Greenhouse Gas Management Plan

Alkimos Seawater Desalination Plant

Referral to the Environmental Protection Authority under Part IV of the *Environmental Protection Act 1986*

Revision 3 – February 2023

watercorporation.com.au

Fresh Water Thinking

Executive Summary

The Water Corporation is the proponent for the Alkimos Seawater Desalination Plant (SDP).

The ASDP is proposed to be located adjacent to Water Corporation's existing Alkimos Water Resource Recovery Facility (WRRF). The total operating capacity of the SDP is planned to be 100 gigalitres per annum (GL/a).

The Environmental Protection Authority (EPA) has identified that the greenhouse gas (GHG) emissions from this project are required to be addressed in the form of a Greenhouse Gas Management Plan (GHGMP) and considered in the environmental impact assessment (EIA) process under Part IV of the *Environmental Protection Act 1986*. This document is the GHGMP for ASDP and is informed by the *Environmental Factor Guideline, Greenhouse Gas Emissions* (EPA April 2020).

The Water Corporation 2035 Strategic Plan vision is for our people, communities and state to thrive. A goal within the 2035 Strategic Plan is to accelerate the environmental sustainability of the water cycle as our climate changes. In alignment with our vision, the Water Corporation proposes to construct and operate ASDP at net zero (Scope 1 and 2) emissions.

This ASDP GHGMP demonstrates the range of measures to avoid, reduce and offset GHG emissions from ASDP. In the development of this GHGMP the Water Corporation has taken into account:

- the WA Government aspirational target of zero net GHG emissions before 2050;
- the Water Corporation Strategic Plan 2035 corporate target of net zero GHG emissions (Scope 1 and 2) by 2035;
- the WA Government target to cut its own emissions by 80 percent below 2020 levels by 2030 including an increase in renewable sources providing energy into the South West Interconnected System (SWIS);
- Water Corporation Energy Procurement Project securing up to 400MW of wind-generated renewable energy by 2032 annually, providing 1,576,800WM hours to the SWIS annually.
- Water Corporation Stage 1 of the Energy Procurement Project securing upto 100 MW was announced by Government on 26 November 2022.
- the ASDP project proposed Scope 1 and 2 GHG emissions; and
- the application of the mitigation hierarchy as detailed in Sections 4.1 and 4.2.

The Water Corporation proposes to implement ASDP with a net zero carbon commitment for construction and operation. The Water Corporation will avoid, reduce or offset emissions:

- to achieve net zero Scope 1 and Scope 2 tonnes of CO_2-e during construction and operation;
- reported and calculated on an annual and 5 yearly basis commencing 2023;

- with the acquisition and surrender of suitable offsets (Large-scale Renewable energy Certificates [LGCs] and Australian Carbon Credit Units [ACCUs]) which will be completed no more than 6 months after the end of the five yearly emissions calculation period.
- the surrender of ACCU's or LGC's generated within a maximum period of 5 years from emissions in alignment with the 5-yearly reporting period.

The avoidance, reduction and offset of Scope 1 and 2 emissions during operation excludes emission reductions in the SWIS made by the WA Government independent of Water Corporation renewable energy projects. (i.e. if the SWIS is net zero emissions, then Water Corporation does not need to contribute additional offsets apart from the insignificant Scope 1 emissions created in ASDP operation).

The estimated emissions profile is presented in Table Ex1 and Ex2 and Figure A below.

Table Ex1: Summary un-mitigated maximum estimated GHG emissions profile (100GL)

GHG emissions	GHG Emissions Schedule		
	Construction - 2023-2026	**Commissioning - 2027-28**	**Operations - 2028**
Scope 1 emissions	Up to 32,746 tCO_2-e	Up to 635 tCO_2-e	421 tCO_2-e per annum
Scope 2 emissions	Up to 3,468 tCO_2-e [Note 1 & 2]	Up to 40,039 tCO_2-e [Note 1 & 2]	Up to 168,897[6] tCO_2-e per annum [Note 3, 4 & 5] Commencing 2028 and decreasing annually with the reduction in the SWIS GHG emission factor
Total	Up to 36,214 tCO_2-e	Up to 40,674 tCO_2-e	Up to 169,318 tCO_2-e per annum

Notes:
1. Using the 2023 National Greenhouse Accounts emission factor (DISER, 2021)
2. Using the 2027 National Greenhouse Accounts emission factor (DISER, 2021)
3. Using the 2028 National Greenhouse Accounts emission factor (DISER, 2021)
4. For the ultimate SDP capacity of 100 GL/annum)
5. Commencing 2028 and decreasing annually with the reduction in the SWIS GHG emission factor
6. Excluding commissioning

Table Ex2: ASDP GHG Emissions for the life of asset (Totals at 5-Year intervals)

Phase	Construction	Commissioning and operation					
Year	2023-2026	2027-2031*	2032-2036	2037-2041	2042-2046	2047-2051	2052-2128
Scope 1 (tCO_2-e)	32,747	2319	2105	2105	2105	2105	32,207 (421 t pa)
Scope 2 (tCO_2-e) **(With reduction in grid emissions by 2050)**	3,468	662,696	609,680	419,155	228,671	45,726	0
GHG emissions total (tCO_2-e)	36,214	665,015	611,785	421,260	230,776	47,831	32,207
GHG emissions avoided, reduced or offset (tCO_2-e)	**36,214**	**665,015**	**611,785**	**421,260**	**230,776**	**47,831**	**32,207**
Total emissions	**2,047,573 t CO2e**						
Net GHG emissions	**0**	**0**	**0**	**0**	**0**	**0**	**0**

*2028 will likely include the commissioning period.

The Water Corporation is committed to transparency in the operation of ASDP and publicly reporting performance against the proposed GHG emissions targets and as such proposes the following reporting actions:

1. Publish this GHGMP publicly on a Water Corporation website and will also make a copy available on request.
2. Prepare and publish a **summary report** of this GHGMP:
3. Prepare and publish an **annual report** performance report
4. Prepare and publish a **consolidated five yearly performance report** detailing the performance during a five-year emissions target period, with the first five-year period ending in 2027.

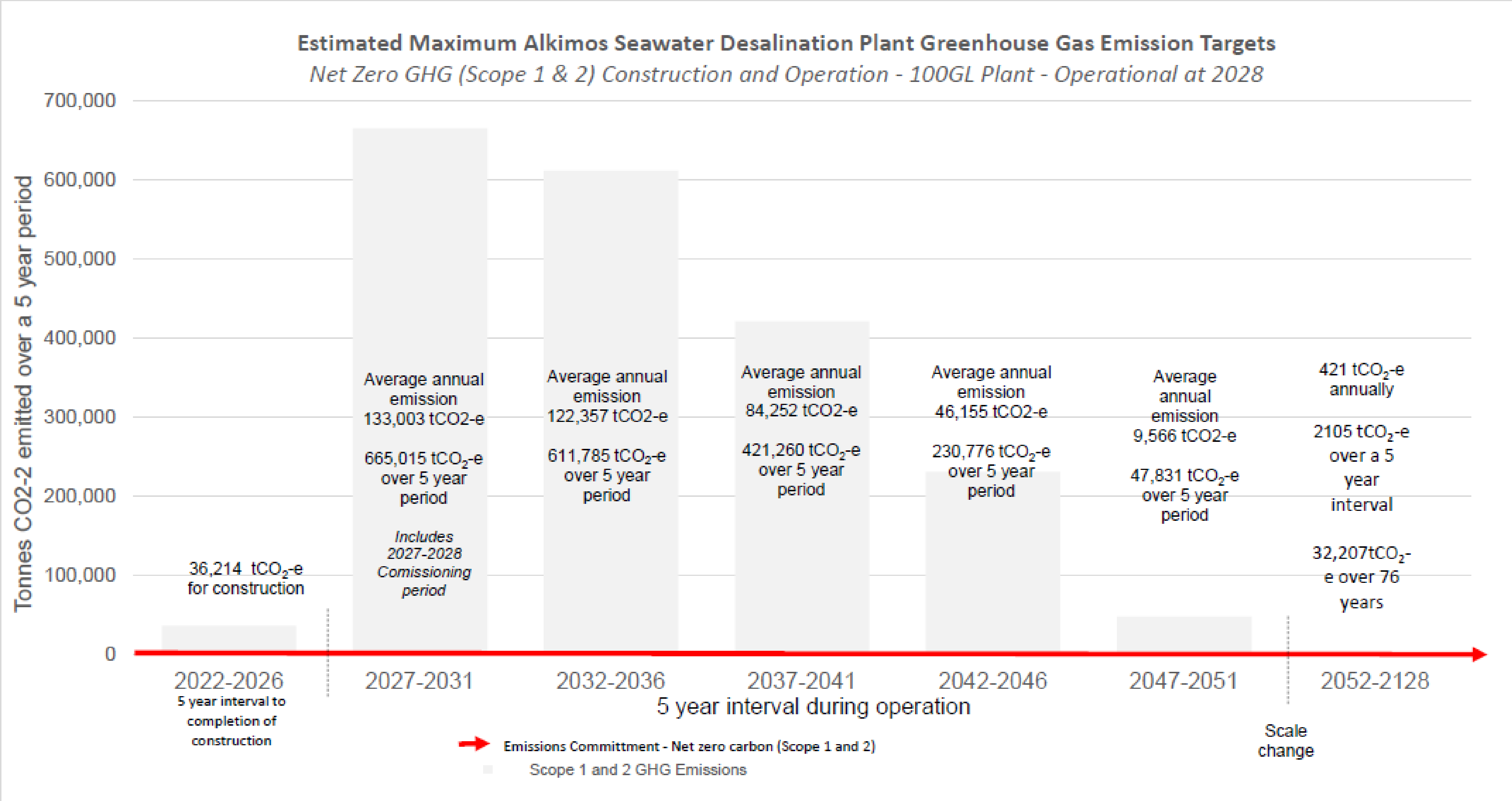

Figure Ex1: ASDP net zero GHG emissions for the life of asset (taking into consideration the grid moves towards net zero emissions by 2050)

Contents

1.0 Introduction

The Water Corporation is the proponent for the Alkimos Seawater Desalination Plant (ASDP).

