Van Oord Marine Contractors

14 October 2024
Rotterdam, The Netherlands

To Marine Directorate

Copy Tony Bennet, CES Marine Officer

From Jesper Elzinga

Subject **Method Statement Sandcapping Ardfern**

Background

A consortium between Seawilding, Van Oord Marine Contractors and University of Groningen intends to execute a seagrass rehabilitation experimental research pilot in Ardfern situated in Argyll and Bute, Scotland. The application at hand concerns a scientific project rather than a commercial project. The experiment will be based around a methodology known as sandcapping. Sand capping is a methodology whereby a thin layer of sand is applied upon an unsuitable sediment layer in order to create the abiotic conditions required for seagrass meadows to thrive. Generally, seagrass is introduced by divers placing seagrass shoots into the newly laid sediment layer one by one. All experiments with sandcapping thus far have been executed through mechanical introduction of the sediment. An example of a typical set up has been shown in Figure 1.

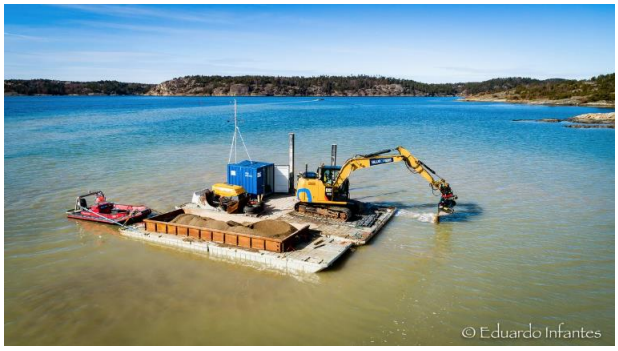


Figure 1: A typical mechanical sandcapping set up with an excavator springing sand into the water column.

The goal of the experiment in Ardfern, is to investigate whether the current sandcapping techniques can be developed in a manner which makes them more suitable for large scale application. In light of this, the sediment introduction will occur hydraulically rather than through mechanical means. This entails that the sediment will be pumped into the water column rather than sprinkled by an excavator on a barge. Rather than applying shoots manually (with divers) after sediment placement, the establishment of seagrass meadows will be attempted by integrating the seeds directly into the sediment deployment process. The aim of doing so is to make the operations more readily upscalable, and to eliminate the costs and risks associated with extensive dive works.

The first phase of the project (application no. 00010812) will cover 200 - 300 m^2 in November 2024 and will to serve as a proof of concept. Within the current application the aim is to cover larger area (of up to 1000 m^2) in March 2025 where we aim to include seagrass (*Zostera marina*) seeds into the sediment mixture and rehabilitate seagrass meadows within this (up to) 1000 m^2 footprint. A temporary works area will also be required for the works. The intended first phase and second phase rehabilitation areas as well as the temporary works area can be seen in Figure 2. The work for phase 2 is expected to take approximately 2-4 weeks.

