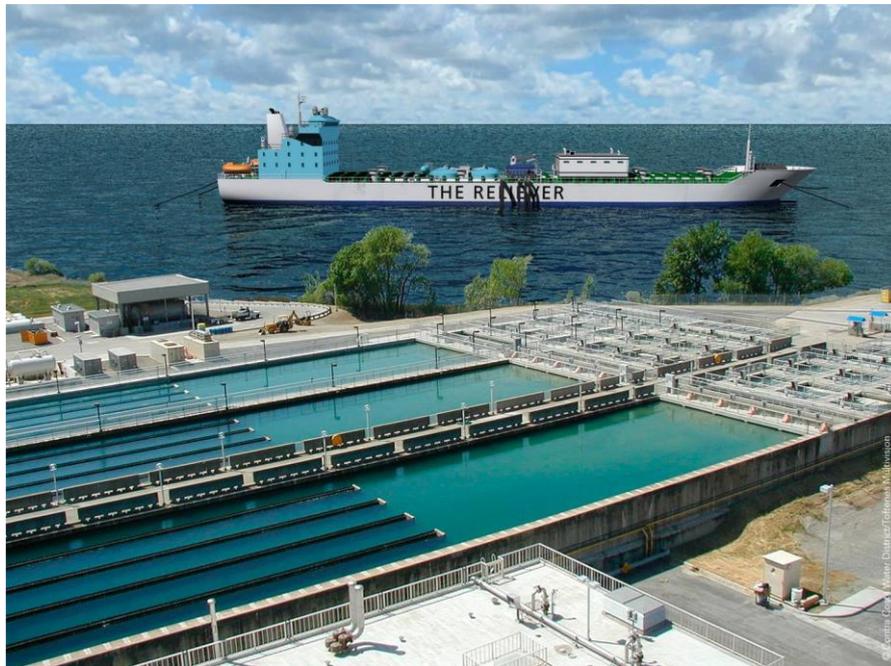


## Project Proposal

# An Offshore Wastewater Treatment Solution for Greater Victoria

## EnviroNor AS



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EnviroNor AS

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## Overview

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*An offshore solution that meets the wastewater requirements for Greater Victoria and eliminates the obstacles of traditional, land-based installations.*

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This proposal outlines an innovative and cost effective approach to address the Greater Victoria region's wastewater treatment needs. We propose to provide the Capital Regional District with a single Floating Aqua Recovery Unit (FARU) that has the daily capacity to treat 125 million litres of municipal wastewater, recover clean water for agricultural purposes and produce biosolids and biogas. This treatment capacity exceeds the current wastewater production of the region, thereby addressing future population growth and urban expansion up to 2065.



## The EnviroNor Concept

EnviroNor AS is a Norwegian company that officially launched in 2011. The core principle of the company is to take decommissioned oil tankers and repurpose them for a variety of offshore aqua recovery solutions including wastewater treatment and seawater desalination. We refer to these as **Floating Aqua Recovery Units (FARUs)**. Our aim is to provide coastal regions with clean water and protect the marine environment from urban pollution.

The concept draws on Norway's extensive expertise in shipping and offshore/sub-sea technologies. It combines knowledge and competence from these sectors to deliver efficient, more affordable treatment services to the water sector, when compared with traditional, land-based solutions.

Due to its exceptional nature, the EnviroNor concept was named DNV GL's Extraordinary Innovation Project of 2014. This was the first time an external project to DNV GL's own research and development activities was awarded this title. The DNV GL has since provided technical support and feasibility appraisal for EnviroNor AS, and are valued partners in our concept development. The results from DNV GL's study show that **EnviroNor is both technically and commercially viable**.



*Key benefits of the concept include:*



Lower capital expenditure.



Reduced construction time (1 - 2 years).



Reduced noise and zero odour (offshore and fully contained processes).



Capacity and technologies are easier to upgrade.



Mobility and location flexibility (tsunami and earthquake avoidance, environmental and aesthetic factors).



Recovery of high quality water (industrial/agricultural grade and even potable grade).



Recovery of biosolids/fertiliser and biogas.