The ASDP is proposed to be located adjacent to Water Corporation's existing Alkimos Water Resource Recovery Facility (WRRF). The total operating capacity of the SDP is planned to be 100 gigalitres per annum (GL/a), with this capacity to be constructed in stages.

The Environmental Protection Authority (EPA) has identified that the likely direct and indirect greenhouse gas (GHG) emissions from this project are required to be addressed in the form of a GHG Management Plan, for consideration in the environmental impact assessment (EIA) process under Part IV of the *Environmental Protection Act 1986*.

The objective of this Greenhouse Gas Management Plan [GHGMP] is to:

- Outline estimated GHG emissions and develop a GHG emissions inventory for the construction and operation phases of ASDP;
- Benchmark the GHG emissions intensity of ASDP with other comparable facilities; and
- Consider a mitigation hierarchy and development of mitigation options for the GHG emissions related to ASDP, i.e. through best practice design, continuous improvement, energy purchasing, carbon offsets as necessary etc.

This GHGMP is informed by the *Environmental Factor Guideline, Greenhouse Gas Emissions* (EPA April 2020).

1.1 Background

Water source planning for Perth and the Integrated Water Supply Scheme (IWSS) has been adapted in response to a drying climate over the past 40 years. Perth has seen a rapid drying of climate with a significant reduction in streamflow to metropolitan dams and recharge to aquifers.

For this reason, Water Corporation has updated its long-term planning to reflect a future of reduced reliance on regular streamflow into dams and is investigating a range of options for the next climate-independent water source. The main new sources considered for the IWSS are additional seawater desalination and groundwater replenishment recycling schemes.

The next new source is currently expected to be required in 2028 to allow for increased demand as a result of the ongoing effects of climate change in south western Australia, increasing population within the metropolitan area, and a reduction in the Gnangara mound allocation.

The Water Corporation has already implemented a number of these schemes, including the Perth Groundwater Replenishment Scheme and the Perth and Southern Seawater Desalination Plants.

The Water Corporation, as a result of its planning processes, has identified the need to build and operate an additional Seawater Desalination Plant in the suburb of Alkimos, approximately 40 kilometres north of the Perth central business district

1.2 Description of ASDP

The desalination process for ASDP is based on an improved version of the reverse osmosis system used in Water Corporation's two existing desalination plants, the Perth SDP situated at Kwinana, and Southern SDP situated at Binningup.

The reverse osmosis process involves the pre-treatment of seawater (removal of particulates using physical filtration and chemical treatment) and then pressurising the filtered seawater over a reverse osmosis membrane so that freshwater is driven through and higher salinity seawater is left behind. The concentrated seawater stream is then discharged back to the sea, while the freshwater stream will undergo further processing to ensure it is of a standard fit for drinking water purposes, before being pumped into the Integrated Water Supply Scheme (IWSS).

Incorporation of Eglinton groundwater is subject to receiving a groundwater allocation licence. Depending on the allocation, this could contribute an additional 6 GL p.a. for public water supply.

A simplified flow schematic, incorporating the proposed treatment of groundwater, is shown in Figure 1.

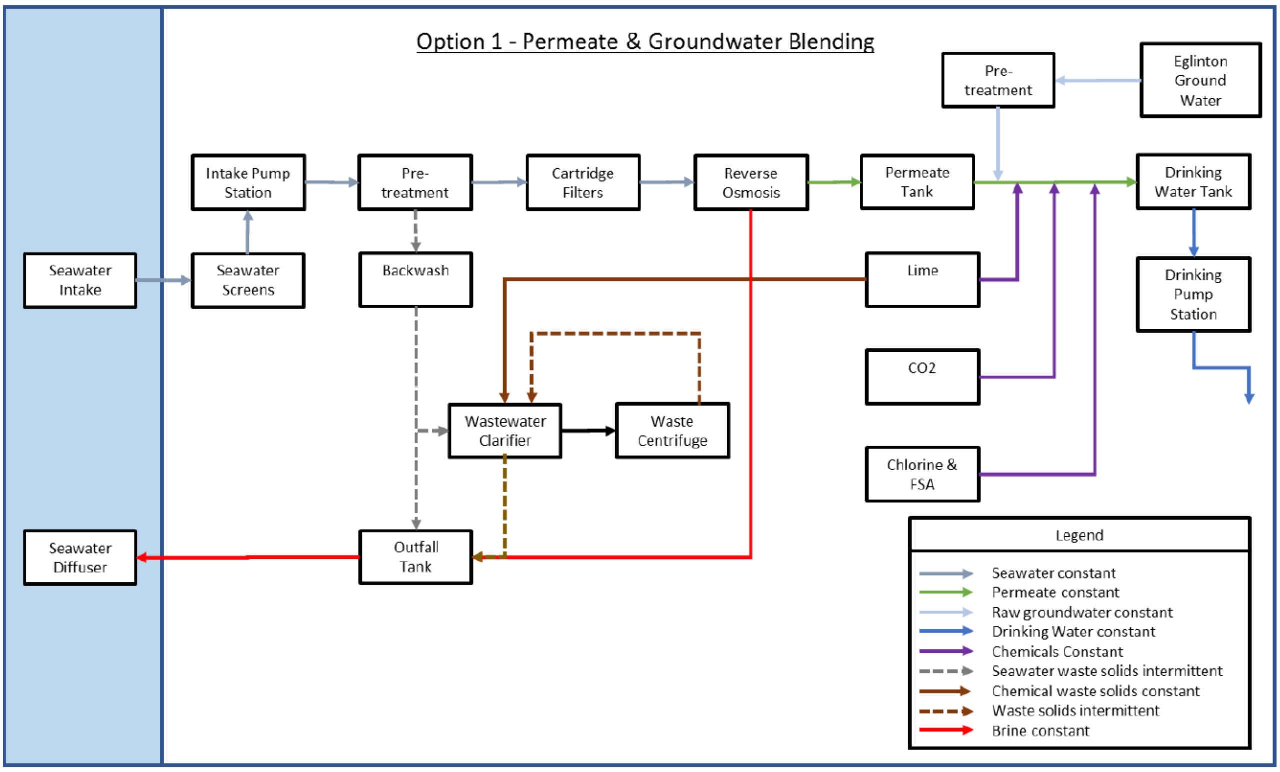

Figure 1: Simplified process flow schematic, ASDP (Jacobs-WP, 2018)

ASDP is proposed to be located adjacent to Water Corporation's existing Alkimos Water Resource Recovery Facility (WRRF). The total operating capacity of the SDP is planned to be 100 gigalitres per annum (GL/a), with this capacity to be constructed in up to four stages.

1.3 EPA Objective

The EPA's environmental objective for greenhouse gas (GHG) emissions is: "To reduce net greenhouse gas emissions in order to minimise the risk of environmental harm associated with climate change". The EPA's environmental objective for GHG emissions is outlined in the guideline for Greenhouse Gas Emissions published in April 2020.

This GHGMP presents the commitments by the Water Corporation to address the Scope 1, 2 and 3 GHG emissions related to ASDP.

1.4 Emission types

Scope 1 GHG emissions are the emissions released to the atmosphere as a direct result of an activity, or a series of activities at a facility level.

Scope 2 GHG emissions are the emissions released to the atmosphere from the indirect consumption of an energy commodity.

Scope 3 GHG emissions are indirect greenhouse gas emissions other than scope 2 emissions that are generated in the wider economy. They occur as a consequence of the activities of a facility, but from sources not owned or controlled by that facility's business. Some examples are extraction and production of purchased materials, transportation of purchased fuels, use of sold products and services, and flying on a commercial airline by a person from another business.

1.5 Framework

The Water Corporation 2035 Strategic Plan vision is for our people, communities and state to thrive. A goal within the 2035 Strategic Plan is to accelerate environmental sustainability of the water cycles as our climate changes. Our target to meet our goal is to achieve net zero GHG (Scope 1 and 2) emissions by 2035.

The Water Corporation is committed to protecting and improving the environment in which it operates or influences. The Water Corporation's Environment Policy is aligned with objectives of the Western Australian Government and EPA guidelines.

A key objective of the Water Corporation Environment Policy (PCY230: Water Corporation 2019) is to achieve net zero GHG emissions by 2050. In addition, other objectives include reducing water use per capita to conserve resources and increasing the reuse of treated wastewater. The objectives in the Water Corporation Environment Policy provide the framework for the approach to the management of GHG emissions associated with the proposed ASDP.

The Environmental Factor Guideline Greenhouse Gas Emissions (EPA 2020) outlines the following GHG assessment considerations as part of an Environmental Impact Assessment:

- Application of the mitigation hierarchy to avoid, reduce and offset emissions;
- The interim and long-term emissions reduction targets the proponent proposes to achieve;
- The adoption of best practice design, technology and management appropriate to mitigate GHG emissions; and,

- Whether the proposed mitigation is plausible, timely, achievable and is all that is reasonable and practicable.