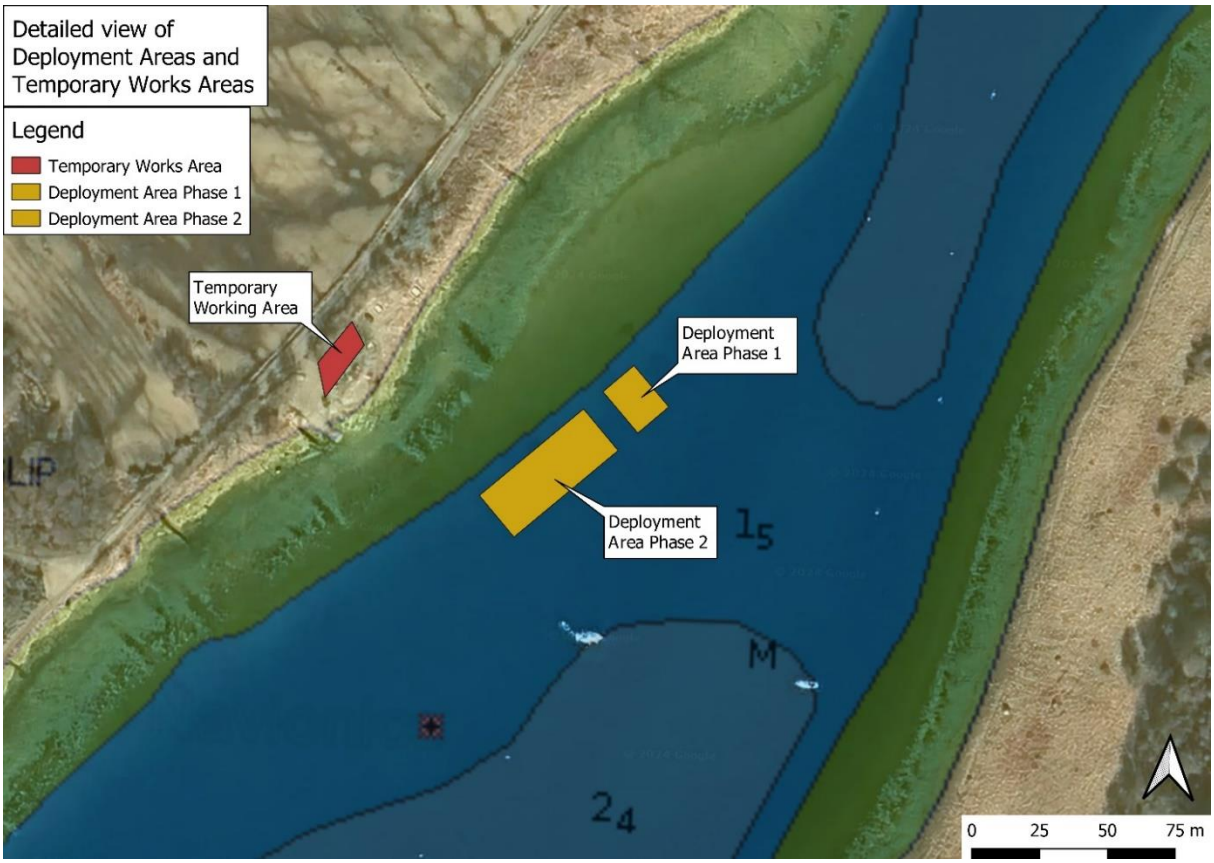


Figure 2: Visualisation of the first phase and second phase rehabilitation areas as well as the temporary works area.

Timing

In natural systems, seeds are released from their spathes in late summer and lay dormant in the sediment until they germinate in early spring (February – March). During this time seeds are subject to a long period of high energy conditions which flush away seeds and are prone to predation. Subsequently, germination rates in the wild are generally very low. Therefore, to increase germination rates and ultimately increase the success of seed based restoration projects, it is becoming common practice to store seeds over the winter and plant them in the spring to reduce such losses. In the North-western Europe, seeds are typically planted in the spring months, as this reduces seed losses and increases plant densities (Govers *et al*., 2022) by aligning planting with natural growth cycles and environmental conditions that favour seedling establishment (i.e. increased light availability and temperature). Seeds have been harvested in August 2024 with our partner Seawilding and need to be planted in February – March to follow these natural growth cycles.

Methodology

The new technology is envisioned to be executed by pumping a thin layer of sand (~10 cm) and seagrass seed mixture onto a muddy seafloor with the goal to rehabilitate the seagrass meadows in the local area. In order to do so, we aim to set up a land-based mixing station from which a thin sediment-water mixture will be pumped towards a pontoon and applied to the seafloor via a diffuser. A more detailed overview of this methodology will be described within this section of the method statement.

Materials

The sand will be sourced from a local terrestrial source. Our results from previous lab test's carried out at TU Delft, show seed distribution within the sand-cap is most optimal (between -1 and -5 cm) when using medium grain size (d50=0.34mm). The sand will be transported directly from a local commercial quarry and stored on the Temporary Works Area. The temporary works area is around 200m away from where the

sand will be deposited. The sand will be deposited within the maximum time span of one week so no biological contamination is anticipated.

100,000 *Zostera marina* seeds were collected with Seawilding from Loch Craignish in August 2024 under Seawilding's existing permit. The reproductive shoots of *Z. marina* were processed by Seawilding by common seagrass seed processing protocols, whereby the plant material decays in a seawater filled tank and the mature seeds drop out on the bottom of the tank. Weekly, the mature seeds were collected from the tank and moved into long-term storage. The seeds are stored in conditions which are known to reduce premature germination.

Mixing Station

Within the temporary works area we will set up a mixing station. The purpose of the mixing station is to mix the stored sand and seagrass seeds into a homogeneous mixture prior to pumping the mixture towards the rehabilitation area. This mixing station is conceptually visualised in Figure 3. The mixing station consists of a mixing tank, from which the created mixture is pumped at approximately 60 m_3 per hour through a shore based pump which extracts water from near the rehabilitation area through a flexible pipeline with a maximum diameter of 6 inch. Within this mixing basin, the sand will be added at rate of around 10 m_3 per hour by a small excavator and conveyor belt.