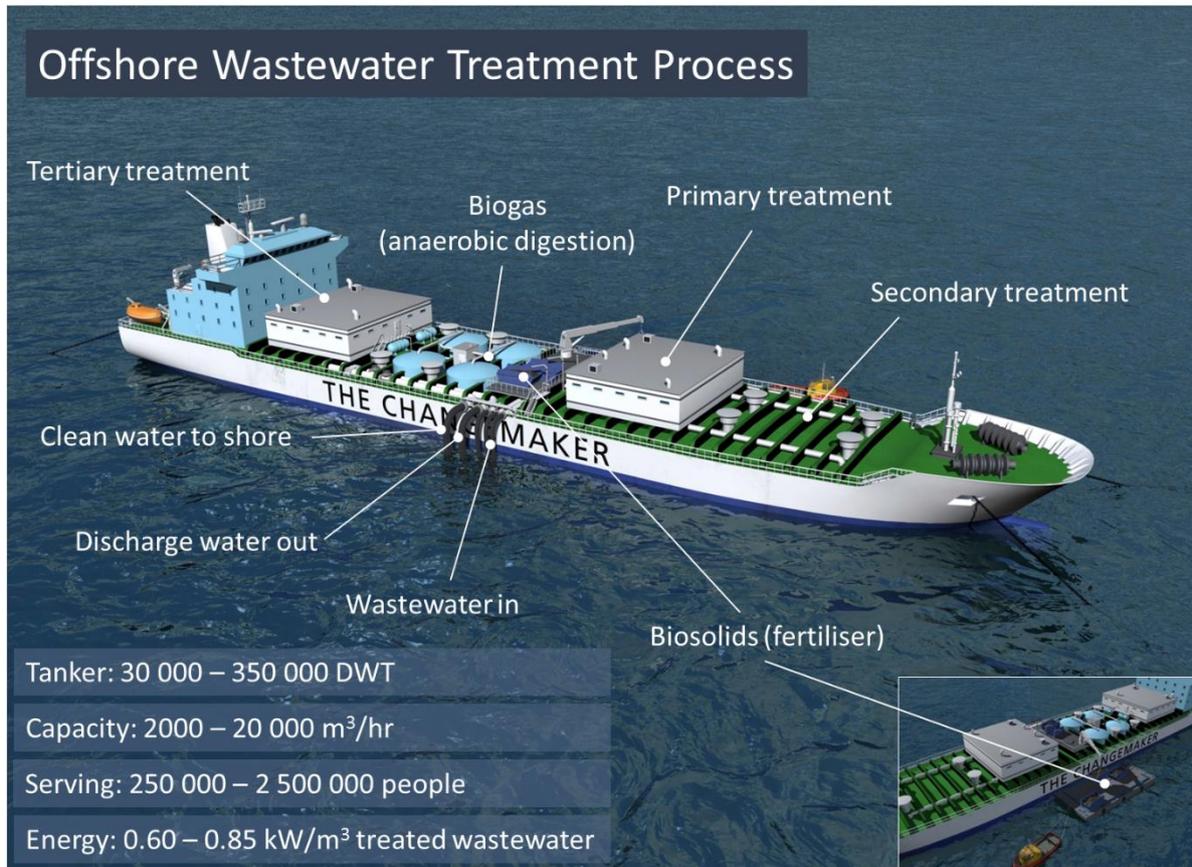


Life extension of existing oil tankers.



## The Changemaker

Our large-scale wastewater treatment FARU, named the “**Changemaker**”, is designed to treat municipal wastewater on a permanent basis and provides treatment to a tertiary level. Depending on the vessel size, it can serve city populations ranging from **250 000 to 2.5 million people** (equivalent to 50 – 500 million litres of wastewater per day).



### Treatment Process:

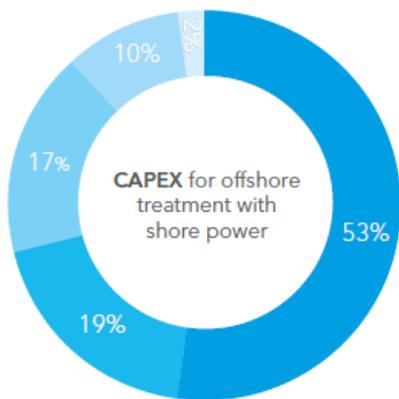
- ✓ Primary treatment through filtration.
- ✓ Biological treatment for removal of organic substrate and nitrification via moving bed biofilm reactors (MBBR) in two parallel lines.
- ✓ Coagulation and floatation treatment.
- ✓ Sludge treatment (biosolids) and anaerobic digestion (biogas extraction).
- ✓ If the wastewater is to be reused for industrial purposes or irrigation, further treatment will include fine filtration and disinfection by UV.



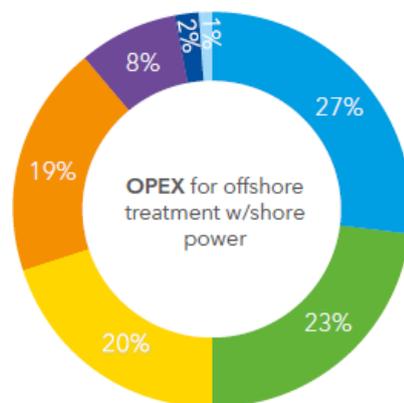
*Costs:*

An EnviroNor Changemaker has **less than 70%** of the capital expenses (CAPEX) when compared to a land-based solution. The lower CAPEX is mainly due to a reduction in construction costs by removing the need for land-purchase and by re-using existing structure, tanks and equipment on board the vessel. These savings become greater as the vessel size increases.

The main operating expense (OPEX) drivers are the costs of personnel, maintenance, chemicals and other operational costs related to the treatment process. The energy costs constitute only 10 – 13% of the OPEX, depending on whether power from shore (termed “cold-ironing” in shipping vernacular) or marine gas oil (e.g. LNG) consumed on board is applied. Furthermore, recovery of methane biogas within the treatment process can support up to **30 - 50% of the energy demand**.



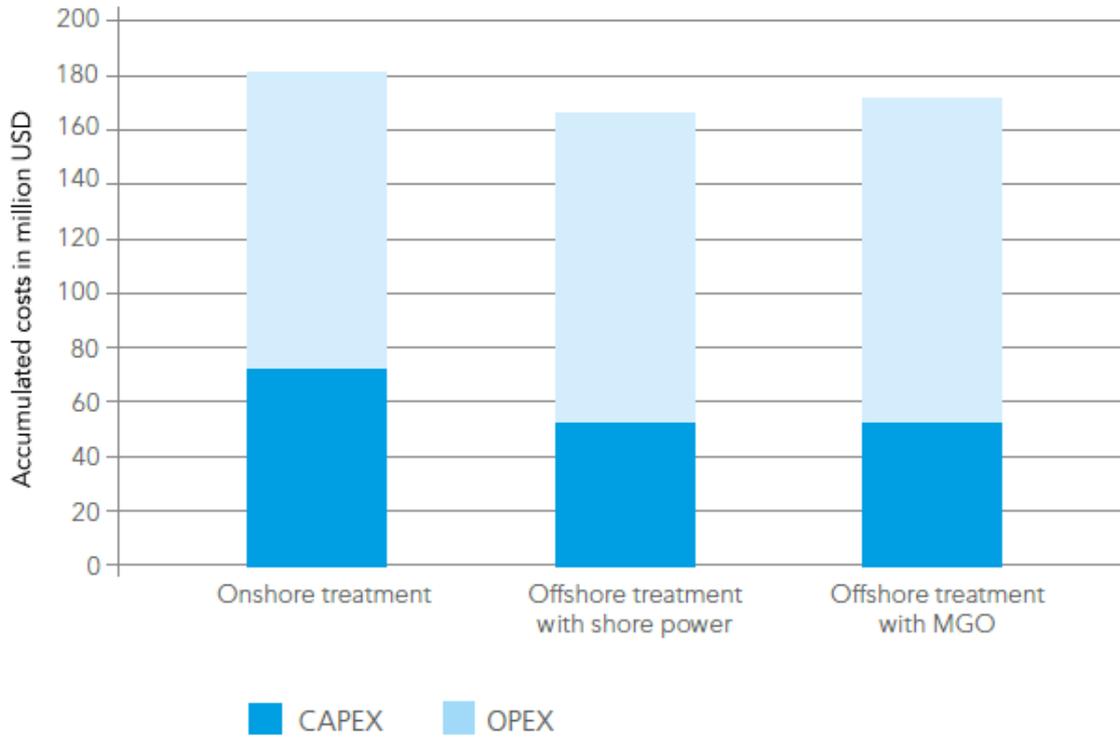
- Technology costs
- Construction and conversion costs
- Vessel costs
- Engineering costs
- Shore power system



