072	$ 2,520,544	$ 2,569,016	$ 2,617,488	$ 2,665,960	$ 2,714,432	$ 2,762,904	$ 2,811,376	$ 2,859,848	$ 5,816,640	$ 5,913,584
Total Benefits and Revenue	**$ -**	**$ 2,423,600**	**$ 2,472,072**	**$ 2,520,544**	**$ 2,569,016**	**$ 2,617,488**	**$ 2,665,960**	**$ 2,714,432**	**$ 2,762,904**	**$ 2,811,376**	**$ 2,859,848**	**$ 5,816,640**	**$ 5,913,584**
Cash Flow Before Taxes	**-$47,000,000**	**$1,226,628**	**$1,278,271**	**$1,330,497**	**$1,383,329**	**$1,874,707**	**$2,441,486**	**$1,476,768**	**$1,501,587**	**$1,525,933**	**-$4,984,685**	**$3,754,635**	**$4,801,439**
Income Tax Calculation													
Depreciation Expense		4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	0.00	0.00
Operating Cost		-1,196,971.60	-1,193,801.03	-1,190,046.85	-1,185,686.99	-1,208,300.73	-1,214,474.30	-1,237,663.79	-1,261,317.07	-1,285,443.41	-1,310,052.27	-2,062,005.07	-2,102,145.18
Operating Benefits		2,423,600.00	2,472,072.00	2,520,544.00	2,569,016.00	2,617,488.00	2,665,960.00	2,714,432.00	2,762,904.00	2,811,376.00	2,859,848.00	5,816,640.00	5,913,584.00
Net Income Taxes	**$ -**	**-1,777,988.52**	**-1,793,481.29**	**-1,809,149.14**	**-1,824,998.70**	**-1,832,756.18**	**-1,845,445.71**	**-1,853,030.46**	**-1,860,476.08**	**-1,867,779.78**	**-1,874,938.72**	**-1,126,390.48**	**-1,143,431.65**
Cash Flow After Taxes	**-47,000,000.00**	**-551,360.12**	**-515,210.32**	**-478,652.00**	**-441,669.69**	**41,950.69**	**596,039.99**	**-376,262.25**	**-358,889.15**	**-341,847.18**	**-6,859,623.39**	**2,628,244.45**	**3,658,007.18**
Discounted Cash Flow (After Tax)	**-47,000,000.00**	**-537,650.04**	**-489,906.53**	**-443,826.14**	**-399,351.15**	**36,988.00**	**512,461.69**	**-315,457.60**	**-293,410.06**	**-272,527.93**	**-5,332,656.70**	**1,992,385.83**	**2,704,061.57**
Cumulative Cash Flow	**-47,000,000.00**	**-47,537,650.04**	**-48,027,556.57**	**-48,471,382.72**	**-48,870,733.86**	**-48,833,745.87**	**-48,321,284.17**	**-48,636,741.77**	**-48,930,151.84**	**-49,202,679.77**	**-54,535,336.47**	**-52,542,950.64**	**-49,838,889.07**

Business Case Results:

NPV of Cash Flow	**$39,859,351**
IRR	**4.2%**
Profitability Index	**1.85**

Assumptions:

		Source
CPI Rate	2.00%	GANDEN estimate
Benefit Escalation Factor	10.00%	GANDEN estimate
Income Tax Rate	30.00%	GANDEN estimate
Discounted cash flow Rate	2.55%	Provided by Council
Electrical cost (per kWh)	$0.10	Provided by Council
Operator / Maintainer Hourly Rate (includes 72.5% oncosts)	$69.00	Provided by Council
Water price per kl	$1.66	Provided by Rous
Peaking factor	80%	GANDEN estimate
Membrane Replacement		
Membrane UF Life	6.00	Years, SUEZ Example
Membrane UF Replacement Cost	$ 495,000.00	Per train (2.5MLD), including delivery and installation (Suez email)
Membrane RO Life	5.00	Years, SUEZ Example
Membrane RO Replacement Cost	$ 232,759.80	Per train (2.5MLD), including delivery and installation (Suez email)
USD to AUD conversion rate	$1.59	AUD to USD. Accessed 21/04/2020

Operating costs

Fixed costs	Operation Annual Salary + OH x 2	$ 240,000.00
	Maintenance Annual Salary + OH x 1	$ 120,000.00
	Management Annual Salary	$ 75,000.00
Montly variable costs	Chemicals ($/kl)	$0.12
	Consumables ($/kl	$0.03
	Power (kwh/kl)	4

Energy Usage per Annum	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant Ultimate Capacity (kL per day)	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	5000.00	10000.00	10000.00	10000.00
Adjusted at 80% production volume	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**8000.00**	**8000.00**	**8000.00**
Water price (per kL)	$1.66	$1.69	$1.73	$1.76	$1.79	$1.83	$1.86	$1.89	$1.93	$1.96	$1.99	$2.03	$2.06
Average estimated permeate production per annum kl	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.37

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
2033	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0
$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0
$0	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$473,928.08	-$515,689.84	-$558,286.84	-$601,735.77	-$646,053.69	-$691,257.96	-$737,366.32	-$784,396.85	-$832,367.99	-$881,298.55	-$931,207.72	-$982,115.07	-$1,034,040.57	-$1,087,004.58	-$1,141,027.88	-$1,196,131.63	-$1,252,337.47
-$2,143,088.08	**-$2,184,849.84**	**-$2,227,446.84**	**-$2,270,895.77**	**-$2,315,213.69**	**-$2,360,417.96**	**-$2,406,526.32**	**-$2,453,556.85**	**-$2,501,527.99**	**-$2,550,458.55**	**-$2,600,367.72**	**-$2,651,275.07**	**-$2,703,200.57**	**-$2,756,164.58**	**-$2,810,187.88**	**-$2,865,291.63**	**-$2,921,497.47**
$ 6,010,528	$ 6,107,472	$ 6,204,416	$ 6,301,360	$ 6,398,304	$ 6,495,248	$ 6,592,192	$ 6,689,136	$ 6,786,080	$ 6,883,024	$ 6,979,968	$ 7,076,912	$ 7,173,856	$ 7,270,800	$ 7,367,744	$ 7,464,688	$ 7,561,632
$ 6,010,528	**$ 6,107,472**	**$ 6,204,416**	**$ 6,301,360**	**$ 6,398,304**	**$ 6,495,248**	**$ 6,592,192**	**$ 6,689,136**	**$ 6,786,080**	**$ 6,883,024**	**$ 6,979,968**	**$ 7,076,912**	**$ 7,173,856**	**$ 7,270,800**	**$ 7,367,744**	**$ 7,464,688**	**$ 7,561,632**
$3,867,440	**$3,922,622**	**$4,908,008**	**$4,030,464**	**$4,083,090**	**$6,114,830**	**$4,185,666**	**$5,166,618**	**$4,284,552**	**$4,332,565**	**$4,379,600**	**$6,405,637**	**$5,401,695**	**$4,514,635**	**$4,557,556**	**$4,599,396**	**$4,640,135**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-2,143,088.08	-2,184,849.84	-2,227,446.84	-2,270,895.77	-2,315,213.69	-2,360,417.96	-2,406,526.32	-2,453,556.85	-2,501,527.99	-2,550,458.55	-2,600,367.72	-2,651,275.07	-2,703,200.57	-2,756,164.58	-2,810,187.88	-2,865,291.63	-2,921,497.47
6,010,528.00	6,107,472.00	6,204,416.00	6,301,360.00	6,398,304.00	6,495,248.00	6,592,192.00	6,689,136.00	6,786,080.00	6,883,024.00	6,979,968.00	7,076,912.00	7,173,856.00	7,270,800.00	7,367,744.00	7,464,688.00	7,561,632.00
-1,160,231.98	**-1,176,786.65**	**-1,193,090.75**	**-1,209,139.27**	**-1,224,927.09**	**-1,240,449.01**	**-1,255,699.70**	**-1,270,673.75**	**-1,285,365.60**	**-1,299,769.64**	**-1,313,880.09**	**-1,327,691.08**	**-1,341,196.63**	**-1,354,390.62**	**-1,367,266.84**	**-1,379,818.91**	**-1,392,040.36**
2,707,207.94	**2,745,835.51**	**3,714,917.61**	**2,821,324.96**	**2,858,163.22**	**4,874,381.03**	**2,929,965.97**	**3,895,944.61**	**2,999,186.41**	**3,032,795.82**	**3,065,720.20**	**5,077,945.85**	**4,060,498.00**	**3,160,244.79**	**3,190,289.29**	**3,219,577.46**	**3,248,094.17**
1,951,452.46	**1,930,079.56**	**2,546,327.24**	**1,885,742.88**	**1,862,862.18**	**3,097,972.15**	**1,815,870.81**	**2,354,504.25**	**1,767,479.97**	**1,742,844.13**	**1,717,956.75**	**2,774,802.73**	**2,163,653.36**	**1,642,076.71**	**1,616,468.03**	**1,590,743.90**	**1,564,927.91**
-47,887,436.61	**-45,957,357.05**	**-43,411,029.81**	**-41,525,286.93**	**-39,662,424.75**	**-36,564,452.60**	**-34,748,581.79**	**-32,394,077.53**	**-30,626,597.56**	**-28,883,753.43**	**-27,165,796.68**	**-24,390,993.95**	**-22,227,340.59**	**-20,585,263.88**	**-18,968,795.85**	**-17,378,051.96**	**-15,813,124.05**

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.09	$2.12	$2.16	$2.19	$2.22	$2.26	$2.29	$2.32	$2.36	$2.39	$2.42	$2.46	$2.49	$2.52	$2.56	$2.59	$2.62
1.39	1.42	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73	1.75

30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
2050	**2051**	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0
$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0
$2,911,039	**$0**	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$1,309,667.41	-$1,368,143.96	-$1,427,790.04	-$1,488,629.04	-$1,550,684.82	-$1,613,981.72	-$1,678,544.55	-$1,744,398.65	-$1,811,569.82	-$1,880,084.42	-$1,949,969.30	-$2,021,251.89	-$2,093,960.13	-$2,168,122.53	-$2,243,768.18	-$2,320,926.74	-$2,399,628.48
-$2,978,827.41	**-$3,037,303.96**	**-$3,096,950.04**	**-$3,157,789.04**	**-$3,219,844.82**	**-$3,283,141.72**	**-$3,347,704.55**	**-$3,413,558.65**	**-$3,480,729.82**	**-$3,549,244.42**	**-$3,619,129.30**	**-$3,690,411.89**	**-$3,763,120.13**	**-$3,837,282.53**	**-$3,912,928.18**	**-$3,990,086.74**	**-$4,068,788.48**
$ 7,658,576	$ 7,755,520	$ 7,852,464	$ 7,949,408	$ 8,046,352	$ 8,143,296	$ 8,240,240	$ 8,337,184	$ 8,434,128	$ 8,531,072	$ 8,628,016	$ 8,724,960	$ 8,821,904	$ 8,918,848	$ 9,015,792	$ 9,112,736	$ 9,209,680
$ 7,658,576	**$ 7,755,520**	**$ 7,852,464**	**$ 7,949,408**	**$ 8,046,352**	**$ 8,143,296**	**$ 8,240,240**	**$ 8,337,184**	**$ 8,434,128**	**$ 8,531,072**	**$ 8,628,016**	**$ 8,724,960**	**$ 8,821,904**	**$ 8,918,848**	**$ 9,015,792**	**$ 9,112,736**	**$ 9,209,680**
$7,590,788	**$4,718,216**	**$4,755,514**	**$4,791,619**	**$4,826,507**	**$5,791,193**	**$6,872,535**	**$4,923,625**	**$4,953,398**	**$4,981,828**	**$5,939,926**	**$5,034,548**	**$7,038,784**	**$5,081,565**	**$5,102,864**	**$6,053,688**	**$5,140,892**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-2,978,827.41	-3,037,303.96	-3,096,950.04	-3,157,789.04	-3,219,844.82	-3,283,141.72	-3,347,704.55	-3,413,558.65	-3,480,729.82	-3,549,244.42	-3,619,129.30	-3,690,411.89	-3,763,120.13	-3,837,282.53	-3,912,928.18	-3,990,086.74	-4,068,788.48
7,658,576.00	7,755,520.00	7,852,464.00	7,949,408.00	8,046,352.00	8,143,296.00	8,240,240.00	8,337,184.00	8,434,128.00	8,531,072.00	8,628,016.00	8,724,960.00	8,821,904.00	8,918,848.00	9,015,792.00	9,112,736.00	9,209,680.00
-1,403,924.58	**-1,415,464.81**	**-1,426,654.19**	**-1,437,485.69**	**-1,447,952.15**	**-1,458,046.28**	**-1,467,760.63**	**-1,477,087.61**	**-1,486,019.45**	**-1,494,548.28**	**-1,502,666.01**	**-1,510,364.43**	**-1,517,635.16**	**-1,524,469.64**	**-1,530,859.15**	**-1,536,794.78**	**-1,542,267.46**
6,186,863.21	**3,302,751.23**	**3,328,859.77**	**3,354,133.27**	**3,378,555.02**	**4,333,147.20**	**5,404,774.81**	**3,446,537.75**	**3,467,378.73**	**3,487,279.31**	**4,437,259.89**	**3,524,183.68**	**5,521,148.71**	**3,557,095.83**	**3,572,004.67**	**4,516,893.68**	**3,598,624.06**
2,906,702.42	**1,513,109.15**	**1,487,148.13**	**1,461,178.86**	**1,435,219.73**	**1,794,961.66**	**2,183,200.76**	**1,357,573.79**	**1,331,821.50**	**1,306,158.29**	**1,620,646.43**	**1,255,151.88**	**1,917,483.02**	**1,204,653.05**	**1,179,621.75**	**1,454,571.11**	**1,130,045.43**
-12,906,421.62	**-11,393,312.47**	**-9,906,164.34**	**-8,444,985.49**	**-7,009,765.75**	**-5,214,804.09**	**-3,031,603.33**	**-1,674,029.53**	**-342,208.03**	**963,950.25**	**2,584,596.68**	**3,839,748.57**	**5,757,231.59**	**6,961,884.64**	**8,141,506.39**	**9,596,077.49**	**10,726,122.92**