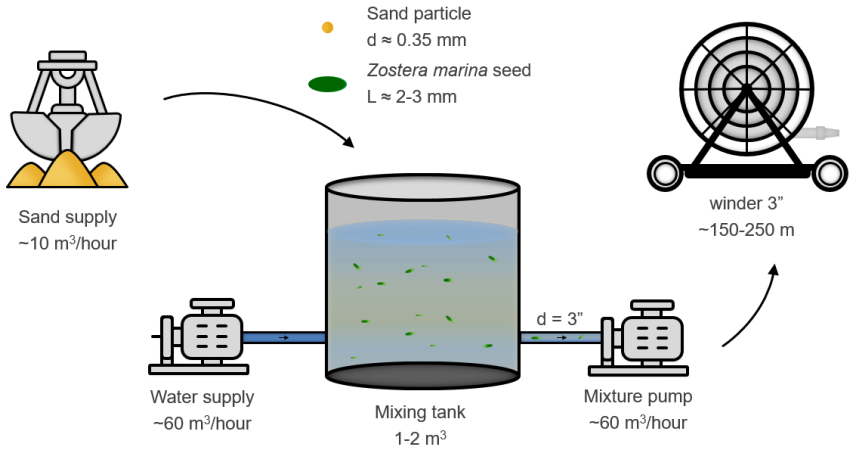
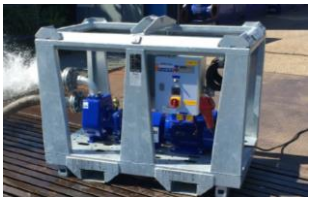


Figure 3: Conceptual overview of the working principles behind the mixing station

The seed will also be supplied into this mixing basin. Due to the vigorous inflow of the pumped water, a homogeneous mixture will be created within the basin. This same homogeneous mixture will be pumped towards the rehabilitation area within a flexible hose by a pump of similar discharge capacity of the supply pump. Due to the unavailability of power on site, both pumps will be petrol or diesel operated. An overview of the envisioned equipment in the temporary works area can be seen in Figure 4.

Small ~2.7 T Excavator

Sediment-Seed Mixing Tank ~2m³



Two petrol-powered pumps

Hose reel to store floating pipeline

Figure 4: Envisioned equipment for the temporary works area

Sand and Seed Storage

The mixing station is supplied with both sand as well as *Z. marina* seeds. The *Z. marina* seeds are currently being stored in a chiller unit of Seawilding, they will remain in the chiller unit for as long as possible prior to their dispersal.

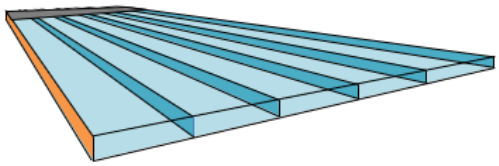
For the scope of the second phase, we envision to use mix a total of around 80 m^3 of sand for deployment. The foreseen method of supply is either by a tipper truck which will place the sand in a heap near the mixing station, or a delivery truck delivering sand in big bags.

The purpose of the small excavator associated with the works is to both supply the mixing station but also to ensure that this sand is moved to a location where it can readily be supplied into the mixing station into a continuous fashion. Figure 5 contains images of the area within which the sand is expected to be temporarily stored. Any welfare facilities will be installed at this temporary works area.

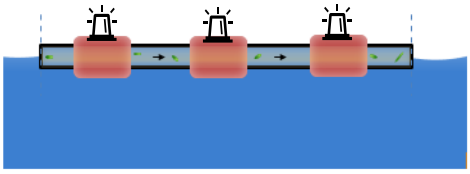
Figure 5: Two field images of the temporary works area within which the sand will be stored prior to deployment.