- Manning
- Chemicals
- Other operating expenses
- Maintenance
- Power
- Equipment and technology
- Vessel docking costs



### Cost comparison over 20 years



*\*Cost comparisons given in the figure above are for illustrative purposes only. They are calculated for a 40 000 DWT vessel with a treatment capacity of 50 million litres per day. Absolute costs will increase with vessel size, but the relative savings will increase as well. \**



# EnviroNor Proposal for the Greater Victoria Region

Current wastewater production, with connections to the CRD's Core Area System, totals approximately 90 million L per day (MLD). This wastewater is discharged, untreated, into the Juan de Fuca Strait via two outfalls that lie 1 – 2 km offshore and 4 – 5 km apart; Macaulay and Clover Point.

As of 2006, the CRD was placed under federal and provincial order to implement secondary wastewater treatment in the Core Area by 2020. The project has been allocated a \$788 million budget to achieve this, with \$500 million from federal funding agreements. Within the scope of the project is the construction of a wastewater treatment plant, a biosolids recovery centre and improvements to the conveyance system of pump stations and pipes.

The original proposal, developed by the Seaterra Program, included a \$179 million wastewater treatment plant at McLoughlin Point with a treatment capacity of 124 MLD. In addition to this, a separate Resource Recovery Centre (RRC) was to be built using an earmarked federal fund of \$83.4 million and an additional \$62 million from provincial funding. The RRC included processes for the recovery of biosolids and biogas from the residual solids produced at the treatment plant.

## The EnviroNor Solution

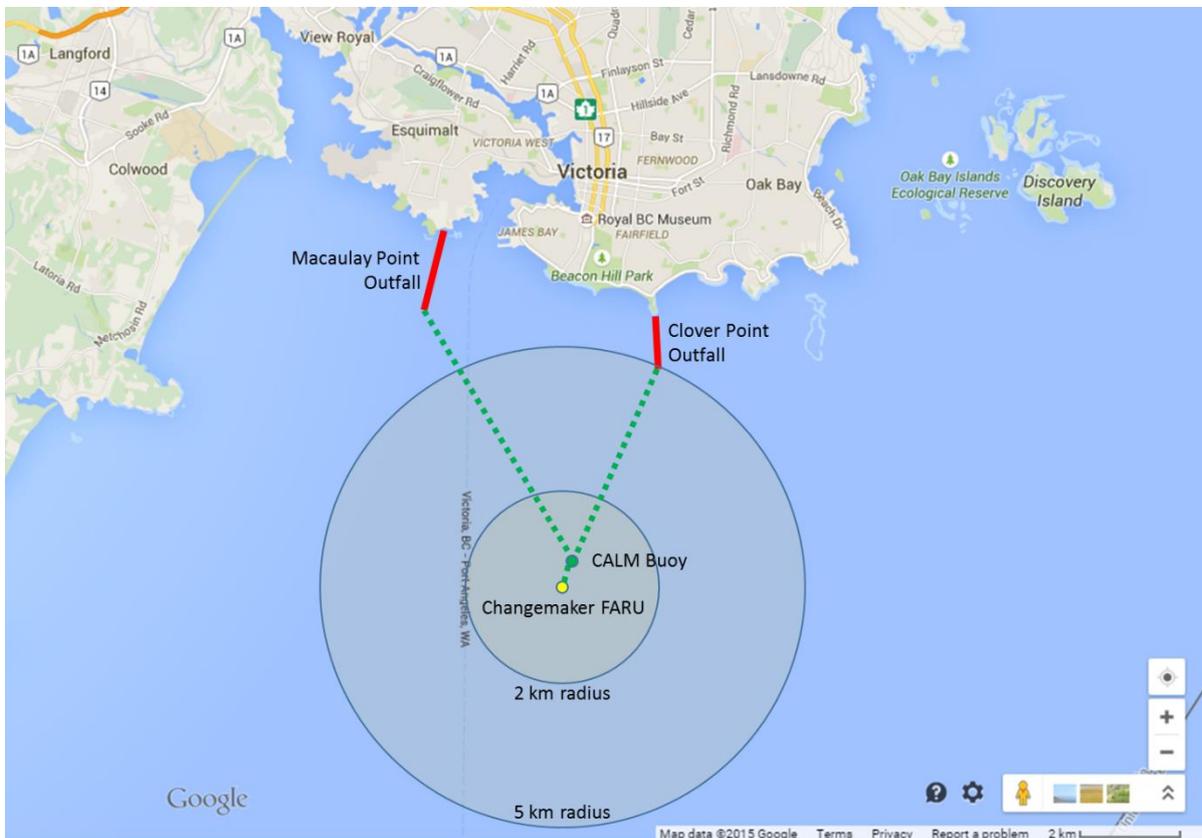
A comparable sized Changemaker, to the McLoughlin Point treatment plant, would be a 100 000 DWT vessel with a **125 MLD treatment capacity**. This FARU would be capable of tertiary level treatment (as outlined above) and would also have the ability to recover water, biosolids and biogas. Produced biosolids can be transported by barge to shore for onward distribution whilst the methane biogas can be utilised within the Changemaker to offset energy requirements. The recovered water from the treatment process would be suitable for both industrial and agricultural uses and can be returned onshore to join the existing water conveyance infrastructure.