The Water Corporation Environmental Policy (PCY230) (Water Corporation 2019) and the Environmental Factor Guideline Greenhouse Gas Emissions (EPA 2020) have been used to guide the approach to ASDP design and focus on the reduction of GHG emissions. The key components of the guideline have been used to develop the GHG assessment.

1.6 Relevant policy and guidance

The relevant State and Commonwealth policy and guidelines include:

- Environmental Protection Authority. Factor Guideline: Greenhouse Gas Emissions; (EPA 2020)
- *National Greenhouse and Energy Reporting Act 2007* [Cth] (NGER Act);
- Emissions Reductions Fund [*Carbon Credits (Carbon Farming Initiative) Act 2011* Cth]; and
- Western Australian Government's State Greenhouse Gas Emissions Policy for Major Projects 2019.

1.6.1 Environmental Protection Authority Environmental Factor Guideline: Greenhouse Gas Emissions (EPA 2020)

The Water Corporation has considered the requirements of the Environmental Protection Authority. Factor Guideline: Greenhouse Gas Emissions (EPA EFG GHG Emissions) (EPA 2020). A key requirement is the development of a GHGMP as part of the assessment process that demonstrated their contribution towards the aspiration of net zero emissions by 2050. Table 1 below outlines the requirements of the EPA EFG GHG Emissions (EPA 2020) and the location of where the requirements are considered in this GHGMP.

Table 1: Alkimos GHGMP and the requirements of the EPA EFG GHG Emissions (EPA 2020)

EPA Factor Guideline Requirement	Relevant Section in this GHGMP
Application of the mitigation hierarchy to avoid reduce and offset emissions	4.0
Emissions reduction targets the proponent proposes to achieve	5.0
Adoption of best practice design, technology and management appropriate to mitigate GHG emissions	4.0
Whether proposed mitigation is plausible, timely, achievable and is all that is reasonable and practicable.	4.0
Credible estimates of scope 1, scope 2 and scope 3 GHG emissions (annual and total) over the life of a proposal including a breakdown by source	2.0 and 5.0
Projected emissions intensity (emissions per unit of production) for the proposal and benchmarking against other comparable projects.	3.0
Strategies which demonstrate that all reasonable and practicable measures have been applied to avoid, reduce and offset a proposal's scope 1 emissions over the life of the proposal.	4.0

Offsetting emissions (carbon offsets) through the implementation of a GHG emissions offset package to offset some or all residual emissions.	4.0
Offsets integrity	4.0
Periodic public reporting against the GHGMP	5.0

1.6.2 National Greenhouse and Energy Reporting (NGER)

The GHG assessment for the proposed SDP has followed the methods and guidance for the reporting and dissemination of information related to GHG emissions from relevant organisations in Australia as required by the NGER Act.

For corporations, such as the Water Corporation, thresholds for reporting under the requirements of the NGER Act are GHG emissions of greater than 50,000 t CO2-e [carbon dioxide equivalent] per year (Scope 1 and Scope 2 emissions), production of 200 TJ or more of energy per year, or consumption of 200 TJ or more of energy per year. The Water Corporation is reporting Scope 1 and Scope 2 emissions annually under the NGER Act for its entire operation.

1.6.3 Emissions Reductions Fund

The Commonwealth Government's Direct-Action Plan focuses on sourcing low-cost emission reductions. The Direct-Action Plan includes an Emissions Reduction Fund (ERF). The legislation to implement the ERF came into effect on 13 December 2014 through the NGER Act and amendments to the *Carbon Credits* (*Carbon Farming Initiative) Act 2011* (Cth).

The ERF is a voluntary scheme provided by the Government which provides financial incentives to organisations and individuals to adopt new practices and technologies to reduce their GHG emissions. Under the scheme, in the event participants are not able avoid and reduce GHG emissions adequately, industry can offset GHG emissions through earning Australian carbon credit units (ACCUs) for emissions reduction. ACCUs can then be sold to generate income, either to the government through a carbon abatement contract, or in the secondary (commercial) market.

Within the ERF, a safeguard mechanism is applied, which is designed to ensure emission reductions credited, are not offset through increases elsewhere in the economy. The mechanism works through setting a baseline for emissions for facilities emitting over 100,000 tCO_2-e (Scope 1) annually (based on historical performance) and requiring facilities to keep their emissions below this baseline. The mechanism includes methodologies for dealing with growth and exceptional circumstances and came into operation on 1 July 2016.

1.6.4 Western Australian Government's State Greenhouse Gas Emissions Policy for Major Projects 2019

The *Western Australian Government's State Greenhouse Gas Emissions Policy for Major Projects* (State Emissions Policy, WA Govt 2019), commits the State Government to working with all sectors of the WA economy to achieve net zero GHG emissions by 2050. The State Emissions Policy also commits to working to achieve the Australian Government's interim target of 26 to 28% emissions reduction by 2030 (based on a reduction below the 2005 national GHG emissions).

The State Emissions Policy encourages local innovation and the development of carbon offsets.

The State Emissions Policy is relevant to the proposed ASDP, as it sets the expectations for targeting best practice design, construction and operation of the desalination process for energy efficiency.

2.0 Greenhouse Gas Emissions Inventory of ASDP

2.1 Construction - Scope 1 (2023 – 2026)

The construction works for ASDP are expected to take approximately four years. The key activities will include:

- Civil earthworks – cut and fill excavation activities, road construction, etc. for approximately 12-18 months;
- Tunnel construction – this will include removal of excavated dirt and slurry, and bringing in around 36,000 concrete segments;
- Marine work – construction of the riser holes in the ocean floor for tie-ins with the two tunnels;
- Construction of the desalination plant; and
- Construction of the trunk main to connect into the water supply network.

The main contributor to construction Scope 1 emissions will be a result of diesel combustion in heavy earthmoving equipment, specifically for excavation works and transport of earth to and from site, and mobile plant on site. Details of the type and number of mobile plant and equipment is not available at this stage of the design, as such estimates for diesel use have been obtained from:

- For excavators and earthmoving trucks - estimates of diesel consumption rates based on guidelines for mine haul and transport operations (AG, 2020b).
- For mobile plant and site vehicles – estimates of fuel usage rates for each mobile equipment and vehicle type were sourced from the Carbon Estimate and Reporting Tool (CERT, 2017). These calculations were based on preliminary estimates for the average number of months for the operation of the plant and vehicles.

A summary of construction phase Scope 1 GHG emissions is detailed in Table 2.

Table 2: Estimated construction plant activity (2023 - 2026) GHG emissions – Regarded as Scope 1 for the Water Corporation

Construction activity	Units	Values
Excavation works (cut and fill) - Earth volume excavated (Bank cubic metres) - Diesel use Note 1	 m^3 (BCM) kL	 1.3×10^6 910
Transport of earth to/from site - Earth volume moved, site (0.99) and tunnel (0.13) - (loose cubic metre - 1.68 Swell Factor) - Diesel use Note 2	 m^3 (BCM) m^3 (LCM) kL	 1.12×10^6 1.88×10^6 940 Note 3
Mobile plant and equipment - Diesel use	 kL	 5,096
Site vehicles - Diesel use	 kL	 82
Total diesel use	kL GJ	7028 271,280
Total CO_2-e emissions for construction phase Note 4	**t CO_2-e**	**18,962**

Note 1: Diesel consumption for heavy mobile equipment used for excavations works estimated using factor of 0.7 L / BCM (based on estimates from Australian Government, 2020: Analyses of diesel use for mine haul and transport operations, Department of Resources, Energy and Tourism, Australian Government)

Note 2: Diesel consumption for trucks transporting earth and rocks estimated using factor of 0.5 L / LCM (based on estimates from Australian Government, 2020: Analyses of diesel use for mine haul and transport operations, Department of Resources, Energy and Tourism, Australian Government)

Note 3: Diesel energy content = 38.6 GJ / kL, from NGA Factors (National Greenhouse Accounts Factors, Oct 2020)

Note 4: Diesel emission factor 69.9 kg Co2-e/GJ (National Greenhouse Accounts Factors, Oct 2020)
Calculation of total emissions = Quantity of fuel x energy content factor x emission factor for gas type / 1000

2.2 Land clearing (2023 – 2026) (Scope 1)

At the start of the construction phase, vegetation will be removed from the site in preparation for civil works. Greenhouse gas impacts associated with land clearing arise from the reduction in the amount of 'carbon sink' which would otherwise sequester carbon dioxide from the environment, as well as the carbon removed at the time of the land clearing.

The estimate of GHG emissions associated with land clearing follows the methodology provided in the 'Greenhouse Gas Assessment Workbook for Road Projects' by the Transport Authorities Greenhouse Group in February 2013. This methodology involves the identification of the maximum potential biomass ('maxbio') class for the proposed site, assesses the areas and type of vegetation to be removed, and uses emission factors to calculate the associated GHG emissions. The maxbio class is derived from the Australian Greenhouse Office and estimates the maximum tonnes dry vegetation matter per hectare for a specific location.

The methodology assumes that:

- All carbon sources (i.e. woody, non-woody, debris and soil) are removed;

- All carbon removed is converted to carbon dioxide and released to the atmosphere; and
- Sequestration from revegetation of the project site is not included.

The 'maxbio' class for the proposed ASDP site was identified as 'Class 2' from the Transport Authorities Greenhouse Group, 2013 document. The vegetation to be cleared and hence the calculated GHG emissions are shown in Table 3.