Deployment Station

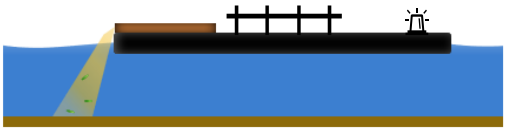
The deployment hose will be of a maximum length of 300 m and will supply a small custom built pontoon which will nourish the seafloor with a thin layer (approximately 10 cm) of sediment-seed mixture. The pontoon itself will most likely consist of floating jetty (or floater dock) elements which can be readily procured in the local area. An example of such floatation device has been placed in the right bottom of Figure 6. Care will be taken that the pipeline will remain floating between the water's edge and the pontoon and has lights, primarily to ensure it does not drag along the seabed (and works sites) unnecessarily however also to ensure the safety on recreants who may inadvertently find themselves within the works area. The pontoon will remain within the area which is indicated as Rehabilitation Area in Figure 2. The pontoon itself consists of a couple point where the flexible pipeline is attached to the spreader mechanism. The coupling point with the spreader mechanism will be elevated somewhat to ensure there is a downward slope for the sediment-seed-water to travel down. The width of the spreader mechanism where it reaches the water line will be around 2.5 m in order to ensure some width is provided to the nourishing areas. By moving the pontoon over an area of around 20 metres, the 2.5 m width allows for 50 m^2 sections (or runs) to be nourished rather easily. The aim is to nourish around 5 m^3 of sediment (laced with proxy-seeds) per run which corresponds to the 100 m^2 section described above. Figure 5 provides an overview of the expected equipment pieces which will function as the deployment station.



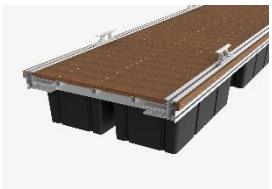
Spreader



Floating pipeline/hose



Deployment pontoon



Floater dock elements

Figure 6: Envisioned equipment for the Deployment Station

According to the bathymetric information available, the pontoon will navigate in waters between 0.5 and 2 metres deep. The pontoon itself will not be machine propelled however rather moved around by tightening or releasing anchor lines. The anchors are envisioned to either be deployed in the muddy seafloor surrounding the deployment or attached to local mooring points if permission is granted by the local mooring association Craignish Lagoon Mooring Association.

Monitoring

After the sediment-seed mixture has been deployed, initial monitoring will be conducted in order to verify the sediment deployment area as well as the distribution of the seeds within the nourished profile. Further ecological monitoring to quantify initial germination success, development of seedings and survival of adult plants will be carried out with our partner Seawilding following generalized seagrass monitoring protocols (Kent et al., 2021).

Environmental Impact

While the current scope entails an experiment, Van Oord has broad experience in executing large scale marine works. As experienced marine contractor, Van Oord commonly assesses the potential impacts of such works as well as mitigation measures. As stated in the Application Form for this Marine License, the main expected environmental impacts associated to these works would be 1) introduction of invasive species , 2) excessive spreading of suspended sediment induced turbidity and 3) impact on the habitat of the silty seabed to be sand-capped.

1. The introduction of invasive species will be managed through our Seagrass Restoration Biosecurity Plan. This plan is based on Seawilding's currently approved Biosecurity Plan and has been altered slightly to reflect the current works.

2. The sediment that will be used is expected to have substantially limited amount of fine sediment content, smaller than 5% (Figure 7). Consequently, only this small amount of fine sediment has potential of dispersing further than the boundaries of the proposed area. The mixture (water-sand-seeds) that will be pumped into the rehabilitation area, will be released below the free surface to ensure that no interaction with air takes place. Air entrapment in the mixture can cause turbulent mixing which can keep the fine sediment high in the water column and potentially propagating outside of the boundaries of the proposed area.

   The local hydrodynamic conditions are smaller than 0.2 m/s according to the Copernicus Marine Ocean visualisation tools. The low current velocity is an additional factor that can ensure no substantial transport of the mixture. On top of that, the pumping speed of the mixture along the water depth (1.5 - 2.0 m) ensures that the mixture motion is directly downwards.

The spray pontoon is expected to move and spread the mixture within the boundaries of the proposed area. This will ensure that limited re-suspension of the deposited mixture will occur, with only expected limited local sand roll or saltation.

Based on the above, the sediment is expected to remain within the boundaries of the proposed area. Additionally, based on the sand diameter and the local hydrodynamic conditions it can be concluded that the mixture layer is expected to remain stable, and no significant transport is expected to take place.

Therefore, the sensitive receivers, namely seagrass (*Z. marina* & *Z. noltii*) and <Redacted> are located more than several hundred metres away from the project site at a distance where turbidity due to the works will not reach and therefore not have an impact.