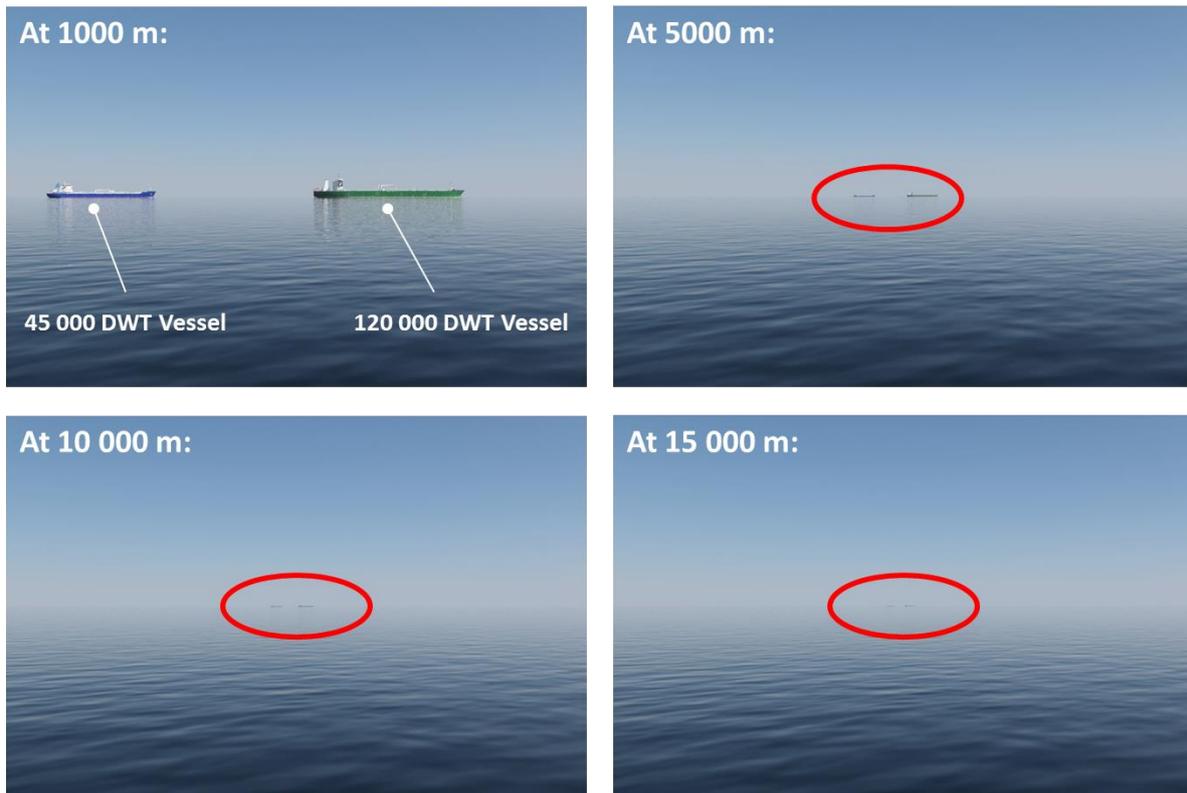


## Location

The existing outfalls provide a logical and convenient point at which to connect the Changemaker to the CRD’s Core Area wastewater conveyance network. Subsea piping, connected to these outfalls, would converge at a CALM buoy anchored adjacent to the FARU. From this mooring, a hose assembly would carry the wastewater into the vessel for treatment.

To limit visibility from shore, we propose to anchor the vessel approximately 5 km from the Clover Point outfall and 2 km east of the main shipping lane that enters Victoria Harbour. At this distance, the vessel will be **6 km from the closest point onshore.**





### Costing overview\*

Within the original wastewater management proposal, CRD had budgeted \$324.4 million for the treatment plant and RRC. A single Changemaker is capable of performing the function of both of these installations for a total CAPEX of approximately **\$190 million**. Without additional local information, an estimate for the OPEX is not possible at this stage. However, we can confirm that the operational costs for an offshore FARU will be comparable to that of a similarly sized land-based installation (i.e. the proposed McLoughlin Point wastewater treatment plant).

In order to arrive at a more accurate budgetary cost, we would perform a feasibility study that includes all aspects of the project. This would be carried out in collaboration with DNV GL ([www.dnvgl.com](http://www.dnvgl.com)) to assess the technical and logistical requirements, as well as the environmental constraints. This study would typically be conducted over a three-month period at an approximate cost of **\$300 000**.

*\*Values given are estimates only, and are subject to change. They are based on publicly available information and the anticipated requirements of the CRD.*



## Partnership arrangement between EnviroNor and CRD

The nature of the contract between EnviroNor and CRD can be structured in a number of different ways (e.g. PPP, BOT, 15-year lease etc.). A “pay-as-you-use” service reduces up-front investment for the customer, but requires a flat rate daily charge and an additional throughput fee per m<sup>3</sup> water. An alternative is a Build-Operate-Transfer (BOT) agreement where the CRD may take over the FARU after an agreed period of time or at the end of the contract period.

In the case of the CRD, where funding is available to purchase the FARU upfront, we would still retain management of the operations for a fixed period (4 – 8 years), during which time local staff would be trained to operate and maintain both the treatment plant and the vessel itself. This is to ensure that the system is operated efficiently and effectively and will continue to do so into the future.

## Financing opportunities with Export Credit Norway\*

Export Credit Norway ([www.eksportkreditt.no](http://www.eksportkreditt.no)) is a state-owned limited liability company that provides long-term debt financing on competitive terms to customers of Norwegian exporters. These loans are guaranteed by the Norwegian Guarantee Institute for Export Credits (GIEK) and/or commercial banks.

For environmental projects, including water and wastewater treatment solutions, Export Credit Norway is currently offering long-term loans with low, fixed interest rates, for a period of up to 18 years. At present, the fixed interest rates offered by Export Credit Norway on a CIRR, OECD, 18-year loan are 3.38% (USD) and 1.81% (EUR). The financing offered is typically for 85 % of the export contract value.