2050	2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066
10000.00	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.66	$2.69	$2.72	$2.76	$2.79	$2.82	$2.86	$2.89	$2.92	$2.95	$2.99	$3.02	$3.05	$3.09	$3.12	$3.15	$3.19
1.77	1.79	1.81	1.84	1.86	1.88	1.90	1.93	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.12

47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
2067	**2068**	**2069**	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**	**2077**	**2078**	**2079**	**2080**	**2081**	**2082**	**2083**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0
$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0
$0	**$1,980,000**	**$0**	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**	**$0**	**$0**	**$0**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$2,479,904.25	-$2,561,785.53	-$2,645,304.44	-$2,730,493.73	-$2,817,386.81	-$2,906,017.74	-$2,996,421.30	-$3,088,632.92	-$3,182,688.78	-$3,278,625.76	-$3,376,481.47	-$3,476,294.30	-$3,578,103.39	-$3,681,948.66	-$3,787,870.83	-$3,895,911.45	-$4,006,112.88
-$4,149,064.25	**-$4,230,945.53**	**-$4,314,464.44**	**-$4,399,653.73**	**-$4,486,546.81**	**-$4,575,177.74**	**-$4,665,581.30**	**-$4,757,792.92**	**-$4,851,848.78**	**-$4,947,785.76**	**-$5,045,641.47**	**-$5,145,454.30**	**-$5,247,263.39**	**-$5,351,108.66**	**-$5,457,030.83**	**-$5,565,071.45**	**-$5,675,272.88**
$ 9,306,624	$ 9,403,568	$ 9,500,512	$ 9,597,456	$ 9,694,400	$ 9,791,344	$ 9,888,288	$ 9,985,232	$ 10,082,176	$ 10,179,120	$ 10,276,064	$ 10,373,008	$ 10,469,952	$ 10,566,896	$ 10,663,840	$ 10,760,784	$ 10,857,728
$ 9,306,624	**$ 9,403,568**	**$ 9,500,512**	**$ 9,597,456**	**$ 9,694,400**	**$ 9,791,344**	**$ 9,888,288**	**$ 9,985,232**	**$ 10,082,176**	**$ 10,179,120**	**$ 10,276,064**	**$ 10,373,008**	**$ 10,469,952**	**$ 10,566,896**	**$ 10,663,840**	**$ 10,760,784**	**$ 10,857,728**
$5,157,560	**$7,152,622**	**$5,186,048**	**$6,128,841**	**$5,207,853**	**$5,216,166**	**$5,222,707**	**$7,207,439**	**$6,161,366**	**$5,231,334**	**$5,230,423**	**$5,227,554**	**$5,222,689**	**$8,126,827**	**$5,206,809**	**$5,195,713**	**$5,182,455**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-4,149,064.25	-4,230,945.53	-4,314,464.44	-4,399,653.73	-4,486,546.81	-4,575,177.74	-4,665,581.30	-4,757,792.92	-4,851,848.78	-4,947,785.76	-5,045,641.47	-5,145,454.30	-5,247,263.39	-5,351,108.66	-5,457,030.83	-5,565,071.45	-5,675,272.88
9,306,624.00	9,403,568.00	9,500,512.00	9,597,456.00	9,694,400.00	9,791,344.00	9,888,288.00	9,985,232.00	10,082,176.00	10,179,120.00	10,276,064.00	10,373,008.00	10,469,952.00	10,566,896.00	10,663,840.00	10,760,784.00	10,857,728.00
-1,547,267.93	**-1,551,786.74**	**-1,555,814.27**	**-1,559,340.68**	**-1,562,355.96**	**-1,564,849.88**	**-1,566,812.01**	**-1,568,231.72**	**-1,569,098.17**	**-1,569,400.27**	**-1,569,126.76**	**-1,568,266.11**	**-1,566,806.58**	**-1,564,736.20**	**-1,562,042.75**	**-1,558,713.77**	**-1,554,736.54**
3,610,291.83	**5,600,835.73**	**3,630,233.29**	**4,569,500.79**	**3,645,497.23**	**3,651,316.38**	**3,655,894.69**	**5,639,207.35**	**4,592,268.25**	**3,661,933.97**	**3,661,295.77**	**3,659,287.59**	**3,655,882.03**	**6,562,090.34**	**3,644,766.42**	**3,636,998.79**	**3,627,718.59**
1,105,518.63	**1,672,402.97**	**1,057,029.15**	**1,297,434.74**	**1,009,340.90**	**985,813.82**	**962,506.01**	**1,447,745.32**	**1,149,650.12**	**893,950.12**	**871,569.30**	**849,430.77**	**827,538.02**	**1,448,446.05**	**784,502.18**	**763,364.47**	**742,483.34**
11,831,641.56	**13,504,044.52**	**14,561,073.67**	**15,858,508.41**	**16,867,849.31**	**17,853,663.13**	**18,816,169.13**	**20,263,914.45**	**21,413,564.58**	**22,307,514.69**	**23,179,084.00**	**24,028,514.77**	**24,856,052.79**	**26,304,498.83**	**27,089,001.01**	**27,852,365.49**	**28,594,848.83**

2067	2068	2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.22	$3.25	$3.29	$3.32	$3.35	$3.39	$3.42	$3.45	$3.49	$3.52	$3.55	$3.59	$3.62	$3.65	$3.69	$3.72	$3.75
2.15	2.17	2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.37	2.39	2.41	2.43	2.46	2.48	2.50

64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
2084	**2085**	**2086**	**2087**	**2088**	**2089**	**2090**	**2091**	**2092**	**2093**	**2094**	**2095**	**2096**	**2097**	**2098**	**2099**	**2100**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0
$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039
$0	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$4,118,518.33	-$4,233,171.90	-$4,350,118.54	-$4,469,404.11	-$4,591,075.39	-$4,715,180.10	-$4,841,766.90	-$4,970,885.44	-$5,102,586.35	-$5,236,921.27	-$5,373,942.90	-$5,513,704.96	-$5,656,262.26	-$5,801,670.70	-$5,949,987.32	-$6,101,270.26	-$6,255,578.87
-$5,787,678.33	**-$5,902,331.90**	**-$6,019,278.54**	**-$6,138,564.11**	**-$6,260,235.39**	**-$6,384,340.10**	**-$6,510,926.90**	**-$6,640,045.44**	**-$6,771,746.35**	**-$6,906,081.27**	**-$7,043,102.90**	**-$7,182,864.96**	**-$7,325,422.26**	**-$7,470,830.70**	**-$7,619,147.32**	**-$7,770,430.26**	**-$7,924,738.87**
$ 10,954,672	$ 11,051,616	$ 11,148,560	$ 11,245,504	$ 11,342,448	$ 11,439,392	$ 11,536,336	$ 11,633,280	$ 11,730,224	$ 11,827,168	$ 11,924,112	$ 12,021,056	$ 12,118,000	$ 12,214,944	$ 12,311,888	$ 12,408,832	$ 12,505,776
$ 10,954,672	**$ 11,051,616**	**$ 11,148,560**	**$ 11,245,504**	**$ 11,342,448**	**$ 11,439,392**	**$ 11,536,336**	**$ 11,633,280**	**$ 11,730,224**	**$ 11,827,168**	**$ 11,924,112**	**$ 12,021,056**	**$ 12,118,000**	**$ 12,214,944**	**$ 12,311,888**	**$ 12,408,832**	**$ 12,505,776**
$5,166,994	**$6,080,323**	**$7,109,281**	**$5,106,940**	**$5,082,213**	**$5,055,052**	**$5,956,448**	**$4,993,235**	**$6,938,478**	**$4,921,087**	**$4,881,009**	**$5,769,230**	**$4,792,578**	**$4,744,113**	**$6,672,741**	**$4,638,402**	**$5,512,076**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-5,787,678.33	-5,902,331.90	-6,019,278.54	-6,138,564.11	-6,260,235.39	-6,384,340.10	-6,510,926.90	-6,640,045.44	-6,771,746.35	-6,906,081.27	-7,043,102.90	-7,182,864.96	-7,325,422.26	-7,470,830.70	-7,619,147.32	-7,770,430.26	-7,924,738.87
10,954,672.00	11,051,616.00	11,148,560.00	11,245,504.00	11,342,448.00	11,439,392.00	11,536,336.00	11,633,280.00	11,730,224.00	11,827,168.00	11,924,112.00	12,021,056.00	12,118,000.00	12,214,944.00	12,311,888.00	12,408,832.00	12,505,776.00
-1,550,098.10	**-1,544,785.23**	**-1,538,784.44**	**-1,532,081.97**	**-1,524,663.78**	**-1,516,515.57**	**-1,507,622.73**	**-1,497,970.37**	**-1,487,543.30**	**-1,476,326.02**	**-1,464,302.73**	**-1,451,457.31**	**-1,437,773.32**	**-1,423,233.99**	**-1,407,822.21**	**-1,391,520.52**	**-1,374,311.14**
3,616,895.57	**4,535,538.07**	**5,570,497.02**	**3,574,857.92**	**3,557,548.83**	**3,538,536.33**	**4,448,825.57**	**3,495,264.19**	**5,450,934.36**	**3,444,760.71**	**3,416,706.37**	**4,317,772.93**	**3,354,804.42**	**3,320,879.31**	**5,264,918.48**	**3,246,881.22**	**4,137,765.19**
721,860.75	**882,694.89**	**1,057,158.43**	**661,560.02**	**641,986.17**	**622,676.96**	**763,394.19**	**584,854.47**	**889,412.22**	**548,094.62**	**530,113.02**	**653,258.31**	**494,944.71**	**477,756.84**	**738,600.85**	**444,169.66**	**551,966.43**
29,316,709.58	**30,199,404.46**	**31,256,562.89**	**31,918,122.91**	**32,560,109.08**	**33,182,786.03**	**33,946,180.22**	**34,531,034.69**	**35,420,446.91**	**35,968,541.53**	**36,498,654.55**	**37,151,912.86**	**37,646,857.57**	**38,124,614.41**	**38,863,215.26**	**39,307,384.92**	**39,859,351.35**

2084	2085	2086	2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.78	$3.82	$3.85	$3.88	$3.92	$3.95	$3.98	$4.02	$4.05	$4.08	$4.12	$4.15	$4.18	$4.22	$4.25	$4.28	$4.32
2.52	2.55	2.57	2.59	2.61	2.63	2.66	2.68	2.70	2.72	2.74	2.77	2.79	2.81	2.83	2.86	2.88