Table 3: Estimated construction phase vegetation clearing GHG emissions (2023 - 2026) – Scope 1

Vegetation type to be cleared	Area to be cleared (hectares)	Vegetation class	Emission factor (t CO_2-e / ha)	Scope 1 GHG emissions (t CO_2-e)
Open heath to open scrub, over low shrubland	44.53 Note 1	H	309	13,760
Macroalgae Reef (Mixed Assemblage dominated by Ecklonia; <30% Caulerpa, mixed brown, Sargassum, mixed Red and Encrusting Red)	2.1 Note 2	n/a	11.74 Note 3	24.7
Total emissions from vegetation clearing			**tCO_2-e**	**13,784.7**

Note 1: This area includes the clearing of the 16 m wide pipeline corridor. It is noted this is outside the assessed main site but has been included as part of the total vegetation clearing for the project. The vegetation class may vary across this pipeline route, however Water Corporation has selected the higher emission factor.

Note 2: Calculation of area of marine clearing is based on the Macroalgae Reef areas detailed in the Environmental Review Document. The total marine footprint for the intake and outfall structures is 8.38 ha (equally divided between the two structures). Of the two structures, the outfall diffuser is located entirely in bare sand and the intake structure is approximately covered by 60% Macroalgae Reef benthic habitat. Of this particular benthic habitat, it is assumed that this habitat would only account for approximately 70% coverage. Therefore, of the approximate 3 ha of habitat, with 70% coverage, it has been calculated at 2.1 ha of impact.

Note 3: emission factor derived from report by Filbee-Dexter & Wernberg (2020) on the Substantial blue carbon in overlooked Australian kelp forests.

2.3 Tunnel Construction (2023 – 2026) (Scope 2)

The tunnelling operation is a large consumer of imported electricity during the construction works. The GHG emission estimates arising from the import of electricity for this activity are shown in Table 4. Emissions using the most recent emission factor. (Department of Industry, Science, Energy and Resources, 2021: National Greenhouse Accounts Factors, Australian National Greenhouse Accounts, October 2021).

Table 4: Estimated construction phase GHG emissions (2023 – 2026) - Scope 2

Construction activity	Units	Values
Electricity use (tunnelling operation)	MWh	6,800
Scope 2 emissions factor (SWIS)	kg CO2-e/kWh	0.51 Note 1
Calculated Scope 2 GHG emissions	t CO_2-e	**3,468**

Note 1: The emission factor for 2023 sourced from the National Greenhouse Accounts Factors (DISER, 2021).

2.4 Operational commissioning (2028 – onwards)

Immediately following construction there will be an approximate 9-month to 1 year commissioning period. This may reflect slightly different figures to normal operations. To quantify likely emissions during this period Water Corporation has drawn upon past experience at the operating SDP's. These activities include:

- Energisation (electrical equipment commissioning),
- Hydraulic commissioning,
- Pre-commissioning,
- Integration Commissioning (Operation & testing of equipment combinations), and
- Allowance for a Proving Period.

Table 5 outlines both the Scope 1 and Scope 2 emissions during commissioning.

Table 5: Estimated commissioning phase GHG emissions (Scope 1 and 2) (2027-2028)

Operational activity	Units	Value
Site commissioning (Scope 2)	MWh	95,333
Scope 2 emissions factor (SWIS)	kg CO2-e/kWh	0.42 Note 1
Calculated Commissioning Scope 2 GHG emissions	t CO_2-e	**40,040**
Integration Commissioning - Operation & testing of equipment combinations – Diesel use (Scope 1)	kL	3 Note 2
SF_6 Switch gear (Sulphur Hexafluoride - switch gear used to protect high voltage electrical equipment) (Scope 1)	kg	3000 Note 3
Calculated Commissioning Scope 1 GHG emissions	t CO_2-e	**635**

Note 1: The emission factor for 2027 was sourced from the National Greenhouse Accounts Factors (DISER, 2021).
Note 2: Diesel energy content = 38.6 GJ / kL, from NGA Factors (National Greenhouse Accounts Factors, Oct 2020) Diesel emission factor 69.9 kg Co2-e/GJ (National Greenhouse Accounts Factors, Oct 2020)
Calculation of total emissions = Quantity of fuel x energy content factor x emission factor for gas type / 1000
t CO2-e: (3 x 38.6 x 69.9) / 1000 = 8
Note 3: SF_6: 23,500 is the global warming potential to convert the kg of gas to kg of Co2-e
0.0089 is the annual leakage factor
Calculation of total emissions = (quantity of SF6 x global warming potential /1000) x annual leakage factor
t CO2-e: (3000kg * 23500 / 1000) * 0.0089 = 627

2.5 Operations emissions

The Scope 1 emissions for the operation of ASDP are expected to include fuel use by on-site vehicles and emergency power generators. The emissions from the on-site vehicles are expected to be negligible (and in any event are offset under an existing Corporation program to annually offset vehicle fleet emissions) and, similarly, emissions from the emergency power generators are expected to be minor due to infrequent and temporary use, which indicates that the majority of energy use occurs from the high-pressure pumps used for Reverse osmosis desalination.

Table 6: Estimated operations phase GHG emissions - Scope 1

Operational activity	Units	Value
Site vehicles and emergency generators – diesel use	kL	1 Note 1
SF_6 Switch gear (Sulphur Hexafluoride - switch gear used to protect high voltage electrical equipment) (Scope 1)	kg	2000 Note 2
Calculated Scope 1 GHG emissions (2020)	t CO2-e / year	**421**

Note 1: Diesel energy content = 38.6 GJ / kL, from NGA Factors (National Greenhouse Accounts Factors, Oct 2020)
Diesel emission factor 69.9 kg Co2-e/GJ (National Greenhouse Accounts Factors, Oct 2020)
Calculation of total emissions = Quantity of fuel x energy content factor x emission factor for gas type / 1000
t CO2-e: (1 x 38.6 x 69.9) / 1000 = 3
Note 2: SF6: 23,500 is the global warming potential to convert the kg of gas to kg of Co2-e
0.0089 is the annual leakage factor
Calculation of total emissions = (quantity of SF6 x global warming potential /1000) x annual leakage factor
t CO2-e: (2000kg * 23500 / 1000) * 0.0089 = 418

The key source of GHG emissions during the operation of the SDP is the indirect emissions resulting from the import of electricity (Scope 2 GHG emissions).
The Scope 2 GHG emission estimates arising from the import of electricity to the site for the ultimate ASDP capacity of 100 GL/annum are shown in Table 7. Emissions are calculated using the most recent emission factor (DISER, 2020) and are post commissioning.

Table 7: Estimated operations phase annual GHG emissions - Scope 1 and 2 (2028 – onwards)

Operational activity	Units	Value
Scope 1 Operational Activity		
Scope 1 emissions	t CO2-e / year	421
Total Scope 1 GHG emissions (2020)	**t CO2-e / year**	**421**
Scope 2 Operational Activity		
Electricity use Note 1	MWh / year	325,006
Clearwater pumping electricity usage	MWh / year	86,940
Total	MWh / year	411,946
Scope 2 emissions factor (2020)		0.41 Note 2
Total Scope 2 GHG emissions (2020)	**t CO2-e / year**	**168,898** Note 3

Notes:

1. Scope 2 estimates exclude electricity use for pumping of water product into the distribution network. Due to variations across different SDPs in the distance and elevation of water product pumping duties, exclusion of the power required for transfer of product into the distribution network is warranted. The electricity use represents an annual average value. The estimate includes the plant operating at maximum capacity (100 GL/yr.) of 38.2 MW for 345 days of the year, with a 20 day outage. During the outage, the plant will operate at maximum capacity for around 5 days for flushing purposes, and then 15 days at 30% capacity to maintain the utilities.
2. The emission factor for 2028 sourced from the National Greenhouse Accounts Factors (DISER, 2021).

3. Commencing 2028 and decreasing annually with the reduction in the SWIS GHG emission factor and includes Clearwater pumping to network.

The 2020 carbon intensity of the SWIS is 0.68 kg CO2-e/kwh and is projected to fall to 0.37kg CO2-e/kwh in 2030 (DISER 2021). Further, the State Government have committed to cut its own emissions by 80 percent below 2020 levels by 2030 including an increase in renewable sources providing energy into the South West Interconnected System (SWIS). The State Government reduction target is in alignment with its commitment to net zero GHG emissions by 2050. The ASDP GHG emission projections assume a linear GHG reductions trajectory of the SWIS from 0.37kg CO2-e/kwh in 2030 to zero in 2050.

2.6 Construction and operations Scope 3 emissions (2028 – onwards)

Water Corporation has only concentrated on upstream Scope 3 activities, such as:

- Purchased goods,
- Capital goods,
- Indirect fuel and electricity emissions not reported in scope 1 and 2, and
- Waste.

Table 8 details the estimated construction and operation Scope 3 GHG Emissions.

Table 8: Estimated upstream operation GHG emissions (Scope 3) (2028 – onwards)

Activity	Units	Value
Purchased goods (cleaning and potabilisation chemicals)	tCO_2-e	9,365
Indirect fuel and electricity emissions not reported in scope 1 and 2. (losses in the transmission system)	tCO_2-e	5,250
Calculated Operations Scope 3 GHG emissions	t CO_2-e	**14,615**

2.7 Summary of emissions

The consolidated emissions summary is provided in Table 9 and presents potential Scope 1 and Scope 2 GHG emissions associated with the construction and operations phases of the proposed ASDP.