*The application process consists of six steps:*

1. The exporter or buyer contacts Export Credit Norway, describing the prospective export contract and project or purchase to be financed. The loan application must be submitted before the exporter and buyer sign the export contract.



2. Export Credit Norway prepares an indicative term sheet, outlining key terms and conditions in the financing proposal. The exporter and the buyer sign the export contract before the process continues.
3. Loans from Export Credit Norway must be guaranteed by the Norwegian Guarantee Institute for Export Credits (GIEK) and/or one or more acceptable financial institutions. The guarantors will issue loan guarantees in favour of Export Credit Norway after they have conducted a favourable credit assessment of the project and the borrower.
4. After the guarantors have made their guarantee offer, Export Credit Norway drafts a loan agreement in consultation with all involved parties. This loan documentation will incorporate Export Credit Norway's terms and conditions, as well as the terms and conditions set by the guarantors.
5. Export Credit Norway disburses the loan to the exporter subject to the terms and conditions in the loan agreement. Disbursement is made after the exporter has made part or final delivery of the agreed product or service to the buyer.
6. The buyer repays the loan to Export Credit Norway.

#### *Qualifying Terms:*

1. The project must include Norwegian content.
2. Specifically, 30% (or more) of the water/wastewater project content must benefit Norway and Norwegian business.
3. Buyer must allow a Norwegian entity to own the majority, or controlling shares of the business.
4. Project must support the exports of Norwegian subsidiaries.

Other Financing Options: EnviroNor will work with investors and buyers to identify suitable financing options for individual client needs.

*\*Export Credit Norway/GIEK has made no upfront commitment and has not signed any legally binding contract to finance EnviroNor projects. EnviroNor and/or the buyer must apply for financing every time a new project is initiated.*