SCENARIO 1: 5ML INSTALL, ADDITIONAL 5ML IN 2035

Net Cash Flow

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Net Capital Costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Capital Cost - SeaPak 2500	-47,000,000.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replacement of UF Modules every 6 years	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replacement of RO Modules every 5 years	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Total Capital	**-$47,000,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
Operating and Maintenance Costs													
Electricity		-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
Preservation Chemicals & Consumables		-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00
Labour (Operation)		-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
Labour (Maintenance & Management)		-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
Product support		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Environmental Monitoring		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Water Quality Monitoring		$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Escalation of Costs (CPI Adjusted)		-$9,900.00	-$19,998.00	-$30,297.96	-$40,803.92	-$51,520.00	-$62,450.40	-$73,599.41	-$84,971.39	-$96,570.82	-$108,402.24	-$120,470.28	-$132,779.69
Total Costs	**$ -**	**-$504,900.00**	**-$514,998.00**	**-$525,297.96**	**-$535,803.92**	**-$546,520.00**	**-$557,450.40**	**-$568,599.41**	**-$579,971.39**	**-$591,570.82**	**-$603,402.24**	**-$615,470.28**	**-$627,779.69**
Revenue and Operating Benefits													
New Revenue (CPI Adjusted)		$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Total Benefits and Revenue	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
Cash Flow Before Taxes	**-$47,000,000**	**-$504,900**	**-$514,998**	**-$525,298**	**-$535,804**	**-$546,520**	**-$557,450**	**-$568,599**	**-$579,971**	**-$591,571**	**-$603,402**	**-$615,470**	**-$627,780**
Income Tax Calculation													
Depreciation Expense		4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	0.00	0.00
Operating Cost		-504,900.00	-514,998.00	-525,297.96	-535,803.92	-546,520.00	-557,450.40	-568,599.41	-579,971.39	-591,570.82	-603,402.24	-615,470.28	-627,779.69
Operating Benefits		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net Income Taxes	**$ -**	**-1,258,530.00**	**-1,255,500.60**	**-1,252,410.61**	**-1,249,258.82**	**-1,246,044.00**	**-1,242,764.88**	**-1,239,420.18**	**-1,236,008.58**	**-1,232,528.75**	**-1,228,979.33**	**184,641.08**	**188,333.91**
Cash Flow After Taxes	**-47,000,000.00**	**-1,763,430.00**	**-1,770,498.60**	**-1,777,708.57**	**-1,785,062.74**	**-1,792,564.00**	**-1,800,215.28**	**-1,808,019.58**	**-1,815,979.98**	**-1,824,099.58**	**-1,832,381.57**	**-430,829.20**	**-439,445.78**
Discounted Cash Flow (After Tax)	**-47,000,000.00**	**-1,719,580.69**	**-1,683,543.17**	**-1,648,365.71**	**-1,614,027.12**	**-1,580,506.72**	**-1,547,784.36**	**-1,515,840.40**	**-1,484,655.66**	**-1,454,211.45**	**-1,424,489.55**	**-326,597.47**	**-324,845.85**
Cumulative Cash Flow	**-47,000,000.00**	**-48,719,580.69**	**-50,403,123.87**	**-52,051,489.58**	**-53,665,516.70**	**-55,246,023.42**	**-56,793,807.78**	**-58,309,648.18**	**-59,794,303.84**	**-61,248,515.29**	**-62,673,004.83**	**-62,999,602.31**	**-63,324,448.16**

Business Case Results:

NPV of Cash Flow	**-$81,775,805**
IRR	**#NUM!**
Profitability Index	**(0.74)**

Assumptions:		**Source**
CPI Rate	2.00%	GANDEN estimate
Benefit Escalation Factor	10.00%	GANDEN estimate
Income Tax Rate	30.00%	GANDEN estimate
Discounted cash flow Rate	2.55%	Provided by Council
Electrical cost (per kWh)	$0.10	Provided by Council
Operator / Maintainer Hourly Rate (includes 72.5% oncosts)	$69.00	Provided by Council
Water price per kl	$1.66	Provided by Rous
Peaking factor	80%	GANDEN estimate
Membrane Replacement		
Membrane UF Life	6.00	Years, SUEZ Example
Membrane UF Replacement Cost	$ 495,000.00	Per train (2.5MLD), including delivery and installation (Suez email)
Membrane RO Life	5.00	Years, SUEZ Example
Membrane RO Replacement Cost	$ 232,759.80	Per train (2.5MLD), including delivery and installation (Suez email)
USD to AUD conversion rate	$1.59	AUD to USD. Accessed 21/04/2020

Operating costs

Fixed costs	Operation Annual Salary + OH x 2	$ 240,000.00
	Maintenance Annual Salary + OH x 1	$ 120,000.00
	Management Annual Salary	$ 75,000.00
Montly variable costs	Chemicals ($/kl)	$0.12
	Consumables ($/kl)	$0.03
	Power (kwh/kl)	4

Energy Usage per Annum	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant Ultimate Capacity (kL per day)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Adjusted at 80% production volume	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Water price (per kL)	$1.66	$1.69	$1.73	$1.76	$1.79	$1.83	$1.86	$1.89	$1.93	$1.96	$1.99	$2.03	$2.06
Average estimated permeate production per annum kl	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.37

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2033	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
-$145,335.28	-$158,141.99	-$171,204.83	-$184,528.92	-$198,119.50	-$211,981.89	-$226,121.53	-$240,543.96	-$255,254.84	-$270,259.94	-$285,565.14	-$301,176.44	-$317,099.97	-$333,341.97	-$349,908.81	-$366,806.98	-$384,043.12	-$401,623.98
-$640,335.28	**-$653,141.99**	**-$666,204.83**	**-$679,528.92**	**-$693,119.50**	**-$706,981.89**	**-$721,121.53**	**-$735,543.96**	**-$750,254.84**	**-$765,259.94**	**-$780,565.14**	**-$796,176.44**	**-$812,099.97**	**-$828,341.97**	**-$844,908.81**	**-$861,806.98**	**-$879,043.12**	**-$896,623.98**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-$640,335	**-$653,142**	**-$666,205**	**-$679,529**	**-$693,120**	**-$706,982**	**-$721,122**	**-$735,544**	**-$750,255**	**-$765,260**	**-$780,565**	**-$796,176**	**-$812,100**	**-$828,342**	**-$844,909**	**-$861,807**	**-$879,043**	**-$896,624**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-640,335.28	-653,141.99	-666,204.83	-679,528.92	-693,119.50	-706,981.89	-721,121.53	-735,543.96	-750,254.84	-765,259.94	-780,565.14	-796,176.44	-812,099.97	-828,341.97	-844,908.81	-861,806.98	-879,043.12	-896,623.98
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
192,100.58	**195,942.60**	**199,861.45**	**203,858.68**	**207,935.85**	**212,094.57**	**216,336.46**	**220,663.19**	**225,076.45**	**229,577.98**	**234,169.54**	**238,852.93**	**243,629.99**	**248,502.59**	**253,472.64**	**258,542.09**	**263,712.94**	**268,987.20**
-448,234.70	**-457,199.39**	**-466,343.38**	**-475,670.25**	**-485,183.65**	**-494,887.32**	**-504,785.07**	**-514,880.77**	**-525,178.39**	**-535,681.96**	**-546,395.60**	**-557,323.51**	**-568,469.98**	**-579,839.38**	**-591,436.16**	**-603,264.89**	**-615,330.19**	**-627,636.79**
-323,103.63	**-321,370.74**	**-319,647.16**	**-317,932.81**	**-316,227.66**	**-314,531.66**	**-312,844.75**	**-311,166.89**	**-309,498.03**	**-307,838.12**	**-306,187.11**	**-304,544.95**	**-302,911.61**	**-301,287.02**	**-299,671.15**	**-298,063.94**	**-296,465.35**	**-294,875.34**
-63,647,551.78	**-63,968,922.52**	**-64,288,569.68**	**-64,606,502.49**	**-64,922,730.16**	**-65,237,261.82**	**-65,550,106.57**	**-65,861,273.46**	**-66,170,771.49**	**-66,478,609.60**	**-66,784,796.71**	**-67,089,341.67**	**-67,392,253.27**	**-67,693,540.29**	**-67,993,211.44**	**-68,291,275.38**	**-68,587,740.73**	**-68,882,616.07**

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$2.09	$2.12	$2.16	$2.19	$2.22	$2.26	$2.29	$2.32	$2.36	$2.39	$2.42	$2.46	$2.49	$2.52	$2.56	$2.59	$2.62	$2.66
1.39	1.42	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73	1.75	1.77

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
2051	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
-$419,556.46	-$437,847.59	-$456,504.54	-$475,534.64	-$494,945.33	-$514,744.24	-$534,939.12	-$555,537.90	-$576,548.66	-$597,979.63	-$619,839.23	-$642,136.01	-$664,878.73	-$688,076.31	-$711,737.83	-$735,872.59	-$760,490.04	-$785,599.84
-$914,556.46	**-$932,847.59**	**-$951,504.54**	**-$970,534.64**	**-$989,945.33**	**-$1,009,744.24**	**-$1,029,939.12**	**-$1,050,537.90**	**-$1,071,548.66**	**-$1,092,979.63**	**-$1,114,839.23**	**-$1,137,136.01**	**-$1,159,878.73**	**-$1,183,076.31**	**-$1,206,737.83**	**-$1,230,872.59**	**-$1,255,490.04**	**-$1,280,599.84**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-$914,556	**-$932,848**	**-$951,505**	**-$970,535**	**-$989,945**	**-$1,009,744**	**-$1,029,939**	**-$1,050,538**	**-$1,071,549**	**-$1,092,980**	**-$1,114,839**	**-$1,137,136**	**-$1,159,879**	**-$1,183,076**	**-$1,206,738**	**-$1,230,873**	**-$1,255,490**	**-$1,280,600**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-914,556.46	-932,847.59	-951,504.54	-970,534.64	-989,945.33	-1,009,744.24	-1,029,939.12	-1,050,537.90	-1,071,548.66	-1,092,979.63	-1,114,839.23	-1,137,136.01	-1,159,878.73	-1,183,076.31	-1,206,737.83	-1,230,872.59	-1,255,490.04	-1,280,599.84
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
274,366.94	**279,854.28**	**285,451.36**	**291,160.39**	**296,983.60**	**302,923.27**	**308,981.74**	**315,161.37**	**321,464.60**	**327,893.89**	**334,451.77**	**341,140.80**	**347,963.62**	**354,922.89**	**362,021.35**	**369,261.78**	**376,647.01**	**384,179.95**
-640,189.52	**-652,993.32**	**-666,053.18**	**-679,374.25**	**-692,961.73**	**-706,820.96**	**-720,957.38**	**-735,376.53**	**-750,084.06**	**-765,085.74**	**-780,387.46**	**-795,995.21**	**-811,915.11**	**-828,153.41**	**-844,716.48**	**-861,610.81**	**-878,843.03**	**-896,419.89**
-293,293.85	**-291,720.85**	**-290,156.28**	**-288,600.10**	**-287,052.27**	**-285,512.74**	**-283,981.47**	**-282,458.41**	**-280,943.52**	**-279,436.75**	**-277,938.06**	**-276,447.42**	**-274,964.76**	**-273,490.06**	**-272,023.27**	**-270,564.34**	**-269,113.24**	**-267,669.93**
-69,175,909.92	**-69,467,630.76**	**-69,757,787.04**	**-70,046,387.14**	**-70,333,439.41**	**-70,618,952.16**	**-70,902,933.62**	**-71,185,392.03**	**-71,466,335.55**	**-71,745,772.30**	**-72,023,710.36**	**-72,300,157.78**	**-72,575,122.54**	**-72,848,612.60**	**-73,120,635.87**	**-73,391,200.22**	**-73,660,313.46**	**-73,927,983.39**

2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$2.69	$2.72	$2.76	$2.79	$2.82	$2.86	$2.89	$2.92	$2.95	$2.99	$3.02	$3.05	$3.09	$3.12	$3.15	$3.19	$3.22	$3.25
1.79	1.81	1.84	1.86	1.88	1.90	1.93	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.12	2.15	2.17

49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
2069	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**	**2077**	**2078**	**2079**	**2080**	**2081**	**2082**	**2083**	**2084**	**2085**	**2086**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
-$811,211.84	-$837,336.07	-$863,982.80	-$891,162.45	-$918,885.70	-$947,163.41	-$976,006.68	-$1,005,426.82	-$1,035,435.35	-$1,066,044.06	-$1,097,264.94	-$1,129,110.24	-$1,161,592.45	-$1,194,724.29	-$1,228,518.78	-$1,262,989.16	-$1,298,148.94	-$1,334,011.92
-$1,306,211.84	**-$1,332,336.07**	**-$1,358,982.80**	**-$1,386,162.45**	**-$1,413,885.70**	**-$1,442,163.41**	**-$1,471,006.68**	**-$1,500,426.82**	**-$1,530,435.35**	**-$1,561,044.06**	**-$1,592,264.94**	**-$1,624,110.24**	**-$1,656,592.45**	**-$1,689,724.29**	**-$1,723,518.78**	**-$1,757,989.16**	**-$1,793,148.94**	**-$1,829,011.92**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-$1,306,212	**-$1,332,336**	**-$1,358,983**	**-$1,386,162**	**-$1,413,886**	**-$1,442,163**	**-$1,471,007**	**-$1,500,427**	**-$1,530,435**	**-$1,561,044**	**-$1,592,265**	**-$1,624,110**	**-$1,656,592**	**-$1,689,724**	**-$1,723,519**	**-$1,757,989**	**-$1,793,149**	**-$1,829,012**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-1,306,211.84	-1,332,336.07	-1,358,982.80	-1,386,162.45	-1,413,885.70	-1,442,163.41	-1,471,006.68	-1,500,426.82	-1,530,435.35	-1,561,044.06	-1,592,264.94	-1,624,110.24	-1,656,592.45	-1,689,724.29	-1,723,518.78	-1,757,989.16	-1,793,148.94	-1,829,011.92
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
391,863.55	**399,700.82**	**407,694.84**	**415,848.74**	**424,165.71**	**432,649.02**	**441,302.00**	**450,128.05**	**459,130.61**	**468,313.22**	**477,679.48**	**487,233.07**	**496,977.73**	**506,917.29**	**517,055.63**	**527,396.75**	**537,944.68**	**548,703.58**
-914,348.29	**-932,635.25**	**-951,287.96**	**-970,313.72**	**-989,719.99**	**-1,009,514.39**	**-1,029,704.68**	**-1,050,298.77**	**-1,071,304.75**	**-1,092,730.84**	**-1,114,585.46**	**-1,136,877.17**	**-1,159,614.71**	**-1,182,807.01**	**-1,206,463.15**	**-1,230,592.41**	**-1,255,204.26**	**-1,280,308.34**
-266,234.35	**-264,806.47**	**-263,386.25**	**-261,973.65**	**-260,568.62**	**-259,171.13**	**-257,781.13**	**-256,398.59**	**-255,023.46**	**-253,655.71**	**-252,295.30**	**-250,942.18**	**-249,596.32**	**-248,257.67**	**-246,926.21**	**-245,601.88**	**-244,284.66**	**-242,974.50**
-74,194,217.73	**-74,459,024.20**	**-74,722,410.45**	**-74,984,384.10**	**-75,244,952.72**	**-75,504,123.85**	**-75,761,904.98**	**-76,018,303.57**	**-76,273,327.04**	**-76,526,982.75**	**-76,779,278.05**	**-77,030,220.23**	**-77,279,816.54**	**-77,528,074.21**	**-77,775,000.42**	**-78,020,602.30**	**-78,264,886.96**	**-78,507,861.46**

2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$3.29	$3.32	$3.35	$3.39	$3.42	$3.45	$3.49	$3.52	$3.55	$3.59	$3.62	$3.65	$3.69	$3.72	$3.75	$3.78	$3.82	$3.85
2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.37	2.39	2.41	2.43	2.46	2.48	2.50	2.52	2.55	2.57

67	68	69	70	71	72	73	74	75	76	77	78	79	80	Totals
2087	**2088**	**2089**	**2090**	**2091**	**2092**	**2093**	**2094**	**2095**	**2096**	**2097**	**2098**	**2099**	**2100**	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-$47,000,000
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**-$47,000,000**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	**$ (800,000)**
-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	-$50,000.00	**$ (4,000,000)**
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	**$ (19,200,000)**
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	**$ (15,600,000)**
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$ -**
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$ -**
$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	**$ -**
-$1,370,592.16	-$1,407,904.00	-$1,445,962.08	-$1,484,781.32	-$1,524,376.95	-$1,564,764.49	-$1,605,959.78	-$1,647,978.97	-$1,690,838.55	-$1,734,555.32	-$1,779,146.43	-$1,824,629.36	-$1,871,021.94	-$1,918,342.38	**$ (58,235,461)**
-$1,865,592.16	**-$1,902,904.00**	**-$1,940,962.08**	**-$1,979,781.32**	**-$2,019,376.95**	**-$2,059,764.49**	**-$2,100,959.78**	**-$2,142,978.97**	**-$2,185,838.55**	**-$2,229,555.32**	**-$2,274,146.43**	**-$2,319,629.36**	**-$2,366,021.94**	**-$2,413,342.38**	**$ (97,835,461)**
$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
$ -	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
-$1,865,592	**-$1,902,904**	**-$1,940,962**	**-$1,979,781**	**-$2,019,377**	**-$2,059,764**	**-$2,100,960**	**-$2,142,979**	**-$2,185,839**	**-$2,229,555**	**-$2,274,146**	**-$2,319,629**	**-$2,366,022**	**-$2,413,342**	**$ (144,835,461)**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47,000,000.00
-1,865,592.16	-1,902,904.00	-1,940,962.08	-1,979,781.32	-2,019,376.95	-2,059,764.49	-2,100,959.78	-2,142,978.97	-2,185,838.55	-2,229,555.32	-2,274,146.43	-2,319,629.36	-2,366,021.94	-2,413,342.38	-97,835,461.50
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
559,677.65	**570,871.20**	**582,288.62**	**593,934.40**	**605,813.08**	**617,929.35**	**630,287.93**	**642,893.69**	**655,751.57**	**668,866.60**	**682,243.93**	**695,888.81**	**709,806.58**	**724,002.71**	**15,250,638.45**
-1,305,914.51	**-1,332,032.80**	**-1,358,673.46**	**-1,385,846.92**	**-1,413,563.86**	**-1,441,835.14**	**-1,470,671.84**	**-1,500,085.28**	**-1,530,086.99**	**-1,560,688.72**	**-1,591,902.50**	**-1,623,740.55**	**-1,656,215.36**	**-1,689,339.67**	**-129,584,823.05**
-241,671.37	**-240,375.23**	**-239,086.04**	**-237,803.77**	**-236,528.37**	**-235,259.81**	**-233,998.06**	**-232,743.07**	**-231,494.82**	**-230,253.25**	**-229,018.35**	**-227,790.07**	**-226,568.38**	**-225,353.24**	**-81,775,805.30**
-78,749,532.84	**-78,989,908.07**	**-79,228,994.12**	**-79,466,797.88**	**-79,703,326.26**	**-79,938,586.07**	**-80,172,584.13**	**-80,405,327.20**	**-80,636,822.01**	**-80,867,075.27**	**-81,096,093.62**	**-81,323,883.69**	**-81,550,452.07**	**-81,775,805.30**	

2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
$3.88	$3.92	$3.95	$3.98	$4.02	$4.05	$4.08	$4.12	$4.15	$4.18	$4.22	$4.25	$4.28	$4.32
2.59	2.61	2.63	2.66	2.68	2.70	2.72	2.74	2.77	2.79	2.81	2.83	2.86	2.88

SCENARIO 3: 5ML INSTALL, ADDITIONAL 5ML IN 2025

Net Cash Flow

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Net Capital Costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Capital Cost - SeaPak 2500	-47,000,000.00	$0	$0	$0	$0	-$7,000,000	$0	$0	$0	$0	$0	$0	$0
Replacement of UF Modules every 6 years	$0	$0	$0	$0	$0	$0	$990,000	$0	$0	$0	$0	$0	$1,980,000
Replacement of RO Modules every 5 years	$0	$0	$0	$0	$0	$465,520	$0	$0	$0	$0	$931,039	$0	$0
Total Capital	**-$47,000,000**	**$0**	**$0**	**$0**	**$0**	**-$6,534,480**	**$990,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**
Operating and Maintenance Costs													
Electricity		-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$584,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
Membrane Replacement (included in capital expenditure)													
Chemical consumption (based on Reverse Osmosis)		-$480.00	-$480.00	-$480.00	-$480.00	-$480.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
Consumables		-$100.00	-$100.00	-$100.00	-$100.00	-$100.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
Labour (Operation)		-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
Labour (Maintenance & Management)		-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
Product support		-$100,000.00	-$75,000.00	-$50,000.00	-$25,000.00	-$25,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
Environmental Monitoring		-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
Water Quality Monitoring		-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
Escalation of Costs (CPI Adjusted)		-$22,391.60	-$44,221.03	-$65,466.85	-$86,106.99	-$108,720.73	-$203,646.33	-$240,002.46	-$277,085.71	-$314,910.62	-$353,492.03	-$392,845.07	-$432,985.18
Total Costs	**$ -**	**-$1,196,971.60**	**-$1,193,801.03**	**-$1,190,046.85**	**-$1,185,686.99**	**-$1,208,300.73**	**-$1,872,806.33**	**-$1,909,162.46**	**-$1,946,245.71**	**-$1,984,070.62**	**-$2,022,652.03**	**-$2,062,005.07**	**-$2,102,145.18**
Revenue and Operating Benefits													
New Revenue (CPI Adjusted)		$ 2,423,600	$ 2,472,072	$ 2,520,544	$ 2,569,016	$ 2,617,488	$ 5,331,920	$ 5,428,864	$ 5,525,808	$ 5,622,752	$ 5,719,696	$ 5,816,640	$ 5,913,584
Total Benefits and Revenue	**$ -**	**$ 2,423,600**	**$ 2,472,072**	**$ 2,520,544**	**$ 2,569,016**	**$ 2,617,488**	**$ 5,331,920**	**$ 5,428,864**	**$ 5,525,808**	**$ 5,622,752**	**$ 5,719,696**	**$ 5,816,640**	**$ 5,913,584**
Cash Flow Before Taxes	**-$47,000,000**	**$1,226,628**	**$1,278,271**	**$1,330,497**	**$1,383,329**	**-$5,125,293**	**$4,449,114**	**$3,519,702**	**$3,579,562**	**$3,638,681**	**$4,628,083**	**$3,754,635**	**$5,791,439**
Income Tax Calculation													
Depreciation Expense		4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	4,700,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	0.00	0.00
Operating Cost		-1,196,971.60	-1,193,801.03	-1,190,046.85	-1,185,686.99	-1,208,300.73	-1,872,806.33	-1,909,162.46	-1,946,245.71	-1,984,070.62	-2,022,652.03	-2,062,005.07	-2,102,145.18
Operating Benefits		2,423,600.00	2,472,072.00	2,520,544.00	2,569,016.00	2,617,488.00	5,331,920.00	5,428,864.00	5,525,808.00	5,622,752.00	5,719,696.00	5,816,640.00	5,913,584.00
Net Income Taxes	**$ -**	**-1,777,988.52**	**-1,793,481.29**	**-1,809,149.14**	**-1,824,998.70**	**-1,832,756.18**	**-2,657,734.10**	**-2,675,910.46**	**-2,693,868.69**	**-2,711,604.41**	**-2,729,113.19**	**-1,126,390.48**	**-1,143,431.65**
Cash Flow After Taxes	**-47,000,000.00**	**-551,360.12**	**-515,210.32**	**-478,652.00**	**-441,669.69**	**-6,958,049.31**	**1,791,379.57**	**843,791.08**	**885,693.61**	**927,076.97**	**1,898,969.98**	**2,628,244.45**	**4,648,007.18**
Discounted Cash Flow (After Tax)	**-47,000,000.00**	**-537,650.04**	**-489,906.53**	**-443,826.14**	**-399,351.15**	**-6,134,923.88**	**1,540,187.62**	**707,432.94**	**724,099.41**	**739,085.71**	**1,476,255.24**	**1,992,385.83**	**3,435,886.54**
Cumulative Cash Flow	**-47,000,000.00**	**-47,537,650.04**	**-48,027,556.57**	**-48,471,382.72**	**-48,870,733.86**	**-55,005,657.74**	**-53,465,470.12**	**-52,758,037.18**	**-52,033,937.78**	**-51,294,852.06**	**-49,818,596.83**	**-47,826,211.00**	**-44,390,324.46**

Business Case Results:

NPV of Cash Flow	**$45,307,916**
IRR	**4.5%**
Profitability Index	**1.96**

Assumptions:		**Source**
CPI Rate	2.00%	GANDEN estimate
Benefit Escalation Factor	10.00%	GANDEN estimate
Income Tax Rate	30.00%	GANDEN estimate
Discounted cash flow Rate	2.55%	Provided by Council
Electrical cost (per kWh)	$0.10	Provided by Council
Operator / Maintainer Hourly Rate (includes 72.5% oncosts)	$69.00	Provided by Council
Water price per kl	$1.66	Provided by Rous
Peaking factor	80%	GANDEN estimate
Membrane Replacement		
Membrane UF Life	6.00	Years, SUEZ Example
Membrane UF Replacement Cost	$ 495,000.00	Per train (2.5MLD), including delivery and installation (Suez email)
Membrane RO Life	5.00	Years, SUEZ Example
Membrane RO Replacement Cost	$ 232,759.80	Per train (2.5MLD), including delivery and installation (Suez email)
USD to AUD conversion rate	$1.59	AUD to USD. Accessed 21/04/2020

Operating costs

Fixed costs	Operation Annual Salary + OH x 2	$ 240,000.00
	Maintenance Annual Salary + OH x 1	$ 120,000.00
	Management Annual Salary	$ 75,000.00
Montly variable costs	Chemicals ($/kl)	$0.12
	Consumables ($/kl	$0.03
	Power (kwh/kl)	4

Energy Usage per Annum	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant Ultimate Capacity (kL per day)	5000.00	5000.00	5000.00	5000.00	5000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
Adjusted at 80% production volume	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**4000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
Water price (per kL)	$1.66	$1.69	$1.73	$1.76	$1.79	$1.83	$1.86	$1.89	$1.93	$1.96	$1.99	$2.03	$2.06
Average estimated permeate production per annum kl	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.37

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2033	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039
$0	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$473,928.08	-$515,689.84	-$558,286.84	-$601,735.77	-$646,053.69	-$691,257.96	-$737,366.32	-$784,396.85	-$832,367.99	-$881,298.55	-$931,207.72	-$982,115.07	-$1,034,040.57	-$1,087,004.58	-$1,141,027.88	-$1,196,131.63	-$1,252,337.47	-$1,309,667.41
-$2,143,088.08	**-$2,184,849.84**	**-$2,227,446.84**	**-$2,270,895.77**	**-$2,315,213.69**	**-$2,360,417.96**	**-$2,406,526.32**	**-$2,453,556.85**	**-$2,501,527.99**	**-$2,550,458.55**	**-$2,600,367.72**	**-$2,651,275.07**	**-$2,703,200.57**	**-$2,756,164.58**	**-$2,810,187.88**	**-$2,865,291.63**	**-$2,921,497.47**	**-$2,978,827.41**
$ 6,010,528	$ 6,107,472	$ 6,204,416	$ 6,301,360	$ 6,398,304	$ 6,495,248	$ 6,592,192	$ 6,689,136	$ 6,786,080	$ 6,883,024	$ 6,979,968	$ 7,076,912	$ 7,173,856	$ 7,270,800	$ 7,367,744	$ 7,464,688	$ 7,561,632	$ 7,658,576
$ 6,010,528	**$ 6,107,472**	**$ 6,204,416**	**$ 6,301,360**	**$ 6,398,304**	**$ 6,495,248**	**$ 6,592,192**	**$ 6,689,136**	**$ 6,786,080**	**$ 6,883,024**	**$ 6,979,968**	**$ 7,076,912**	**$ 7,173,856**	**$ 7,270,800**	**$ 7,367,744**	**$ 7,464,688**	**$ 7,561,632**	**$ 7,658,576**
$3,867,440	**$3,922,622**	**$4,908,008**	**$4,030,464**	**$4,083,090**	**$6,114,830**	**$4,185,666**	**$5,166,618**	**$4,284,552**	**$4,332,565**	**$4,379,600**	**$6,405,637**	**$5,401,695**	**$4,514,635**	**$4,557,556**	**$4,599,396**	**$4,640,135**	**$7,590,788**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-2,143,088.08	-2,184,849.84	-2,227,446.84	-2,270,895.77	-2,315,213.69	-2,360,417.96	-2,406,526.32	-2,453,556.85	-2,501,527.99	-2,550,458.55	-2,600,367.72	-2,651,275.07	-2,703,200.57	-2,756,164.58	-2,810,187.88	-2,865,291.63	-2,921,497.47	-2,978,827.41
6,010,528.00	6,107,472.00	6,204,416.00	6,301,360.00	6,398,304.00	6,495,248.00	6,592,192.00	6,689,136.00	6,786,080.00	6,883,024.00	6,979,968.00	7,076,912.00	7,173,856.00	7,270,800.00	7,367,744.00	7,464,688.00	7,561,632.00	7,658,576.00
-1,160,231.98	**-1,176,786.65**	**-1,193,090.75**	**-1,209,139.27**	**-1,224,927.09**	**-1,240,449.01**	**-1,255,699.70**	**-1,270,673.75**	**-1,285,365.60**	**-1,299,769.64**	**-1,313,880.09**	**-1,327,691.08**	**-1,341,196.63**	**-1,354,390.62**	**-1,367,266.84**	**-1,379,818.91**	**-1,392,040.36**	**-1,403,924.58**
2,707,207.94	**2,745,835.51**	**3,714,917.61**	**2,821,324.96**	**2,858,163.22**	**4,874,381.03**	**2,929,965.97**	**3,895,944.61**	**2,999,186.41**	**3,032,795.82**	**3,065,720.20**	**5,077,945.85**	**4,060,498.00**	**3,160,244.79**	**3,190,289.29**	**3,219,577.46**	**3,248,094.17**	**6,186,863.21**
1,951,452.46	**1,930,079.56**	**2,546,327.24**	**1,885,742.88**	**1,862,862.18**	**3,097,972.15**	**1,815,870.81**	**2,354,504.25**	**1,767,479.97**	**1,742,844.13**	**1,717,956.75**	**2,774,802.73**	**2,163,653.36**	**1,642,076.71**	**1,616,468.03**	**1,590,743.90**	**1,564,927.91**	**2,906,702.42**
-42,438,872.01	**-40,508,792.45**	**-37,962,465.20**	**-36,076,722.33**	**-34,213,860.15**	**-31,115,887.99**	**-29,300,017.18**	**-26,945,512.93**	**-25,178,032.96**	**-23,435,188.83**	**-21,717,232.07**	**-18,942,429.35**	**-16,778,775.99**	**-15,136,699.28**	**-13,520,231.25**	**-11,929,487.35**	**-10,364,559.44**	**-7,457,857.02**

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.09	$2.12	$2.16	$2.19	$2.22	$2.26	$2.29	$2.32	$2.36	$2.39	$2.42	$2.46	$2.49	$2.52	$2.56	$2.59	$2.62	$2.66
1.39	1.42	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73	1.75	1.77

31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
2051	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**	**2060**	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$1,368,143.96	-$1,427,790.04	-$1,488,629.04	-$1,550,684.82	-$1,613,981.72	-$1,678,544.55	-$1,744,398.65	-$1,811,569.82	-$1,880,084.42	-$1,949,969.30	-$2,021,251.89	-$2,093,960.13	-$2,168,122.53	-$2,243,768.18	-$2,320,926.74	-$2,399,628.48	-$2,479,904.25	-$2,561,785.53
-$3,037,303.96	**-$3,096,950.04**	**-$3,157,789.04**	**-$3,219,844.82**	**-$3,283,141.72**	**-$3,347,704.55**	**-$3,413,558.65**	**-$3,480,729.82**	**-$3,549,244.42**	**-$3,619,129.30**	**-$3,690,411.89**	**-$3,763,120.13**	**-$3,837,282.53**	**-$3,912,928.18**	**-$3,990,086.74**	**-$4,068,788.48**	**-$4,149,064.25**	**-$4,230,945.53**
$ 7,755,520	$ 7,852,464	$ 7,949,408	$ 8,046,352	$ 8,143,296	$ 8,240,240	$ 8,337,184	$ 8,434,128	$ 8,531,072	$ 8,628,016	$ 8,724,960	$ 8,821,904	$ 8,918,848	$ 9,015,792	$ 9,112,736	$ 9,209,680	$ 9,306,624	$ 9,403,568
$ 7,755,520	**$ 7,852,464**	**$ 7,949,408**	**$ 8,046,352**	**$ 8,143,296**	**$ 8,240,240**	**$ 8,337,184**	**$ 8,434,128**	**$ 8,531,072**	**$ 8,628,016**	**$ 8,724,960**	**$ 8,821,904**	**$ 8,918,848**	**$ 9,015,792**	**$ 9,112,736**	**$ 9,209,680**	**$ 9,306,624**	**$ 9,403,568**
$4,718,216	**$4,755,514**	**$4,791,619**	**$4,826,507**	**$5,791,193**	**$6,872,535**	**$4,923,625**	**$4,953,398**	**$4,981,828**	**$5,939,926**	**$5,034,548**	**$7,038,784**	**$5,081,565**	**$5,102,864**	**$6,053,688**	**$5,140,892**	**$5,157,560**	**$7,152,622**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3,037,303.96	-3,096,950.04	-3,157,789.04	-3,219,844.82	-3,283,141.72	-3,347,704.55	-3,413,558.65	-3,480,729.82	-3,549,244.42	-3,619,129.30	-3,690,411.89	-3,763,120.13	-3,837,282.53	-3,912,928.18	-3,990,086.74	-4,068,788.48	-4,149,064.25	-4,230,945.53
7,755,520.00	7,852,464.00	7,949,408.00	8,046,352.00	8,143,296.00	8,240,240.00	8,337,184.00	8,434,128.00	8,531,072.00	8,628,016.00	8,724,960.00	8,821,904.00	8,918,848.00	9,015,792.00	9,112,736.00	9,209,680.00	9,306,624.00	9,403,568.00
-1,415,464.81	**-1,426,654.19**	**-1,437,485.69**	**-1,447,952.15**	**-1,458,046.28**	**-1,467,760.63**	**-1,477,087.61**	**-1,486,019.45**	**-1,494,548.28**	**-1,502,666.01**	**-1,510,364.43**	**-1,517,635.16**	**-1,524,469.64**	**-1,530,859.15**	**-1,536,794.78**	**-1,542,267.46**	**-1,547,267.93**	**-1,551,786.74**
3,302,751.23	**3,328,859.77**	**3,354,133.27**	**3,378,555.02**	**4,333,147.20**	**5,404,774.81**	**3,446,537.75**	**3,467,378.73**	**3,487,279.31**	**4,437,259.89**	**3,524,183.68**	**5,521,148.71**	**3,557,095.83**	**3,572,004.67**	**4,516,893.68**	**3,598,624.06**	**3,610,291.83**	**5,600,835.73**
1,513,109.15	**1,487,148.13**	**1,461,178.86**	**1,435,219.73**	**1,794,961.66**	**2,183,200.76**	**1,357,573.79**	**1,331,821.50**	**1,306,158.29**	**1,620,646.43**	**1,255,151.88**	**1,917,483.02**	**1,204,653.05**	**1,179,621.75**	**1,454,571.11**	**1,130,045.43**	**1,105,518.63**	**1,672,402.97**
-5,944,747.87	**-4,457,599.74**	**-2,996,420.88**	**-1,561,201.15**	**233,760.51**	**2,416,961.28**	**3,774,535.07**	**5,106,356.57**	**6,412,514.85**	**8,033,161.29**	**9,288,313.17**	**11,205,796.19**	**12,410,449.24**	**13,590,070.99**	**15,044,642.10**	**16,174,687.53**	**17,280,206.16**	**18,952,609.13**

2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
10000.00	10000.00	10000.00	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.69	$2.72	$2.76	$2.79	$2.82	$2.86	$2.89	$2.92	$2.95	$2.99	$3.02	$3.05	$3.09	$3.12	$3.15	$3.19	$3.22	$3.25
1.79	1.81	1.84	1.86	1.88	1.90	1.93	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.12	2.15	2.17

49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
2069	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**	**2077**	**2078**	**2079**	**2080**	**2081**	**2082**	**2083**	**2084**	**2085**	**2086**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0
$0	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**	**$0**	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$2,645,304.44	-$2,730,493.73	-$2,817,386.81	-$2,906,017.74	-$2,996,421.30	-$3,088,632.92	-$3,182,688.78	-$3,278,625.76	-$3,376,481.47	-$3,476,294.30	-$3,578,103.39	-$3,681,948.66	-$3,787,870.83	-$3,895,911.45	-$4,006,112.88	-$4,118,518.33	-$4,233,171.90	-$4,350,118.54
-$4,314,464.44	**-$4,399,653.73**	**-$4,486,546.81**	**-$4,575,177.74**	**-$4,665,581.30**	**-$4,757,792.92**	**-$4,851,848.78**	**-$4,947,785.76**	**-$5,045,641.47**	**-$5,145,454.30**	**-$5,247,263.39**	**-$5,351,108.66**	**-$5,457,030.83**	**-$5,565,071.45**	**-$5,675,272.88**	**-$5,787,678.33**	**-$5,902,331.90**	**-$6,019,278.54**
$ 9,500,512	$ 9,597,456	$ 9,694,400	$ 9,791,344	$ 9,888,288	$ 9,985,232	$ 10,082,176	$ 10,179,120	$ 10,276,064	$ 10,373,008	$ 10,469,952	$ 10,566,896	$ 10,663,840	$ 10,760,784	$ 10,857,728	$ 10,954,672	$ 11,051,616	$ 11,148,560
$ 9,500,512	**$ 9,597,456**	**$ 9,694,400**	**$ 9,791,344**	**$ 9,888,288**	**$ 9,985,232**	**$ 10,082,176**	**$ 10,179,120**	**$ 10,276,064**	**$ 10,373,008**	**$ 10,469,952**	**$ 10,566,896**	**$ 10,663,840**	**$ 10,760,784**	**$ 10,857,728**	**$ 10,954,672**	**$ 11,051,616**	**$ 11,148,560**
$5,186,048	**$6,128,841**	**$5,207,853**	**$5,216,166**	**$5,222,707**	**$7,207,439**	**$6,161,366**	**$5,231,334**	**$5,230,423**	**$5,227,554**	**$5,222,689**	**$8,126,827**	**$5,206,809**	**$5,195,713**	**$5,182,455**	**$5,166,994**	**$6,080,323**	**$7,109,281**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-4,314,464.44	-4,399,653.73	-4,486,546.81	-4,575,177.74	-4,665,581.30	-4,757,792.92	-4,851,848.78	-4,947,785.76	-5,045,641.47	-5,145,454.30	-5,247,263.39	-5,351,108.66	-5,457,030.83	-5,565,071.45	-5,675,272.88	-5,787,678.33	-5,902,331.90	-6,019,278.54
9,500,512.00	9,597,456.00	9,694,400.00	9,791,344.00	9,888,288.00	9,985,232.00	10,082,176.00	10,179,120.00	10,276,064.00	10,373,008.00	10,469,952.00	10,566,896.00	10,663,840.00	10,760,784.00	10,857,728.00	10,954,672.00	11,051,616.00	11,148,560.00
-1,555,814.27	**-1,559,340.68**	**-1,562,355.96**	**-1,564,849.88**	**-1,566,812.01**	**-1,568,231.72**	**-1,569,098.17**	**-1,569,400.27**	**-1,569,126.76**	**-1,568,266.11**	**-1,566,806.58**	**-1,564,736.20**	**-1,562,042.75**	**-1,558,713.77**	**-1,554,736.54**	**-1,550,098.10**	**-1,544,785.23**	**-1,538,784.44**
3,630,233.29	**4,569,500.79**	**3,645,497.23**	**3,651,316.38**	**3,655,894.69**	**5,639,207.35**	**4,592,268.25**	**3,661,933.97**	**3,661,295.77**	**3,659,287.59**	**3,655,882.03**	**6,562,090.34**	**3,644,766.42**	**3,636,998.79**	**3,627,718.59**	**3,616,895.57**	**4,535,538.07**	**5,570,497.02**
1,057,029.15	**1,297,434.74**	**1,009,340.90**	**985,813.82**	**962,506.01**	**1,447,745.32**	**1,149,650.12**	**893,950.12**	**871,569.30**	**849,430.77**	**827,538.02**	**1,448,446.05**	**784,502.18**	**763,364.47**	**742,483.34**	**721,860.75**	**882,694.89**	**1,057,158.43**
20,009,638.28	**21,307,073.01**	**22,316,413.92**	**23,302,227.73**	**24,264,733.74**	**25,712,479.06**	**26,862,129.18**	**27,756,079.30**	**28,627,648.60**	**29,477,079.37**	**30,304,617.39**	**31,753,063.44**	**32,537,565.62**	**33,300,930.09**	**34,043,413.43**	**34,765,274.18**	**35,647,969.07**	**36,705,127.49**

2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.29	$3.32	$3.35	$3.39	$3.42	$3.45	$3.49	$3.52	$3.55	$3.59	$3.62	$3.65	$3.69	$3.72	$3.75	$3.78	$3.82	$3.85
2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.37	2.39	2.41	2.43	2.46	2.48	2.50	2.52	2.55	2.57

67	68	69	70	71	72	73	74	75	76	77	78	79	80	Totals
2087	**2088**	**2089**	**2090**	**2091**	**2092**	**2093**	**2094**	**2095**	**2096**	**2097**	**2098**	**2099**	**2100**	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-$54,000,000
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$24,750,000
$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$14,431,108
$0	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**-$14,818,892**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	**$ (90,520,000)**
														$ -
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	**$ (74,400)**
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	**$ (15,500)**
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	**$ (19,200,000)**
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	**$ (15,600,000)**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	**$ (1,025,000)**
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	**$ (2,800,000)**
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	**$ (1,600,000)**
-$4,469,404.11	-$4,591,075.39	-$4,715,180.10	-$4,841,766.90	-$4,970,885.44	-$5,102,586.35	-$5,236,921.27	-$5,373,942.90	-$5,513,704.96	-$5,656,262.26	-$5,801,670.70	-$5,949,987.32	-$6,101,270.26	-$6,255,578.87	**$ (189,731,273)**
-$6,138,564.11	**-$6,260,235.39**	**-$6,384,340.10**	**-$6,510,926.90**	**-$6,640,045.44**	**-$6,771,746.35**	**-$6,906,081.27**	**-$7,043,102.90**	**-$7,182,864.96**	**-$7,325,422.26**	**-$7,470,830.70**	**-$7,619,147.32**	**-$7,770,430.26**	**-$7,924,738.87**	**$ (320,566,173)**
$ 11,245,504	$ 11,342,448	$ 11,439,392	$ 11,536,336	$ 11,633,280	$ 11,730,224	$ 11,827,168	$ 11,924,112	$ 12,021,056	$ 12,118,000	$ 12,214,944	$ 12,311,888	$ 12,408,832	$ 12,505,776	$ 681,516,320
$ 11,245,504	**$ 11,342,448**	**$ 11,439,392**	**$ 11,536,336**	**$ 11,633,280**	**$ 11,730,224**	**$ 11,827,168**	**$ 11,924,112**	**$ 12,021,056**	**$ 12,118,000**	**$ 12,214,944**	**$ 12,311,888**	**$ 12,408,832**	**$ 12,505,776**	**$ 681,516,320**
$5,106,940	**$5,082,213**	**$5,055,052**	**$5,956,448**	**$4,993,235**	**$6,938,478**	**$4,921,087**	**$4,881,009**	**$5,769,230**	**$4,792,578**	**$4,744,113**	**$6,672,741**	**$4,638,402**	**$5,512,076**	**$ 346,131,255**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50,500,000.00
-6,138,564.11	-6,260,235.39	-6,384,340.10	-6,510,926.90	-6,640,045.44	-6,771,746.35	-6,906,081.27	-7,043,102.90	-7,182,864.96	-7,325,422.26	-7,470,830.70	-7,619,147.32	-7,770,430.26	-7,924,738.87	-320,566,172.94
11,245,504.00	11,342,448.00	11,439,392.00	11,536,336.00	11,633,280.00	11,730,224.00	11,827,168.00	11,924,112.00	12,021,056.00	12,118,000.00	12,214,944.00	12,311,888.00	12,408,832.00	12,505,776.00	681,516,320.00
-1,532,081.97	**-1,524,663.78**	**-1,516,515.57**	**-1,507,622.73**	**-1,497,970.37**	**-1,487,543.30**	**-1,476,326.02**	**-1,464,302.73**	**-1,451,457.31**	**-1,437,773.32**	**-1,423,233.99**	**-1,407,822.21**	**-1,391,520.52**	**-1,374,311.14**	**-123,435,044.12**
3,574,857.92	**3,557,548.83**	**3,538,536.33**	**4,448,825.57**	**3,495,264.19**	**5,450,934.36**	**3,444,760.71**	**3,416,706.37**	**4,317,772.93**	**3,354,804.42**	**3,320,879.31**	**5,264,918.48**	**3,246,881.22**	**4,137,765.19**	**222,696,210.54**
661,560.02	**641,986.17**	**622,676.96**	**763,394.19**	**584,854.47**	**889,412.22**	**548,094.62**	**530,113.02**	**653,258.31**	**494,944.71**	**477,756.84**	**738,600.85**	**444,169.66**	**551,966.43**	**45,307,915.95**
37,366,687.51	**38,008,673.68**	**38,631,350.64**	**39,394,744.82**	**39,979,599.29**	**40,869,011.52**	**41,417,106.13**	**41,947,219.15**	**42,600,477.46**	**43,095,422.18**	**43,573,179.01**	**44,311,779.86**	**44,755,949.52**	**45,307,915.95**	

2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.88	$3.92	$3.95	$3.98	$4.02	$4.05	$4.08	$4.12	$4.15	$4.18	$4.22	$4.25	$4.28	$4.32
2.59	2.61	2.63	2.66	2.68	2.70	2.72	2.74	2.77	2.79	2.81	2.83	2.86	2.88

SCENARIO 4: 10ML INSTALL

Net Cash Flow

Year	0	1	2	3	4	5	6	7	8	9	10	11	12
Net Capital Costs	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**
Capital Cost - SeaPak 2500	-54,000,000.00	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Replacement of UF Modules every 6 years	$0	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
Replacement of RO Modules every 5 years	$0	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0
Total Capital	**-$54,000,000**	**$0**	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**
Operating and Maintenance Costs													
Electricity		-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
Membrane Replacement (included in capital expenditure)													
Chemical consumption (based on Reverse Osmosis)		-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
Consumables		-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
Labour (Operation)		-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
Labour (Maintenance & Management)		-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
Product support		-$100,000.00	-$75,000.00	-$50,000.00	-$25,000.00	-$25,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
Environmental Monitoring		-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
Water Quality Monitoring		-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
Escalation of Costs (CPI Adjusted)		-$34,083.20	-$67,838.06	-$101,247.83	-$134,295.18	-$169,564.28	-$203,646.33	-$240,002.46	-$277,085.71	-$314,910.62	-$353,492.03	-$392,845.07	-$432,985.18
Total Costs	**$ -**	**-$1,793,243.20**	**-$1,801,998.06**	**-$1,810,407.83**	**-$1,818,455.18**	**-$1,853,724.28**	**-$1,872,806.33**	**-$1,909,162.46**	**-$1,946,245.71**	**-$1,984,070.62**	**-$2,022,652.03**	**-$2,062,005.07**	**-$2,102,145.18**
Revenue and Operating Benefits													
New Revenue (CPI Adjusted)		$ 4,847,200	$ 4,944,144	$ 5,041,088	$ 5,138,032	$ 5,234,976	$ 5,331,920	$ 5,428,864	$ 5,525,808	$ 5,622,752	$ 5,719,696	$ 5,816,640	$ 5,913,584
Total Benefits and Revenue	**$ -**	**$ 4,847,200**	**$ 4,944,144**	**$ 5,041,088**	**$ 5,138,032**	**$ 5,234,976**	**$ 5,331,920**	**$ 5,428,864**	**$ 5,525,808**	**$ 5,622,752**	**$ 5,719,696**	**$ 5,816,640**	**$ 5,913,584**
Cash Flow Before Taxes	**-$54,000,000**	**$3,053,957**	**$3,142,146**	**$3,230,680**	**$3,319,577**	**$4,312,291**	**$5,439,114**	**$3,519,702**	**$3,579,562**	**$3,638,681**	**$4,628,083**	**$3,754,635**	**$5,791,439**
Income Tax Calculation													
Depreciation Expense		5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	5,400,000.00	0.00	0.00
Operating Cost		-1,793,243.20	-1,801,998.06	-1,810,407.83	-1,818,455.18	-1,853,724.28	-1,872,806.33	-1,909,162.46	-1,946,245.71	-1,984,070.62	-2,022,652.03	-2,062,005.07	-2,102,145.18
Operating Benefits		4,847,200.00	4,944,144.00	5,041,088.00	5,138,032.00	5,234,976.00	5,331,920.00	5,428,864.00	5,525,808.00	5,622,752.00	5,719,696.00	5,816,640.00	5,913,584.00
Net Income Taxes	**$ -**	**-2,536,187.04**	**-2,562,643.78**	**-2,589,204.05**	**-2,615,873.05**	**-2,634,375.52**	**-2,657,734.10**	**-2,675,910.46**	**-2,693,868.69**	**-2,711,604.41**	**-2,729,113.19**	**-1,126,390.48**	**-1,143,431.65**
Cash Flow After Taxes	**-54,000,000.00**	**517,769.76**	**579,502.16**	**641,476.12**	**703,703.78**	**1,677,915.40**	**2,781,379.57**	**843,791.08**	**885,693.61**	**927,076.97**	**1,898,969.98**	**2,628,244.45**	**4,648,007.18**
Discounted Cash Flow (After Tax)	**-54,000,000.00**	**504,894.94**	**551,040.76**	**594,803.48**	**636,278.46**	**1,479,420.86**	**2,391,367.22**	**707,432.94**	**724,099.41**	**739,085.71**	**1,476,255.24**	**1,992,385.83**	**3,435,886.54**
Cumulative Cash Flow	**-54,000,000.00**	**-53,495,105.06**	**-52,944,064.30**	**-52,349,260.82**	**-51,712,982.36**	**-50,233,561.50**	**-47,842,194.28**	**-47,134,761.34**	**-46,410,661.93**	**-45,671,576.22**	**-44,195,320.98**	**-42,202,935.15**	**-38,767,048.62**

Business Case Results:

NPV of Cash Flow	**$50,931,192**
IRR	**4.8%**
Profitability Index	**1.94**

Assumptions:		**Source**
CPI Rate	2.00%	GANDEN estimate
Benefit Escalation Factor	10.00%	GANDEN estimate
Income Tax Rate	30.00%	GANDEN estimate
Discounted cash flow Rate	2.55%	Provided by Council
Electrical cost (per kWh)	$0.10	Provided by Council
Operator / Maintainer Hourly Rate (includes 72.5% oncosts)	$69.00	Provided by Council
Water price per kl	$1.66	Provided by Rous
Peaking factor	80%	GANDEN estimate
Membrane Replacement		
Membrane UF Life	6.00	Years, SUEZ Example
Membrane UF Replacement Cost	$ 495,000.00	Per train (2.5MLD), including delivery and installation (Suez email)
Membrane RO Life	5.00	Years, SUEZ Example
Membrane RO Replacement Cost	$ 232,759.80	Per train (2.5MLD), including delivery and installation (Suez email)
USD to AUD conversion rate	$1.59	AUD to USD. Accessed 21/04/2020

Operating costs

Fixed costs	Operation Annual Salary + OH x 2	$ 240,000.00
	Maintenance Annual Salary + OH x 1	$ 120,000.00
	Management Annual Salary	$ 75,000.00
Montly variable costs	Chemicals ($/kl)	$0.12
	Consumables ($/kl	$0.03
	Power (kwh/kl)	4

Energy Usage per Annum	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Plant Ultimate Capacity (kL per day)	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
Adjusted at 80% production volume	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
Water price (per kL)	$1.66	$1.69	$1.73	$1.76	$1.79	$1.83	$1.86	$1.89	$1.93	$1.96	$1.99	$2.03	$2.06
Average estimated permeate production per annum kl	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.37

13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
2033	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**	**2048**	**2049**	**2050**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039
$0	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$473,928.08	-$515,689.84	-$558,286.84	-$601,735.77	-$646,053.69	-$691,257.96	-$737,366.32	-$784,396.85	-$832,367.99	-$881,298.55	-$931,207.72	-$982,115.07	-$1,034,040.57	-$1,087,004.58	-$1,141,027.88	-$1,196,131.63	-$1,252,337.47	-$1,309,667.41
-$2,143,088.08	**-$2,184,849.84**	**-$2,227,446.84**	**-$2,270,895.77**	**-$2,315,213.69**	**-$2,360,417.96**	**-$2,406,526.32**	**-$2,453,556.85**	**-$2,501,527.99**	**-$2,550,458.55**	**-$2,600,367.72**	**-$2,651,275.07**	**-$2,703,200.57**	**-$2,756,164.58**	**-$2,810,187.88**	**-$2,865,291.63**	**-$2,921,497.47**	**-$2,978,827.41**
$ 6,010,528	$ 6,107,472	$ 6,204,416	$ 6,301,360	$ 6,398,304	$ 6,495,248	$ 6,592,192	$ 6,689,136	$ 6,786,080	$ 6,883,024	$ 6,979,968	$ 7,076,912	$ 7,173,856	$ 7,270,800	$ 7,367,744	$ 7,464,688	$ 7,561,632	$ 7,658,576
$ 6,010,528	**$ 6,107,472**	**$ 6,204,416**	**$ 6,301,360**	**$ 6,398,304**	**$ 6,495,248**	**$ 6,592,192**	**$ 6,689,136**	**$ 6,786,080**	**$ 6,883,024**	**$ 6,979,968**	**$ 7,076,912**	**$ 7,173,856**	**$ 7,270,800**	**$ 7,367,744**	**$ 7,464,688**	**$ 7,561,632**	**$ 7,658,576**
$3,867,440	**$3,922,622**	**$4,908,008**	**$4,030,464**	**$4,083,090**	**$6,114,830**	**$4,185,666**	**$5,166,618**	**$4,284,552**	**$4,332,565**	**$4,379,600**	**$6,405,637**	**$5,401,695**	**$4,514,635**	**$4,557,556**	**$4,599,396**	**$4,640,135**	**$7,590,788**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-2,143,088.08	-2,184,849.84	-2,227,446.84	-2,270,895.77	-2,315,213.69	-2,360,417.96	-2,406,526.32	-2,453,556.85	-2,501,527.99	-2,550,458.55	-2,600,367.72	-2,651,275.07	-2,703,200.57	-2,756,164.58	-2,810,187.88	-2,865,291.63	-2,921,497.47	-2,978,827.41
6,010,528.00	6,107,472.00	6,204,416.00	6,301,360.00	6,398,304.00	6,495,248.00	6,592,192.00	6,689,136.00	6,786,080.00	6,883,024.00	6,979,968.00	7,076,912.00	7,173,856.00	7,270,800.00	7,367,744.00	7,464,688.00	7,561,632.00	7,658,576.00
-1,160,231.98	**-1,176,786.65**	**-1,193,090.75**	**-1,209,139.27**	**-1,224,927.09**	**-1,240,449.01**	**-1,255,699.70**	**-1,270,673.75**	**-1,285,365.60**	**-1,299,769.64**	**-1,313,880.09**	**-1,327,691.08**	**-1,341,196.63**	**-1,354,390.62**	**-1,367,266.84**	**-1,379,818.91**	**-1,392,040.36**	**-1,403,924.58**
2,707,207.94	**2,745,835.51**	**3,714,917.61**	**2,821,324.96**	**2,858,163.22**	**4,874,381.03**	**2,929,965.97**	**3,895,944.61**	**2,999,186.41**	**3,032,795.82**	**3,065,720.20**	**5,077,945.85**	**4,060,498.00**	**3,160,244.79**	**3,190,289.29**	**3,219,577.46**	**3,248,094.17**	**6,186,863.21**
1,951,452.46	**1,930,079.56**	**2,546,327.24**	**1,885,742.88**	**1,862,862.18**	**3,097,972.15**	**1,815,870.81**	**2,354,504.25**	**1,767,479.97**	**1,742,844.13**	**1,717,956.75**	**2,774,802.73**	**2,163,653.36**	**1,642,076.71**	**1,616,468.03**	**1,590,743.90**	**1,564,927.91**	**2,906,702.42**
-36,815,596.16	**-34,885,516.60**	**-32,339,189.36**	**-30,453,446.48**	**-28,590,584.30**	**-25,492,612.15**	**-23,676,741.34**	**-21,322,237.09**	**-19,554,757.12**	**-17,811,912.98**	**-16,093,956.23**	**-13,319,153.50**	**-11,155,500.14**	**-9,513,423.43**	**-7,896,955.41**	**-6,306,211.51**	**-4,741,283.60**	**-1,834,581.17**

2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.09	$2.12	$2.16	$2.19	$2.22	$2.26	$2.29	$2.32	$2.36	$2.39	$2.42	$2.46	$2.49	$2.52	$2.56	$2.59	$2.62	$2.66
1.39	1.42	1.44	1.46	1.48	1.51	1.53	1.55	1.57	1.59	1.62	1.64	1.66	1.68	1.70	1.73	1.75	1.77

31	32	33	34	35	36	37	38	39
2051	**2052**	**2053**	**2054**	**2055**	**2056**	**2057**	**2058**	**2059**
$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0
$0	$0	$0	$0	$931,039	$0	$0	$0	$0
$0	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**	**$0**	**$0**	**$0**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$1,368,143.96	-$1,427,790.04	-$1,488,629.04	-$1,550,684.82	-$1,613,981.72	-$1,678,544.55	-$1,744,398.65	-$1,811,569.82	-$1,880,084.42
-$3,037,303.96	**-$3,096,950.04**	**-$3,157,789.04**	**-$3,219,844.82**	**-$3,283,141.72**	**-$3,347,704.55**	**-$3,413,558.65**	**-$3,480,729.82**	**-$3,549,244.42**
$ 7,755,520	$ 7,852,464	$ 7,949,408	$ 8,046,352	$ 8,143,296	$ 8,240,240	$ 8,337,184	$ 8,434,128	$ 8,531,072
$ 7,755,520	**$ 7,852,464**	**$ 7,949,408**	**$ 8,046,352**	**$ 8,143,296**	**$ 8,240,240**	**$ 8,337,184**	**$ 8,434,128**	**$ 8,531,072**
$4,718,216	**$4,755,514**	**$4,791,619**	**$4,826,507**	**$5,791,193**	**$6,872,535**	**$4,923,625**	**$4,953,398**	**$4,981,828**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3,037,303.96	-3,096,950.04	-3,157,789.04	-3,219,844.82	-3,283,141.72	-3,347,704.55	-3,413,558.65	-3,480,729.82	-3,549,244.42
7,755,520.00	7,852,464.00	7,949,408.00	8,046,352.00	8,143,296.00	8,240,240.00	8,337,184.00	8,434,128.00	8,531,072.00
-1,415,464.81	**-1,426,654.19**	**-1,437,485.69**	**-1,447,952.15**	**-1,458,046.28**	**-1,467,760.63**	**-1,477,087.61**	**-1,486,019.45**	**-1,494,548.28**
3,302,751.23	**3,328,859.77**	**3,354,133.27**	**3,378,555.02**	**4,333,147.20**	**5,404,774.81**	**3,446,537.75**	**3,467,378.73**	**3,487,279.31**
1,513,109.15	**1,487,148.13**	**1,461,178.86**	**1,435,219.73**	**1,794,961.66**	**2,183,200.76**	**1,357,573.79**	**1,331,821.50**	**1,306,158.29**
-321,472.03	**1,165,676.11**	**2,626,854.96**	**4,062,074.69**	**5,857,036.36**	**8,040,237.12**	**9,397,810.91**	**10,729,632.41**	**12,035,790.70**

40	41	42	43	44	45	46	47	48
2060	**2061**	**2062**	**2063**	**2064**	**2065**	**2066**	**2067**	**2068**
$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0
$931,039	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$1,949,969.30	-$2,021,251.89	-$2,093,960.13	-$2,168,122.53	-$2,243,768.18	-$2,320,926.74	-$2,399,628.48	-$2,479,904.25	-$2,561,785.53
-$3,619,129.30	**-$3,690,411.89**	**-$3,763,120.13**	**-$3,837,282.53**	**-$3,912,928.18**	**-$3,990,086.74**	**-$4,068,788.48**	**-$4,149,064.25**	**-$4,230,945.53**
$ 8,628,016	$ 8,724,960	$ 8,821,904	$ 8,918,848	$ 9,015,792	$ 9,112,736	$ 9,209,680	$ 9,306,624	$ 9,403,568
$ 8,628,016	**$ 8,724,960**	**$ 8,821,904**	**$ 8,918,848**	**$ 9,015,792**	**$ 9,112,736**	**$ 9,209,680**	**$ 9,306,624**	**$ 9,403,568**
$5,939,926	**$5,034,548**	**$7,038,784**	**$5,081,565**	**$5,102,864**	**$6,053,688**	**$5,140,892**	**$5,157,560**	**$7,152,622**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-3,619,129.30	-3,690,411.89	-3,763,120.13	-3,837,282.53	-3,912,928.18	-3,990,086.74	-4,068,788.48	-4,149,064.25	-4,230,945.53
8,628,016.00	8,724,960.00	8,821,904.00	8,918,848.00	9,015,792.00	9,112,736.00	9,209,680.00	9,306,624.00	9,403,568.00
-1,502,666.01	**-1,510,364.43**	**-1,517,635.16**	**-1,524,469.64**	**-1,530,859.15**	**-1,536,794.78**	**-1,542,267.46**	**-1,547,267.93**	**-1,551,786.74**
4,437,259.89	**3,524,183.68**	**5,521,148.71**	**3,557,095.83**	**3,572,004.67**	**4,516,893.68**	**3,598,624.06**	**3,610,291.83**	**5,600,835.73**
1,620,646.43	**1,255,151.88**	**1,917,483.02**	**1,204,653.05**	**1,179,621.75**	**1,454,571.11**	**1,130,045.43**	**1,105,518.63**	**1,672,402.97**
13,656,437.13	**14,911,589.02**	**16,829,072.04**	**18,033,725.08**	**19,213,346.83**	**20,667,917.94**	**21,797,963.37**	**22,903,482.00**	**24,575,884.97**