3. Our site survey as well as the communication with local environmental NGO, Seawilding, indicate that the area is currently barren plain mud bed with low ecological value. In fact, seagrass rehabilitation attempts in the area have failed, likely due to unsuitable, anoxic sediment. The purpose of our project is to make an attempt to improve the ecological status of the area by introducing sand and seeds to improve oxygen conditions in the seabed and introduce seagrass in order to also establish a valuable marine habitat. Additionally, previous sand-capping works conducted by researchers in Denmark have shown quick macrofaunal colonisation of the sand-capped area. Namely, species richness, abundance and the diversity of feeding guilds of benthic infauna were significantly higher in the sand-capped area compared to the adjacent uncapped, organic-rich sediment after 1 year (Steinfurth et al., 2024).

By working with these principles we are confident that environmental impact will be insignificant.

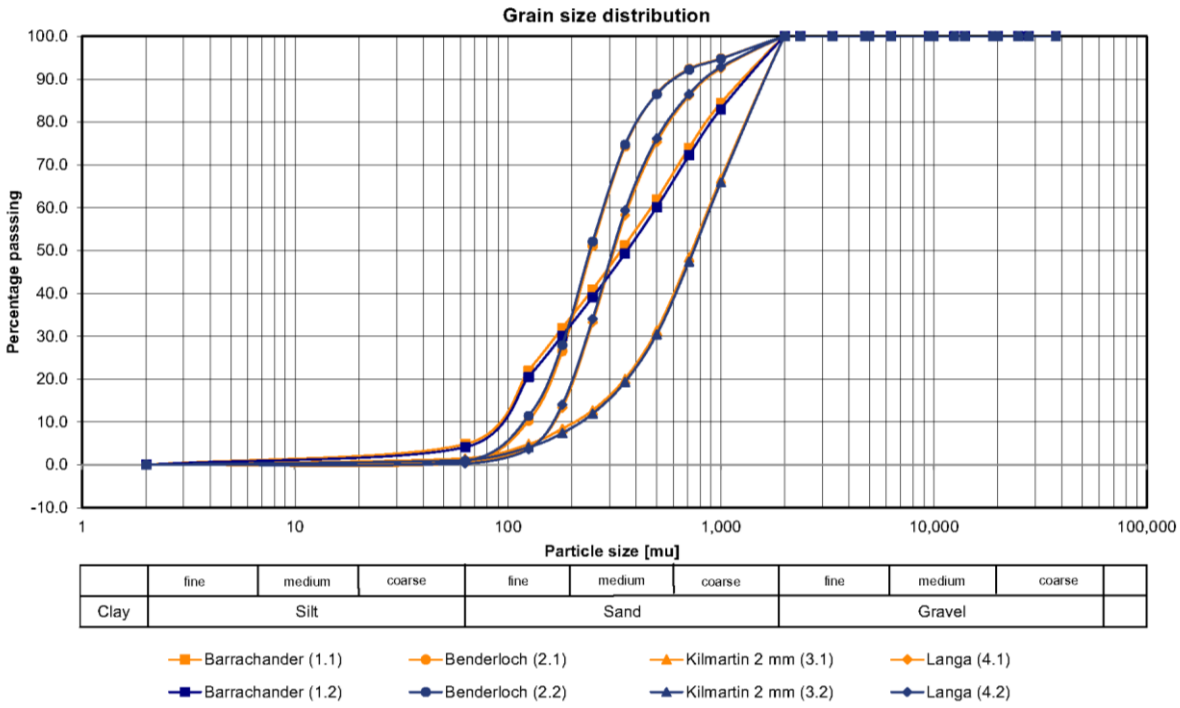


Figure 7: Grain size distribution curves of nearby commercial quarry sand samples tested.

References

Govers, L. L., Heusinkveld, J. H. T., Gräfnings, M. L. E., Smeele, Q., & van der Heide, T. (2022). Adaptive intertidal seed-based seagrass restoration in the Dutch Wadden Sea. *PLoS ONE*, *17*(2 February). https://doi.org/10.1371/journal.pone.0262845

Kent, F., Lilley, R., Unsworth, R., Cunningham, S., Begg, T., Boulcott, P., Jeorrett, C., Horsburgh, R. and Michelotti, M. (2021). Seagrass restoration in Scotland - handbook and guidance. *NatureScot Research Report* 1286.

Steinfurth, R., Nielsen, B., Elsberg, L., Lange, T., Oncken, N., Quintana, C., Kristensen, E., & Flindt, M. (2024). Macrofaunal colonization after large-scale sand-cap restoration of organic enriched sediments in a Danish fjord. *Marine Ecology Progress Series*. https://doi.org/10.3354/meps14511