# An offshore solution for Greater Victoria's wastewater treatment

Sigmund Larsen, CEO & Founder

Dr. Patrick Brading, Environmental Advisor

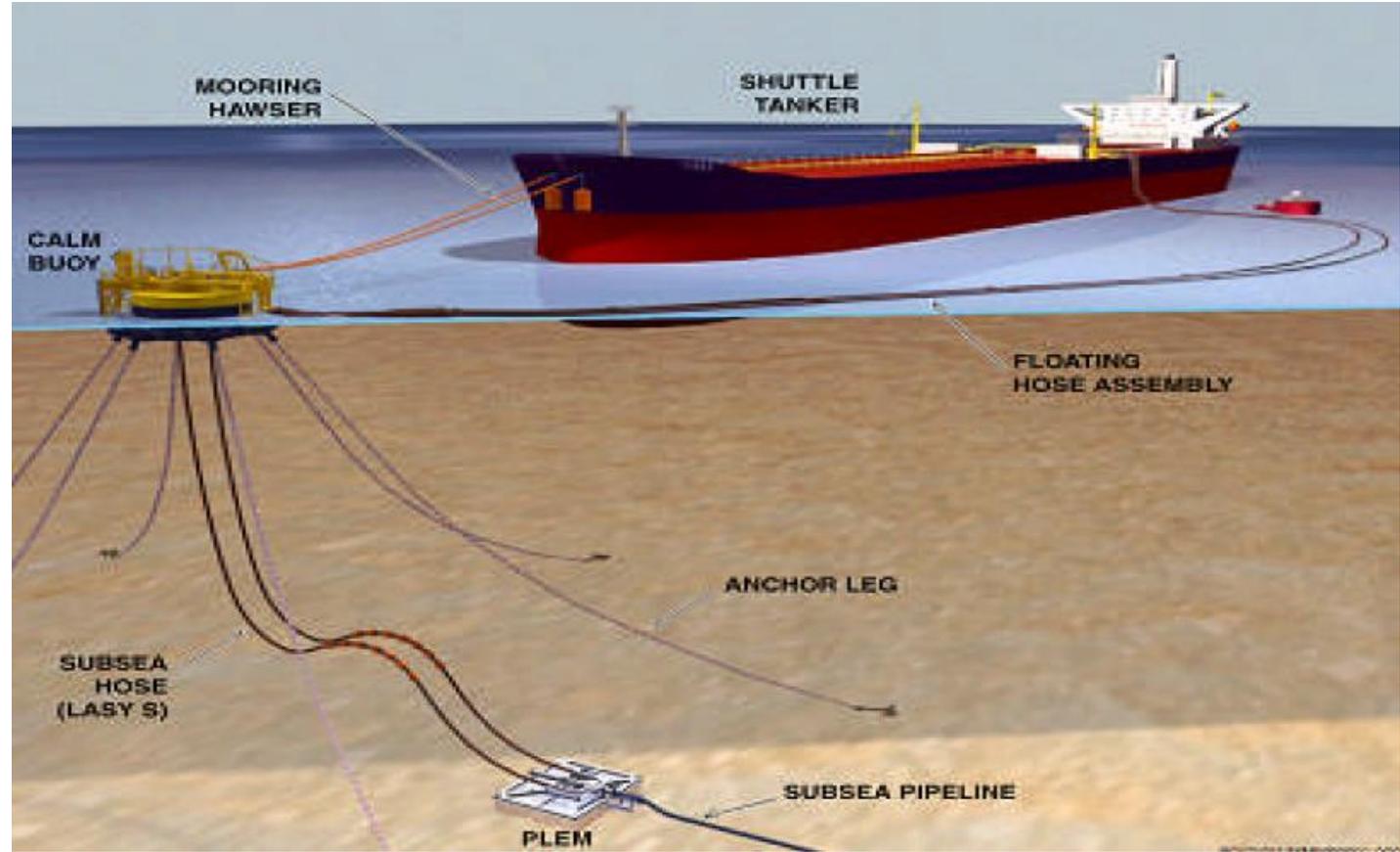


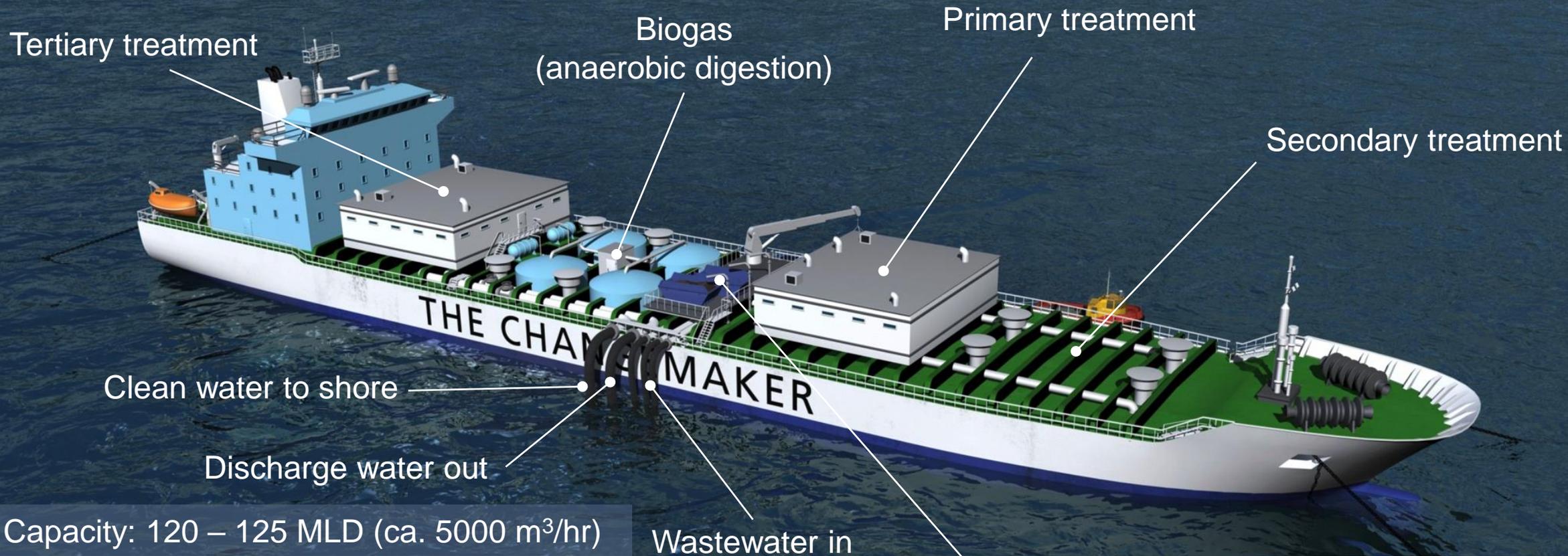
- **Zero land-footprint:**
  - Major cost advantage in areas with high property prices.
  - Avoids competition with other land-uses.
  - Avoids conflict with residential areas (reduced visibility, noise and odour).
- **Mobility:**
  - Greater flexibility in location.
  - Tsunami and earthquake avoidance.
- **Construction:**
  - A shorter construction time (1 – 2 years).
  - Capacity and technologies can be easily upgraded.





- Extensively utilised within the offshore oil and gas sector, over much greater distances and in challenging environments (e.g. North Sea).
- One of two solutions approved and recommended by DNV GL.
- Can connect to existing outfalls at Clover and Macaulay Points, via subsea piping.
- Converging at a CALM Buoy, the combined wastewater stream is conveyed to the Changemaker via a floating hose assembly.





Capacity: 120 – 125 MLD (ca. 5000 m<sup>3</sup>/hr)

Persons equivalent: 600 000 people

Treatment: Tertiary + Resource Recovery

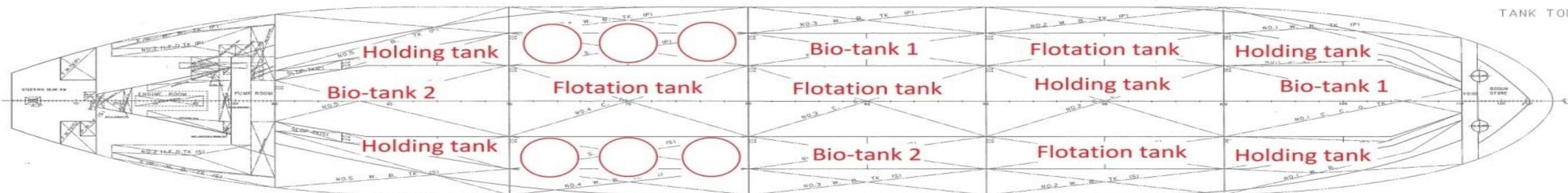
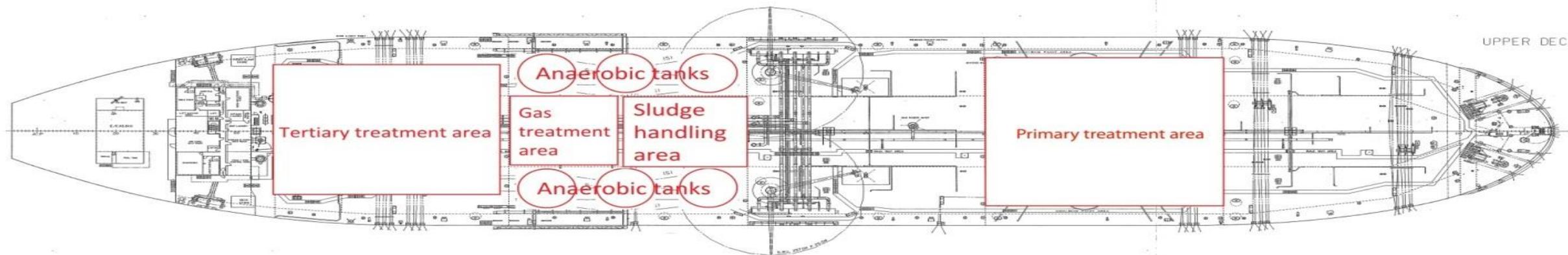
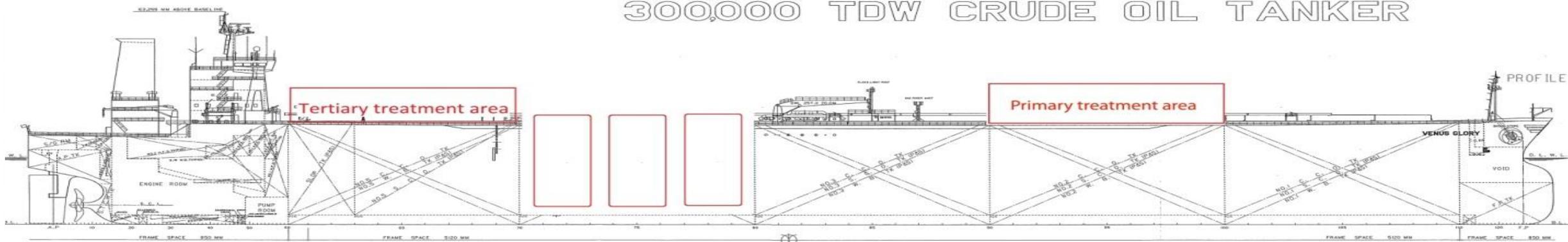
Energy: 0.85 kW/m<sup>3</sup> treated wastewater