2051	2052	2053	2054	2055	2056	2057	2058	2059	2060	2061	2062	2063	2064	2065	2066	2067	2068
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$2.69	$2.72	$2.76	$2.79	$2.82	$2.86	$2.89	$2.92	$2.95	$2.99	$3.02	$3.05	$3.09	$3.12	$3.15	$3.19	$3.22	$3.25
1.79	1.81	1.84	1.86	1.88	1.90	1.93	1.95	1.97	1.99	2.01	2.04	2.06	2.08	2.10	2.12	2.15	2.17

49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
2069	**2070**	**2071**	**2072**	**2073**	**2074**	**2075**	**2076**	**2077**	**2078**	**2079**	**2080**	**2081**	**2082**	**2083**	**2084**	**2085**	**2086**
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000
$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0
$0	**$931,039**	**$0**	**$0**	**$0**	**$1,980,000**	**$931,039**	**$0**	**$0**	**$0**	**$0**	**$2,911,039**	**$0**	**$0**	**$0**	**$0**	**$931,039**	**$1,980,000**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00
-$2,645,304.44	-$2,730,493.73	-$2,817,386.81	-$2,906,017.74	-$2,996,421.30	-$3,088,632.92	-$3,182,688.78	-$3,278,625.76	-$3,376,481.47	-$3,476,294.30	-$3,578,103.39	-$3,681,948.66	-$3,787,870.83	-$3,895,911.45	-$4,006,112.88	-$4,118,518.33	-$4,233,171.90	-$4,350,118.54
-$4,314,464.44	**-$4,399,653.73**	**-$4,486,546.81**	**-$4,575,177.74**	**-$4,665,581.30**	**-$4,757,792.92**	**-$4,851,848.78**	**-$4,947,785.76**	**-$5,045,641.47**	**-$5,145,454.30**	**-$5,247,263.39**	**-$5,351,108.66**	**-$5,457,030.83**	**-$5,565,071.45**	**-$5,675,272.88**	**-$5,787,678.33**	**-$5,902,331.90**	**-$6,019,278.54**
$ 9,500,512	$ 9,597,456	$ 9,694,400	$ 9,791,344	$ 9,888,288	$ 9,985,232	$ 10,082,176	$ 10,179,120	$ 10,276,064	$ 10,373,008	$ 10,469,952	$ 10,566,896	$ 10,663,840	$ 10,760,784	$ 10,857,728	$ 10,954,672	$ 11,051,616	$ 11,148,560
$ 9,500,512	**$ 9,597,456**	**$ 9,694,400**	**$ 9,791,344**	**$ 9,888,288**	**$ 9,985,232**	**$ 10,082,176**	**$ 10,179,120**	**$ 10,276,064**	**$ 10,373,008**	**$ 10,469,952**	**$ 10,566,896**	**$ 10,663,840**	**$ 10,760,784**	**$ 10,857,728**	**$ 10,954,672**	**$ 11,051,616**	**$ 11,148,560**
$5,186,048	**$6,128,841**	**$5,207,853**	**$5,216,166**	**$5,222,707**	**$7,207,439**	**$6,161,366**	**$5,231,334**	**$5,230,423**	**$5,227,554**	**$5,222,689**	**$8,126,827**	**$5,206,809**	**$5,195,713**	**$5,182,455**	**$5,166,994**	**$6,080,323**	**$7,109,281**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
-4,314,464.44	-4,399,653.73	-4,486,546.81	-4,575,177.74	-4,665,581.30	-4,757,792.92	-4,851,848.78	-4,947,785.76	-5,045,641.47	-5,145,454.30	-5,247,263.39	-5,351,108.66	-5,457,030.83	-5,565,071.45	-5,675,272.88	-5,787,678.33	-5,902,331.90	-6,019,278.54
9,500,512.00	9,597,456.00	9,694,400.00	9,791,344.00	9,888,288.00	9,985,232.00	10,082,176.00	10,179,120.00	10,276,064.00	10,373,008.00	10,469,952.00	10,566,896.00	10,663,840.00	10,760,784.00	10,857,728.00	10,954,672.00	11,051,616.00	11,148,560.00
-1,555,814.27	**-1,559,340.68**	**-1,562,355.96**	**-1,564,849.88**	**-1,566,812.01**	**-1,568,231.72**	**-1,569,098.17**	**-1,569,400.27**	**-1,569,126.76**	**-1,568,266.11**	**-1,566,806.58**	**-1,564,736.20**	**-1,562,042.75**	**-1,558,713.77**	**-1,554,736.54**	**-1,550,098.10**	**-1,544,785.23**	**-1,538,784.44**
3,630,233.29	**4,569,500.79**	**3,645,497.23**	**3,651,316.38**	**3,655,894.69**	**5,639,207.35**	**4,592,268.25**	**3,661,933.97**	**3,661,295.77**	**3,659,287.59**	**3,655,882.03**	**6,562,090.34**	**3,644,766.42**	**3,636,998.79**	**3,627,718.59**	**3,616,895.57**	**4,535,538.07**	**5,570,497.02**
1,057,029.15	**1,297,434.74**	**1,009,340.90**	**985,813.82**	**962,506.01**	**1,447,745.32**	**1,149,650.12**	**893,950.12**	**871,569.30**	**849,430.77**	**827,538.02**	**1,448,446.05**	**784,502.18**	**763,364.47**	**742,483.34**	**721,860.75**	**882,694.89**	**1,057,158.43**
25,632,914.12	**26,930,348.86**	**27,939,689.76**	**28,925,503.58**	**29,888,009.58**	**31,335,754.90**	**32,485,405.03**	**33,379,355.14**	**34,250,924.45**	**35,100,355.22**	**35,927,893.24**	**37,376,339.28**	**38,160,841.46**	**38,924,205.94**	**39,666,689.28**	**40,388,550.03**	**41,271,244.91**	**42,328,403.34**

2069	2070	2071	2072	2073	2074	2075	2076	2077	2078	2079	2080	2081	2082	2083	2084	2085	2086
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.29	$3.32	$3.35	$3.39	$3.42	$3.45	$3.49	$3.52	$3.55	$3.59	$3.62	$3.65	$3.69	$3.72	$3.75	$3.78	$3.82	$3.85
2.19	2.21	2.24	2.26	2.28	2.30	2.32	2.35	2.37	2.39	2.41	2.43	2.46	2.48	2.50	2.52	2.55	2.57

67	68	69	70	71	72	73	74	75	76	77	78	79	80	Totals
2087	**2088**	**2089**	**2090**	**2091**	**2092**	**2093**	**2094**	**2095**	**2096**	**2097**	**2098**	**2099**	**2100**	
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	-$54,000,000
$0	$0	$0	$0	$0	$1,980,000	$0	$0	$0	$0	$0	$1,980,000	$0	$0	$25,740,000
$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$0	$0	$0	$0	$931,039	$14,896,627
$0	**$0**	**$0**	**$931,039**	**$0**	**$1,980,000**	**$0**	**$0**	**$931,039**	**$0**	**$0**	**$1,980,000**	**$0**	**$931,039**	**-$13,363,373**
-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	-$1,168,000.00	**$ (93,440,000)**
														$ -
-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	-$960.00	**$ (76,800)**
-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	-$200.00	**$ (16,000)**
-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	-$240,000.00	**$ (19,200,000)**
-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	-$195,000.00	**$ (15,600,000)**
-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	-$10,000.00	**$ (1,025,000)**
-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	-$35,000.00	**$ (2,800,000)**
-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	-$20,000.00	**$ (1,600,000)**
-$4,469,404.11	-$4,591,075.39	-$4,715,180.10	-$4,841,766.90	-$4,970,885.44	-$5,102,586.35	-$5,236,921.27	-$5,373,942.90	-$5,513,704.96	-$5,656,262.26	-$5,801,670.70	-$5,949,987.32	-$6,101,270.26	-$6,255,578.87	**$ (189,911,394)**
-$6,138,564.11	**-$6,260,235.39**	**-$6,384,340.10**	**-$6,510,926.90**	**-$6,640,045.44**	**-$6,771,746.35**	**-$6,906,081.27**	**-$7,043,102.90**	**-$7,182,864.96**	**-$7,325,422.26**	**-$7,470,830.70**	**-$7,619,147.32**	**-$7,770,430.26**	**-$7,924,738.87**	**$ (323,669,194)**
$ 11,245,504	$ 11,342,448	$ 11,439,392	$ 11,536,336	$ 11,633,280	$ 11,730,224	$ 11,827,168	$ 11,924,112	$ 12,021,056	$ 12,118,000	$ 12,214,944	$ 12,311,888	$ 12,408,832	$ 12,505,776	$ 694,119,040
$ 11,245,504	**$ 11,342,448**	**$ 11,439,392**	**$ 11,536,336**	**$ 11,633,280**	**$ 11,730,224**	**$ 11,827,168**	**$ 11,924,112**	**$ 12,021,056**	**$ 12,118,000**	**$ 12,214,944**	**$ 12,311,888**	**$ 12,408,832**	**$ 12,505,776**	**$ 694,119,040**
$5,106,940	**$5,082,213**	**$5,055,052**	**$5,956,448**	**$4,993,235**	**$6,938,478**	**$4,921,087**	**$4,881,009**	**$5,769,230**	**$4,792,578**	**$4,744,113**	**$6,672,741**	**$4,638,402**	**$5,512,076**	**$ 357,086,473**
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54,000,000.00
-6,138,564.11	-6,260,235.39	-6,384,340.10	-6,510,926.90	-6,640,045.44	-6,771,746.35	-6,906,081.27	-7,043,102.90	-7,182,864.96	-7,325,422.26	-7,470,830.70	-7,619,147.32	-7,770,430.26	-7,924,738.87	-323,669,194.29
11,245,504.00	11,342,448.00	11,439,392.00	11,536,336.00	11,633,280.00	11,730,224.00	11,827,168.00	11,924,112.00	12,021,056.00	12,118,000.00	12,214,944.00	12,311,888.00	12,408,832.00	12,505,776.00	694,119,040.00
-1,532,081.97	**-1,524,663.78**	**-1,516,515.57**	**-1,507,622.73**	**-1,497,970.37**	**-1,487,543.30**	**-1,476,326.02**	**-1,464,302.73**	**-1,451,457.31**	**-1,437,773.32**	**-1,423,233.99**	**-1,407,822.21**	**-1,391,520.52**	**-1,374,311.14**	**-127,334,953.71**
3,574,857.92	**3,557,548.83**	**3,538,536.33**	**4,448,825.57**	**3,495,264.19**	**5,450,934.36**	**3,444,760.71**	**3,416,706.37**	**4,317,772.93**	**3,354,804.42**	**3,320,879.31**	**5,264,918.48**	**3,246,881.22**	**4,137,765.19**	**229,751,519.19**
661,560.02	**641,986.17**	**622,676.96**	**763,394.19**	**584,854.47**	**889,412.22**	**548,094.62**	**530,113.02**	**653,258.31**	**494,944.71**	**477,756.84**	**738,600.85**	**444,169.66**	**551,966.43**	**50,931,191.80**
42,989,963.36	**43,631,949.52**	**44,254,626.48**	**45,018,020.67**	**45,602,875.14**	**46,492,287.36**	**47,040,381.98**	**47,570,494.99**	**48,223,753.31**	**48,718,698.02**	**49,196,454.86**	**49,935,055.71**	**50,379,225.37**	**50,931,191.80**	

2087	2088	2089	2090	2091	2092	2093	2094	2095	2096	2097	2098	2099	2100
10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00	10000.00
8000.00	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**	**8000.00**
$3.88	$3.92	$3.95	$3.98	$4.02	$4.05	$4.08	$4.12	$4.15	$4.18	$4.22	$4.25	$4.28	$4.32
2.59	2.61	2.63	2.66	2.68	2.70	2.72	2.74	2.77	2.79	2.81	2.83	2.86	2.88