Table 9: Consolidated un-mitigated estimated GHG emissions profile (Scope 1 and 2)

		Scope	Emissions	Impact	Estimated emissions (tCO_2-e)	Schedule of Emissions
Construction		Scope 1	Diesel combustion	Direct	18,962 (one off)	2023-2026
			Land clearing	Direct	13,785 (one off)	
		Scope 2	Tunnelling operation	Indirect	3,468 [Note 1] (one off)	
Operation	Commissioning	Scope 1	Site Commissioning – Diesel usage, SF_6 Switch gear	Direct	635	2027 -2028 (Estimated 9 months – 1 year)
		Scope 2	Site Commissioning	Indirect	40,040 [Note 2]	
	Post Commissioning Operation	Scope 1	- Diesel usage by emergency power generators - SF6 Switch gear	Direct	421	From 2028 and decreasing annually with the reduction of the SWIS emission factor
		Scope 2	Intake	Indirect	133,251 /annum [Note 3 & 4]	
			Pre-treatment of the seawater	Indirect		
			Pumping of the seawater to high pressures to drive the water through the RO membranes	Indirect		
			Stabilising the processed water following treatment	Indirect		
			Clearwater pumping into network	Indirect	35,645 /annum [Note 3 & 4]	

Notes:

1. Using the 2023 National Greenhouse Accounts emission factor (DISER, 2021)
2. Using the 2027 National Greenhouse Accounts emission factor (DISER, 2021)
3. Using the 2028 National Greenhouse Accounts emission factor (DISER, 2021)
4. For the ultimate SDP capacity of 100 GL/annum

3.0 Benchmarking

3.1 Water Corporation emissions

Securing the next water source for Western Australia through the implementation of ASDP will increase the Water Corporation's current operational GHG emissions profile by approximately 36%. Table 10 details a comparison of ASDP estimated GHG emissions during operations with the total emissions from Water Corporation, WA and Australia.

Table 10: Comparison of ASDP annual operational GHG emissions with the Water Corporation and Western Australia

Emissions source	Total emissions (kt CO_2-e/pa)	ASDP as % Note 1
ASDP operations emissions	169.4	n/a
- Scope 1 emissions	0.421	n/a
- Scope 2 emissions	169	n/a
Water Corporation combined emissions (2019-20)	735 Note 2	23%
- Scope 1 emissions	50	n/a
- Scope 2 emissions	685	25%
Western Australian emissions (scope 1)	68,343 Note 3	0.25%
Australian emissions (scope 1)	327,000 Note 3	0.05%

Notes:

1. Emissions as percentage of emission source plus ASDP emissions.
2. The Water Corporation emissions data is the NGERs reported emissions for year 2019-20.
3. The WA and Australia emissions data source is from the Clean Energy Regulator website 2021.

Considering the Water Corporation annual GHG emissions, the largest current GHG emissions are attributed to the Southern SDP and the Perth SDP which in 2019/2020 accounted for 55% of Water Corporation's total GHG emissions.

The energy intensity of the desalination process is much higher than for alternative water supply methods such as local surface water harvesting and groundwater extraction and treatment. Based on experience in California, USA, (Pacific, 2013), the energy intensity for the supply of water from local surface water surfaces is around 0.5 MWh / ML and 1.1 MWh / ML for local groundwater. The energy intensities from surface and groundwater sources are significantly lower than that for seawater desalination which range from 3.2 to 5.0 MWh / ML.

The implementation of ASDP creates a new and additional water source for the IWSS and will not displace water produced by methods with lower energy intensity, except for the above consideration that part of the need for ASDP will reduce the reliance on Gnangara groundwater (which is also a State policy objective).

The sources of water for Water Corporation's Integrated Water Supply Scheme (IWSS) which provides water to Perth and surrounding areas, include surface water stored in dams and more recently, groundwater and desalination. A breakdown of the current sources of drinking water (by percentage) in the Perth area is shown in Table 11. The average energy intensity reported by Water Corporation for the supply of water was 2.1 MWh / ML for the last 5 years (2015 - 2019), which is reflective of the significant amount of water sourced from seawater desalination in recent years.

Table 11: Perth's current drinking water supply sources (WC, 2020b)

Water supply source	Percentage of total drinking water supply
Desalination	48%
Groundwater	40%
Dams (from catchments)	10%
Groundwater replenishment	2%

3.2 Comparison against other SDP GHG Emissions

For the benchmarking of seawater desalination facilities, the energy intensity parameter used for comparison is defined as a kilowatt hour (kWh) of energy required to produce 1 kilolitre (kL) of water.

The amount of energy required is directly related to the tonnes of CO2-e emitted by multiplication with an emission factor (kg CO2-e / kWh). As the emission factor is dependent on the source of production of the electricity, which is variable for different countries (and across Australian jurisdictions), comparisons are best achieved using the energy intensity of facilities. In addition, the use of energy intensity as the comparison parameter avoids complications with offsetting of emissions.

Summaries of the energy intensities for several larger Australian and international seawater desalination facilities, each using reverse osmosis technology, are provided in Table 12 and table 13, respectively.

In order to compare ASDP with other plants, it was necessary for Water Corporation to exclude clearwater pumping from the intensity calculations. Excluding clearwater pumping is considered the best way to benchmark Water Corporation's proposal to other SDP operations and confirm the application of best available technology / best practice technology.

With reference to the Australian and international examples, it is not always clear whether clearwater pumping is included in that intensity calculation.

The key factors that impact the overall energy required during the desalination process include:

- Feed water quality (TDS, turbidity, temperature),
- Product water quality requirements,
- Plant height above sea level, and
- Pipe work layout and size (friction)

These factors become relevant when considering the overall energy required and comparing that to ASDP. For example, the Gold Coast SDP has much warmer intake waters to ASDP, and Adelaide SDP is located 52m above sea level whereas Southern SDP is located at (or just above) sea level.

Pumps, electric motors and Energy Recovery Devices are factors that are not considered areas that can achieve greater efficiencies. New membranes and plant control management can improve in future, but only for minimal gains.

Water Corporation is an experienced operator of desalination facilities. The areas where efficiencies can be made have been applied to ASDP.

Table 12: Comparison of energy intensities for Australian seawater desalination plants

Plant name	Location	Start Year	Capacity		Energy Use	Intensity	Energy inclusions
			ML/day	GL/year	GWh / yr	kWh / kL	
ASDP	***Alkimos, WA***	***-***	***300***	***100***	***325***	***3.3**** (estimate)	SWIPS, Pretreat, RO, Potabilization
ASDP (with clear water pumping)					***412***	***4.12*** (estimate)	SWIPS, Pretreat, RO, Potabilization, CWPS
Perth SDP [Ref 2]	Kwinana, WA	2006	145	45	158	3.5*	SWIPS, Pretreat, RO, Potabilization
Southern SDP [Ref 6]	Binningup, WA	2012	300	100	340	3.4*	SWIPS, Pretreat, RO, Potabilization
Gold Coast SDP [Ref 1/2]	Tugun, SE Qld	2009	125	49	150	3.6	Total plant including CWPS
Sydney SDP [Ref 3]	Kurnell, NSW	2010	125 - 500	45 - 180	225 - 906	4.9 - 5.0	Total plant including CWPS (assumed)
Wonthaggi SDP [Ref 4]	Victoria	2012	410	150	788	5.3	Total plant including CWPS (assumed)
Port Stanvac SDP [Ref 5/7]	Adelaide, SA	2012	270	100	n/a	3.47 - 3.70	Unknown

*** without clearwater pumping**
SWIPS – Seawater Intake Pumping Station
Pretreat – Pre-treatment
CWPS – Clear Water Pumping Station

Reference sources:
1. Key Issues for Seawater Desalination in California, Energy and GHG Emissions (Pacific 2013)
2. Desalination Fact Sheet (AWA, 2020)
3. Sydney SDP environmental assessment (SW, 2005)
4. Aquasure web site (AWS, 2020)
5. Financial costs, energy consumption and GHG for major supply water sources (Goyder, 2014)
6. Southern SDP PER (EPA, 2020)
7. Planning, design, construction and operation of the Adelaide Desalination Plant (AWA, 2016)
5. Financial costs, energy consumption and GHG for major supply water sources (Goyder, 2014)
6. Southern SDP PER (EPA, 2020)
7. Planning, design, construction and operation of the Adelaide Desalination Plant (AWA, 2016)

At the proposed eventual production capacity of 100 GL /yr (excluding the energy requirement of the pumps distributing the produced water to the IWSS) the annual power consumption for ASDP is estimated at 325 GWh / yr. This translates to an energy intensity, operating at ultimate capacity of 100 GL/yr, of 3.3 kWh / kL. This is comparable with the best, i.e. lowest, energy intensities reported for both Australian and international facilities (Table 12 and Table 13).

Table 13: Comparison of energy intensities for international seawater desalination plants (Pacific, 2013)

Plant name	Location	Year Contracted / Start-up	Capacity	Feed TDS	RO Energy Intensity	Energy inclusions
			ML/day	g/L	kWh / kL	
ASDP	***Alkimos, WA***	***-***	***300***	***38.5***	***3.3***	SWIPS, Pretreat, RO, Potabilization
Umm Al Houl Expansion	Qatar	2019	282	45.9	3.60	Undefined
Tocopila SWRO	Chile	2019	6.48	-	3.2	Undefined
Al Khobar 1	Saudi Arabia	2018	210	48 - 53	4.0	Undefined
Marina East Desal Plant	Singapore	2016	137	35.4	3.37	Undefined
Barka IV	Oman	2016	281	42	3.0	SWIPS, Pretreat, RO, Potabilization
Sohar SWDP	Al Batinah	2016	250	40	3.023	Undefined
Tuas III	Singapore	2015	136		3.5	SWIPS, Pretreat, RO, Potabilization
Tuaspring / Tuas II	Singapore	2011	318.5	35.4	3.5	Undefined
Sorek	Israel	2010 / 13	627		3.5	SWIPS, Pretreat, RO, Potabilization

Plant name	Location	Year Contracted / Start-up	Capacity	Feed TDS	RO Energy Intensity	Energy inclusions
			ML/day	g/L	kWh / kL	
El Prat (Barcelona)	Spain	2009	200	39.7	3.5	SWIPS, Pretreat, RO, Potabilization
Caofeidian	China	2009	50		4.0	Undefined
Ashkelon Expansion	Israel	2009	41		3.8	Undefined
Hadera	Israel	2006 / 09	273		4.5	Undefined
Fujairah 1	UAE	2006	170		4.8	Undefined
Aruba	Caribbean	2006	8		4.0	Undefined
Bonaire	Dutch Antilles	2006	8		4.0	Undefined
Alicante II	Spain	2006	65		3.7	Undefined
China (name unknown)	China	2005	35		4.1	Undefined
Egypt (name unknown)	Egypt	2005	1		4.0	Undefined
Raleigh IWSPP	Saudi Arabia	2005	230		4.8	Undefined
Rambla Morales	Spain	2005	60		3.3	Undefined
Valdelentisco	Spain	2005	140		4.4	Undefined
Khor Fakhan Power Plant	UAE	2005	23		4.0	Undefined

4.0 Application of the Mitigation Hierarchy

The objective of the design, construction and proposed operation of ASDP is to implement measures, in order of priority, to avoid, reduce and offset GHG emissions.

The GHG emissions profile generated from the construction and operation of a desalination plant is primarily influenced by energy use. In addition to energy use, the following factors also influence GHG emissions and are components of ASDP measures to avoid and reduce GHG emissions:

- Site selection,
- Desalination technology,
- Use of energy recovery devices,
- The rate of recovery, i.e., the volume of freshwater produced per volume of seawater processed, and
- Design of intake and outfall and treatment processes to maximise use of gravity flow.

As the above factors vary from plant to plant, the energy intensity will also vary. The selection of the site for the desalination plant will determine the salinity of the source water and the temperature of the feed seawater. High salinity and high temperature feed water can limit the osmosis process as they affect the osmosis pressure, hence requiring more energy for the process. The quality of the seawater feed can also affect the extent of fouling of the membrane pores, thereby impacting the energy required for the pre-treatment phase.

In addition to these potential variations across the plants which may affect the energy intensity, the reporting boundary for each site may also vary. For example, if a site includes the energy for the water product distribution pumps in its reporting, then this would increase the reported energy intensity.

4.1 Greenhouse gas emissions avoidance

The following strategies outline the Water Corporation's Alkimos GHG avoidance strategies:

1. A continued focus on efficient use of water to reduce consumption. The Water Corporation has targets for reducing the per capita use of water in Perth. In addition to the implementation of various water efficiency initiatives, Water Corporation is addressing this by also exploring alternative sources of water for irrigation to counter the risk of irrigation demand moving to scheme water as a result of groundwater allocation reduction.

2. Locating ASDP close to consumer locations. Part of ASDP capacity will replace the reduced groundwater allocation (due to climate change) in the northern suburbs of Perth. The energy required to pump the water from the proposed ASDP to the northern suburbs consumers is lower compared to a more distant source, such as at Seabird (approximately 40 km further north), or an alternative desalination plant location south of the Swan River in Perth. ASDP is located close to the water source on the coast, minimising energy used in seawater pumping, with the design incorporating gravity intake and outfall tunnels.

   Planning studies by Water Corporation considered Seabird as an alternative location for the next major Seawater Desalination Plant for the Perth IWSS (an alternative to Alkimos SDP).

Drinking water pumping power for the Seabird option was estimated as 48,247 MWh/annum greater than that for Alkimos SDP. Selection of the Alkimos as the next SDP site therefore has reduced GHG emissions by 19,780 t CO_2-e / year for the period between Alkimos SDP start-up (2028) and the eventual Seabird SDP start-up (at least 10 years).

3. The Water Corporation will be seeking to apply a sustainability management system to the design, construction and operation of ASDP. The sustainability management system will ensure contemporary best practice design principles to avoid GHG emissions in the construction and operation will be captured. The Corporation has already negotiated for a substantial portion of the earthworks spoil from the ASDP site to be incorporated into the local future Alkimos Coastal Village development. This represents a substantial reduction in GHG emissions compared to the base case of transporting the spoil for disposal outside of the Alkimos area. The reduction is estimated as ~6,600 t CO_2-e total during the bulk earthworks construction period in 2023 / 24.

   This example illustrates one major saving that has been identified for the Alkimos project construction. Many others have already been identified and it is expected that more will follow.

4. Competitive bid strategy supporting the principles of sustainable procurement will be used to award the contract to design, build and operate ASDP. The competitive bid strategy is focused on contemporary best practice from international consortia bidding for the design and construction of the plant prioritise the avoidance of GHG emissions, including partners incentivised in design, build and operation for increased energy efficiency.

4.2 Greenhouse gas emissions reduction and energy efficiency measures

The following strategies outline the Water Corporations Alkimos GHG reduction strategies

1. Implementation of energy recovery devices. For Water Corporation's Perth SDP and Southern SDP, best practice was implemented through the use of energy recovery technologies. ASDP will also incorporate Energy Recovery Devices which recover energy from the concentrate stream and apply this recovered energy to the feed stream of the reverse osmosis process. Water Corporation was the first to pioneer this technology with the Perth SDP (in 2006). The reverse osmosis process and membrane selection will aim to optimise overall plant recovery and reduce the volume of seawater pumped.

   State-of-the-art energy recovery devices such as the ERI PX® Pressure Exchanger (as used at Water Corporations' two existing seawater desalination plants) are highly efficient devices that transfer pressure energy from the RO brine stream to a portion of the RO feed. This reduces the 1st—pass RO pumping power requirement by approximately 60%. For Alkimos SDP the 1st pass RO pumping power with energy recovery is approximately 2.2 kWh/m3. This would be approximately 3.66 kWh/m3 without energy recovery.

   The inclusion of energy recovery saves approximately 1.44 kWh/m3 or 144,000 MWh/annum equivalent to ~59,000 t CO_2-e / year. This reduction is already included in the emission estimates provided in this GHG Management Plan.

   As current ERD technology is already highly efficient, there is very limited scope for further efficiency improvement. More likely improvements will be achieved in RO membrane technology and application of artificial intelligence to plant operation and optimisation. These improvements are likely to be realised within the timeframe of Alkimos SDP design, construction and future operation and could reasonably achieve 0.1 kWh/m3 further improvement in specific energy consumption equivalent to ~4,000 t CO2-e / year. There are already examples in field tests where implementation of AI on existing seawater reverse osmosis systems have delivered such benefits. This reduction is not included in the emission estimates within this GHG Management Plan and would commence at plant startup in 2028 and be present for the life of the facility..

2. Competitive bid strategy will be used to design, build and operate the plant. The competitive bid strategy is focused on ensuring contemporary global best practice from international consortia bidding for the design and construction of the plant to maximise energy efficiency and GHG emissions reduction including partners incentivised in design, build and operation for increased energy efficiency.

3. Energy use at ASDP is to be mitigated primarily through design, incorporating efficiency and energy recovery. As part of the best practice approach to reduce energy consumption and GHG emissions, various energy efficiency measures have been incorporated in the proposed ASDP design. These measures include the following:

   - The overall location of the plant will result in the delivery of water close to a large concentration of consumers and avoids the energy requirement to pump an extra 40 kilometres (from an alternative SDP site near the township of Seabird).

   - Intake and Outfall Tunnel diameters and lengths were selected to optimise flow velocities and energy use while meeting environmental objectives. The seawater intake tunnel diameter has been specified to achieve a low flow velocity of less than 1.0m/sec for the 100 GL/annum plant. While this has been done for a number of reasons including construction safety and construction schedule, it also provide a power reduction benefit at the seawater intake pump station. A more conventional velocity for this flow would be around 1.5 m/sec which would require 1990 MWh/annum additional pumping power, equivalent to ~815 t CO2-e / year. This reduction that will commence in 2028 and exist for the life of the plant has already been included in the GHG estimates within this Management Plan.

   - The hydraulic arrangement of the site was staged to optimise gravity flows though the plant from the intake, thereby reducing energy use for pumping.

     A typical seawater desalination plant returns approximately 60% of the seawater intake flow to the ocean as brine. Only the remaining 40% is produced as desalinated water and subsequently pumped to the distribution network. Therefore, reducing the elevation of the desalination plant will reduce the total pumping energy required. The proposed location of the Alkimos SDP has been moved since early concept design and the detailed earthworks design has lowered the elevation of the treatment facilities further. In the early location/concept the RO building was located on a pad at approximately 36m AHD while in the current design the RO building pad level is approximately 10m AHD. This change reduces pumping power by and estimated 14,700 MWh/annum equivalent to ~6,000 t CO2-e / year.

- Pre-treatment process selection was made using membrane options that had a history of producing biologically stable treated water. These were selected over alternatives that had had been shown to experience downstream biological fouling issues, which results in higher pumping energy requirement for the Reverse Osmosis desalination process. This is operationally more efficient and has a 'whole of life' energy saving. The Water Corporation experiences significant pre-treatment membrane fouling problems at its Southern Seawater Desalination Plant (SSDP).

  The Alkimos SDP design aims to implement improved design and membrane selection, so the fouling is reduced to acceptable levels. This is conservatively estimated to reduce the average pumping head on the Alkimos seawater pumps by 1m (compared to SSDP). This would reduce annual power consumption by 566 MWh/annum additional pumping power, equivalent to ~230 t CO2-e / year commencing in 2028 and persisting for the life of the plant.

  Additional savings in chemical use will also be realised but have not been quantified.

- A split-hybrid membrane design with recoveries of at least 50% was selected and shown to meet the treated water quality requirements in all scenarios, reducing sizing of upstream process units and associated mechanical equipment, with attendant energy savings.

  With current SWRO technology, the minimum total specific power consumption for seawater RO occurs at a 1st pass recovery rate of approximately 50%. The specific power consumption at this recovery rate is approximately 1.1% lower than at 45% recovery, which is the design recovery rate for SSDP. The selection of the higher recovery rate is therefore estimated to reduce Alkimos SDP power consumption by 3630 MWh/annum equivalent to ~1480 t CO2-e / year.

- Energy Recovery Devices have been integrated into the design to optimise the recovery of energy within the reverse osmosis process itself.

- The arrangement of the associated low-pressure reverse osmosis pumps and a cartridge filter system was optimised to minimise energy losses.

- Incorporation of Eglinton groundwater will only proceed if a groundwater allocation licence is obtained. The groundwater treatment plant (GWTP) design was based on the existing Neerabup GWTP filtration units and incorporated the current generation filtration design accepted at the Jandakot GWTP which is recognised as a reliable and energy efficient arrangement The efficiency benefits of the Leopold filter underdrainage system, as installed at the Water Corporations Jandakot GWTP and proposed for the Eglinton GWTP filters, have been generally noted by Water Corporation operators, but not measured. Observed benefits include improved filter backwashing resulting in fewer backwashes and reduced headloss when backwashing resulting in lower backwash pump power consumption.

  As these benefits are yet to be measured it is not possible to provide an estimate of GHG reduction.

- Blending of the SDP permeate and GWTP filtrate reduced the energy required in the production of 'on-spec' blended water and the chemical demand of the stabilisation system. The blending of 4.9 GL/annum of Eglinton groundwater into Alkimos permeate provides at least 390 tonnes of excess alkalinity (as $CaCO_3$) that would otherwise need to be dosed as chemical to potabilise the RO permeate. The reduced chemical dosing for alkalinity addition amounts to approximately 300 tonnes per annum of hydrated lime and 350 tonnes per annum of carbon dioxide gas. Both of these chemicals would be purchased from a local manufacturer and transported to site.

The major GHG saving is the reduction of embodied carbon in the manufacture and transport of these two chemicals which is not able to be quantified by the Water Corporation.

- Lighting would be low consumption LEDs.

  Accounting only for the high bay lighting used in the tall treatment buildings (approximately 20,000 m^2 of total floor area) the use of high efficiency high-bay LED lighting instead of HID will save ~1950 MWh per year of power ***equivalent to ~800 t CO2-e / year.***

  Compared to high output fluorescent (HIF) high bay lighting the relative savings are estimated as ~350 MWh per year of power ***equivalent to ~140 t CO2-e / year.***

- Rooftop solar panel options will be adopted for power augmentation. The investigation work determined a potential preliminary energy output of approximately 3,100 MWh/year.

  The estimated solar power output equates to a GHG reduction of approximately ***1270 t CO2-e / year.***

4. During plant operation, continuous improvement principles will be adopted to reduce emissions over the project life. Specific energy consumption for the total process will be monitored and key performance indicators set, with corrective action triggers, to ensure the plant continues to operate at target energy consumption levels or better. Activities which will be undertaken during operation to reduce energy use include:

- Monitoring of key performance indicators, such as differential pressure across membranes (which can indicate loss of performance) (e.g., membrane cleaning and replacement, pump overhauls).

  Power monitoring is to occur throughout the plant, with visibility through the control system and data historian. The control system will be configured to convert power consumption to specific energy consumption (kWh/kL) for each plant area plus useful summations (eg. seawater pumping + pre-treatment + RO + potabilization).

  Overall specific energy consumption will be a KPI reported on in the monthly operating report. Variance above the specific energy consumption shall require root cause investigation and corrective actions.

- Carrying out regular pump efficiency measurements and ensuring regular overhaul of pumps to improve operation and efficiency.

- Monitoring trends of specific energy use per kL of water production to assist in troubleshooting and efficiency improvements.

- Maximising plant utilisation to reduce inefficiencies attributed to starting / stopping the plant.
- Addressing continuous improvement by following innovation trends in membrane technology and replacing existing membranes with contemporary best practice technology to reduce energy use.

.3 Greenhouse Gas Emissions Offsets

The Water Corporation proposes to construct and operate ASDP to net zero Scope 1 and Scope 2 GHG emissions. To achieve this commitment the Water Corporation will offset:

- 100% of Scope 1 and 2 emissions during construction which have not been avoided or reduced, and
- 100% of Scope 1 and 2 emissions during operations which is not being avoided or reduced.

The Water Corporation's commitment to offset Scope 2 emissions excludes emission reductions in the SWIS made by the WA Government independent of Water Corporation renewable energy projects. (i.e., if the SWIS is net zero emissions, then Water Corporation does not need to contribute additional offsets apart from the insignificant Scope 1 emissions created in ASDP operation).

The Water Corporation is implementing its Climate Change and Energy Strategy (Water Corporation 2021) establishing a plausible, timely, achievable, reasonable and practicable pathway to address GHG emissions and engage the energy market. The focus of the Water Corporation's GHG emission management strategy includes, demand and supply adaptation, operational adaptation and energy procurement and Management

As a GTE, Water Corporation is working with the State to decarbonise the SWIS. Water Corporation's Energy Procurement Plan will provide over 400MW of wind energy to SWIS by 2032. The 400MW provision will power 1,576,800 WM hours per annum. ASDP at full capacity will required 400,000MW hrs per annum. The proposal is anticipated to require half of this energy requirement (200,000MW hrs per annum) until 2032. The renewable energy provision to power ASDP will be provided to the SWIS. Approximately 450,000MW hours of renewable energy will be provided to the SWIS by 2024, with a further 800,000MW hours supplied to the SWIS by 2028. Providing renewable energy to the SWIS is the method ASDP proposed to meet net zero scope 2 GHG emissions for construction and operation.

To the extent that GHG emissions from ASDP energy requirements cannot be avoided or adequately reduced, the Water Corporation will offset GHG emissions using either Authorised Offsets or production and purchase of an equivalent amount of renewable energy, or a combination of the two.

The Water Corporation is currently developing a diverse portfolio of GHG emissions offsets registered under the Commonwealth Emissions Reduction Fund regulated by the Clean Energy Regulator, which may include:

- the supply of renewable energy from wind and solar energy projects to offset energy from carbon intensive sources,

- the generation of ACCU's through savannah burning, biodiverse native revegetation and pine plantation projects.

For the purposes of this Plan, Authorised Offsets are units representing GHG Emissions issued under one of the following schemes and cancelled or retired in accordance with any rules applicable at the relevant time governing the cancellation or retiring of units of that kind:

(a) Australian Carbon Credit Units issued under the Carbon Credits (Carbon Farming Initiative) Act 2011 (Cth);

(b) Verified Emission Reductions issued under the Gold Standard program;

(c) Verified Carbon Units issued under the Verified Carbon Standard program; or

(d) other offset units that the Minister has notified the proponent in writing meet integrity principles and are based on clear, enforceable and accountable.

The Corporation will seek to access a range of different offset types as a risk reduction measure.

Vegetation-based offsets are proposed to be limited to offset Scope 1 emissions and are currently Planted and generating ACCU's.

In developing a range of offsets, the Corporation will seek to provide some significant co-benefits for the State, particularly around improving biodiversity, supporting agriculture and partnering or contracting with Aboriginal businesses and corporations to develop and manage the offset processes.

5.0 ASDP GHG emissions targets

In the development of this GHGMP the Water Corporation has taken into account:

- the WA Government (and Water Corporation) aspirational target of zero net GHG emissions by 2050;
- an increase in renewable sources providing energy into the SWIS;
- the projected decline of coal use for electricity generation;
- the ASDP project proposed Scope 1 and 2 GHG emissions; and
- the application of the mitigation hierarchy.

5.1 Net Zero Scope 1 and Scope 2 GHG Emissions during construction and operation

The Water Corporation proposes to construct and operate ASDP with a net zero GHG emissions (Scope 1 and 2). The Water Corporation will avoid, reduce or offset emissions:

- to achieve net zero Scope 1 and Scope 2 tonnes of CO_2-e during construction and operation;
- calculated on a 5 yearly basis commencing 2023 (or project commencement);
- with the acquisition and surrender of suitable offsets will be completed no more than 6 months after the end of the five yearly emissions calculation period
- with the surrender of ACCU's or LGC's generated within a maximum period of 5 years from emissions in alignment with the 5-yearly reporting period..

The avoidance, reduction and offset of Scope 1 and 2 emissions during operation excludes emission reductions in the SWIS made by the WA Government independent of Water Corporation renewable energy projects (i.e. if the SWIS is net zero emissions, then Water Corporation does not need to contribute additional offsets apart from the insignificant Scope 1 emissions created in ASDP operation).

The estimated emissions profile is presented in Table 14 and Table 15 and Figure 2.

Table 14: Summary un-mitigated maximum estimated GHG emissions profile

GHG emissions	GHG Emissions Schedule		
	Construction - 2023-2026	**Commissioning - 2027-28**	**Operations - 2028 and beyond**
Scope 1 emissions	Up to 32,747 tCO_2-e	Up to 635 tCO_2-e	421 tCO_2-e per annum
Scope 2 emissions	Up to 3,468 tCO_2-e Note 1 & 2	Up to 40,039 tCO_2-e Note 1 & 2	Up to 168,897[6] tCO_2-e per annum Note 3, 4 & 5 Commencing 2028 and decreasing annually with the reduction in the SWIS GHG emission factor
Total	Up to 36,214 tCO_2-e	Up to 40,674 tCO_2-e	Up to 169,318 tCO_2-e per annum

Notes:

1. Using the 2023 National Greenhouse Accounts emission factor (DISER, 2021)
2. Using the 2027 National Greenhouse Accounts emission factor (DISER, 2021)
3. Using the 2028 National Greenhouse Accounts emission factor (DISER, 2021)
4. For the ultimate SDP capacity of 100 GL/annum)
5. Commencing 2028 and decreasing annually with the reduction in the SWIS GHG emission factor
6. Excluding commissioning

Table 15: ASDP maximum emissions and net GHG Emissions for the life of asset

Phase	Construction	Commissioning and operation					
Year	**2023-2026**	**2027-2031***	**2032-2036**	**2037-2041**	**2042-2046**	**2047-2051**	**2052-2128**
Scope 1 (tCO_2-e)	32,747	2319	2105	2105	2105	2105	32,207 (421 t pa)
Scope 2 (tCO_2-e) **(With reduction in grid emissions by 2050)**	3,468	662,696	609,680	419,155	228,671	45,726	0
GHG emissions total (tCO_2-e)	36,214	665,015	611,785	421,260	230,776	47,831	32,207
GHG emissions avoided, reduced or offset (tCO_2-e)	**36,214**	**665,015**	**611,785**	**421,260**	**230,776**	**47,831**	**32,207**
Total emissions	**2,047,573 t CO2e**						
Net GHG emissions	**0**	**0**	**0**	**0**	**0**	**0**	**0**

*2028 will likely include the commissioning period.

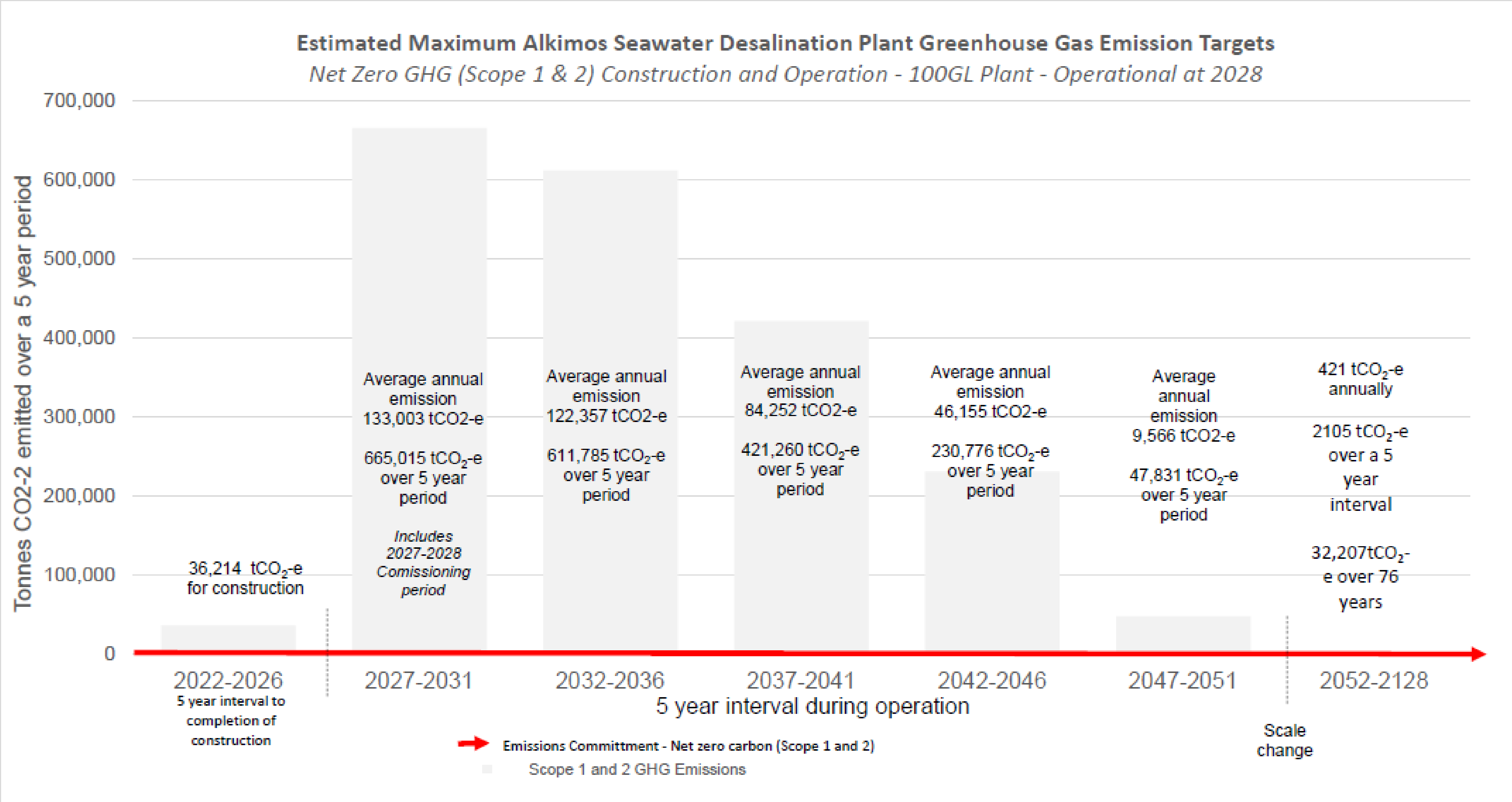

Figure 2: ASDP net zero GHG emissions for the life of asset (taking into consideration the grid moves towards net zero emissions by 2050)

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5.2 Reporting and Transparency

The Water Corporation is committed to transparency in the operation of ASDP and publicly reporting performance against the proposed GHG emissions targets and as such proposes the following reporting actions:

1. Publish this GHGMP publicly on a Water Corporation website and will also make a copy available on request.
2. Prepare and publish a **summary report** of this GHGMP detailing the:
   - net GHG emissions targets
   - quantity of GHG emissions
   - GHG emissions intensity
   - GHG emissions avoidance, reduction and offset measures
   - quantity of desalinated water produced
   - the scheduled GHGMP review.
3. Prepare and publish an **annual report** detailing the:
   - quantity of GHG emissions
   - net GHG emissions
   - GHG emissions intensity
   - quantity of desalinated water produced.
4. Prepare and publish a **consolidated five yearly performance report** detailing the performance during a five-year emissions target period, with the first five-year period ending in 2027. The five-yearly report will detail the:
   - quantity of GHG emissions
   - net GHG emissions
   - GHG emissions intensity
   - quantity of desalinated water produced
   - type, quantity, identification or serial number and date of retirement or cancellation of any Authorised Offsets which have been used to retire or cancel GHG emissions.
5. A summary document comprising of a summary plan and progress statement outlining key information from the GHGMP (and reports to that time) and the GHGMP (if revised). The summary will include:
   - a graphical comparison of the GHG emissions reduction commitments demonstrating net zero construction and operation
   - proposal performance against benchmarking for comparable facilities
   - GHG emissions intensity
   - A summary of emission reduction measures undertaken
   - Clear statement as to whether interim targets have been achieved
   - type, quantity, identification or serial number and date of retirement or cancellation of any Authorised Offsets which have been used to retire or cancel GHG emissions.

The Water Corporation importantly note that in the event of a national framework for managing GHG Emissions, such as a Carbon Tax or similar, compliance will be sought with that framework. Through this EP Act assessment process, the Corporation will seek to have included a suitable

Condition to allow the management of GHG emissions to be managed under a regulated Commonwealth program should one be invoked that covers entities like the Corporation.

7.0 Conclusions

This document has been prepared to address the objective of the Environmental Protection Authority factor guideline for Greenhouse Gas Emissions.

This Greenhouse Gas Management Plan has detailed:

- A GHG emissions inventory for the construction and operation phases of the SDP (Section 2)
- the adoption of best practice design, benchmarking, technology and management appropriate to mitigate GHG emissions (Section 3 and 4), and
- The application of the mitigation hierarchy to avoid, reduce and offset emissions, including interim and long-term emissions reduction targets (Section 4); and,
- The Corporation's objective of having zero net GHG emissions created by ASDP during construction and operation (Section 5).

All this information is designed to adequately demonstrate that the Water Corporation proposal in respect to GHG emissions from ASDP, in the form of the mitigation hierarchy, is plausible, timely, achievable and is reasonable and practicable.

6.0 References

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