CAPEX estimate: \$190 million

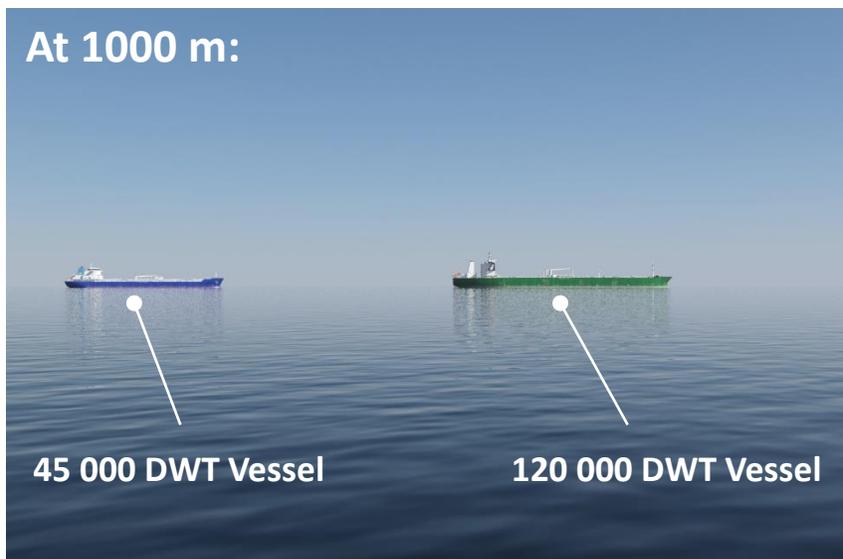




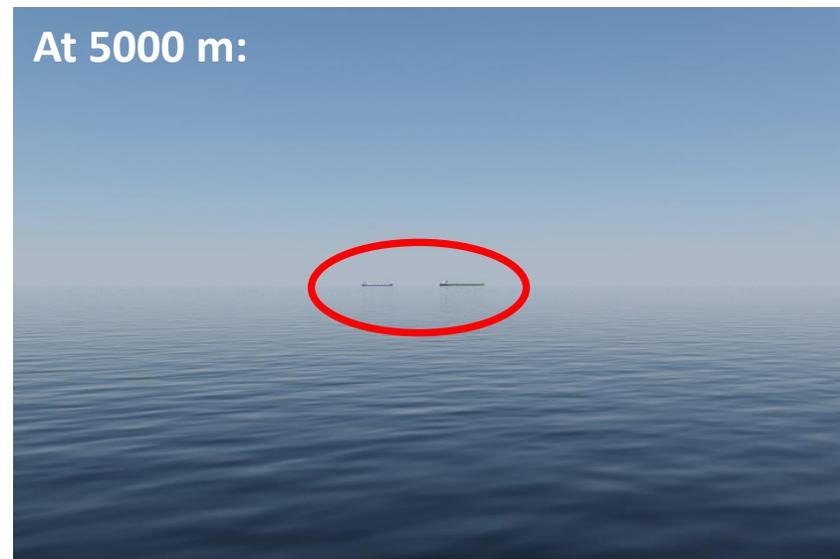
## 300,000 TDW CRUDE OIL TANKER



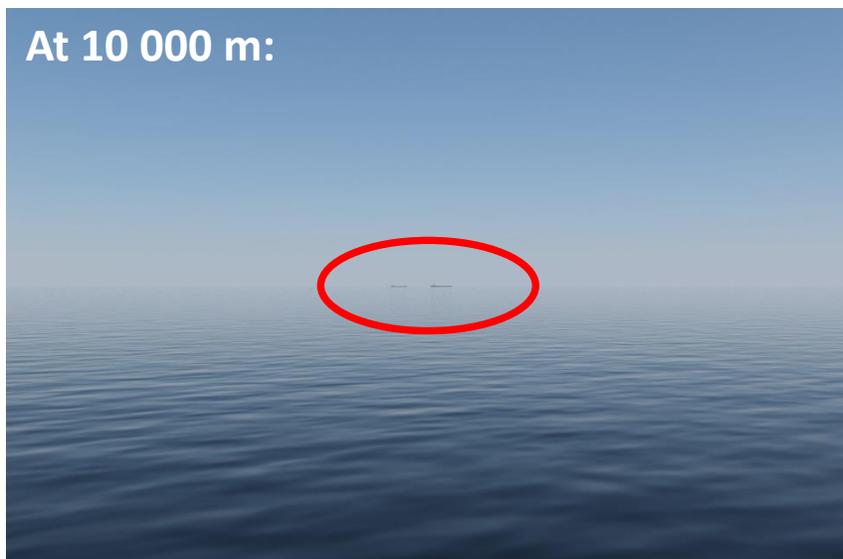
At 1000 m:



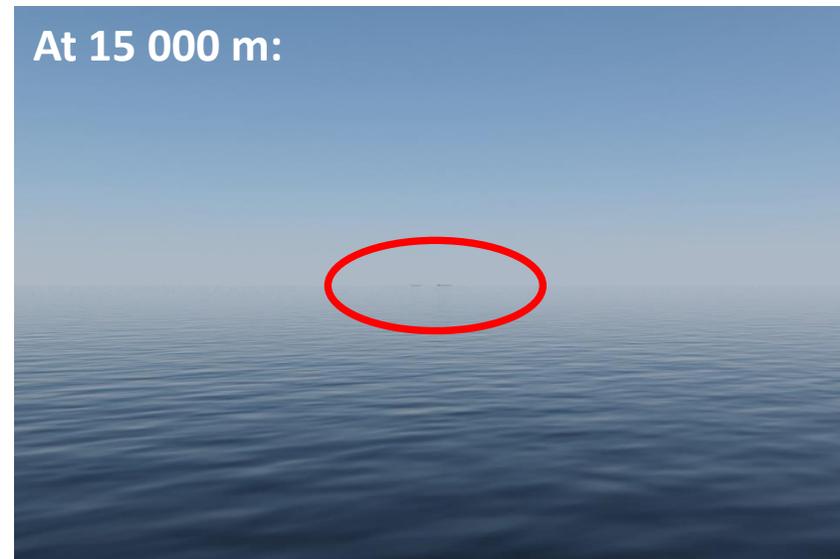
At 5000 m:

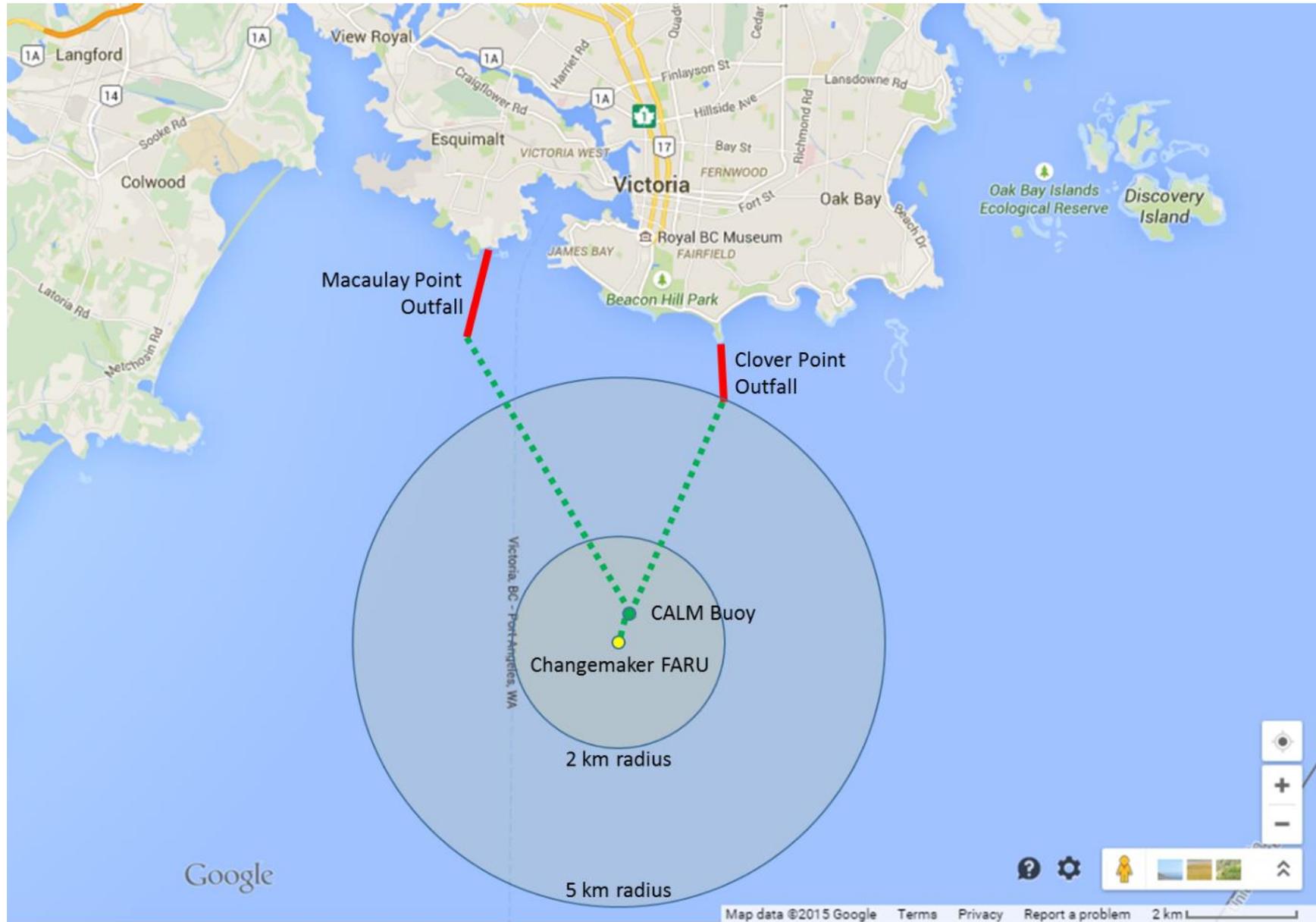


At 10 000 m:



At 15 000 m:







Lower capital expenditure.



Reduced construction time (1 - 2 years).



Reduced noise and zero odour (offshore and fully contained processes).



Capacity and technologies are easier to upgrade.



Mobility and location flexibility (tsunami and earthquake avoidance, environmental and aesthetic factors).



Recovery of high quality water (industrial/agricultural grade and even potable grade).



Recovery of biosolids/fertiliser and biogas.



Life extension of existing oil tankers.



- EnviroNor AS is an environmentally conscious water company, founded in March 2011 by Sigmund Larsen.
- Sigmund is an entrepreneur and a business and shipping executive from Norway, with over 30 years of maritime industry experience in senior-level positions within ship-owning companies.
- DNV GL awarded EnviroNor its 2014 "Extraordinary Innovation Project" and performed the technical and commercial verification of the concept. The results from this study confirmed that the EnviroNor Concept is both technically and commercially viable.



#### Collaborative Partners:

