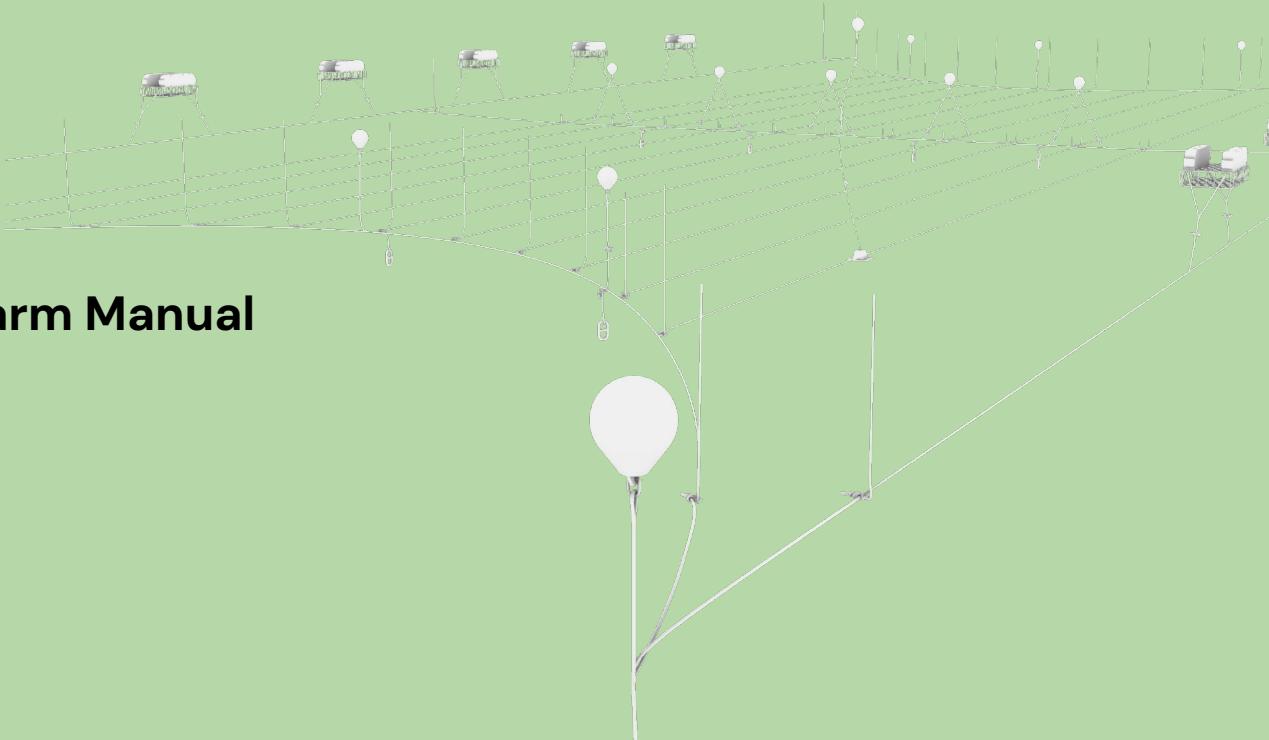




Open Climate Solutions

IMTA Seaweed Farm Manual



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Acknowledgment

Special thanks to the following contributors for their outstanding efforts and commitment:

- Kilchoan Melfort Trust, especially Marnik van Cauter
- Kelson Marine, especially Toby Dewhurst and Nathaniel Baker
- SAMS, especially Dr. Adrian MacLeod
- Kames Fishing especially Jamie McAndrew
- Seaweed Services Ltd., especially Kyle McPherson

We want to express our sincere appreciation for the individuals listed above who have played a crucial role in the success of our pilot seaweed farm. Their dedication, expertise, and passion have significantly contributed to the growth and excellence of our efforts to open source our learnings during this process.

Their practical insights, expertise and collaborative approach have been instrumental in the development and implementation of this initiative. We acknowledge and thank each of these contributors for their valuable contributions, recognizing the impact they have had on our mission to openly share knowledge and insights derived from our pilot seaweed farm.





About the Manual

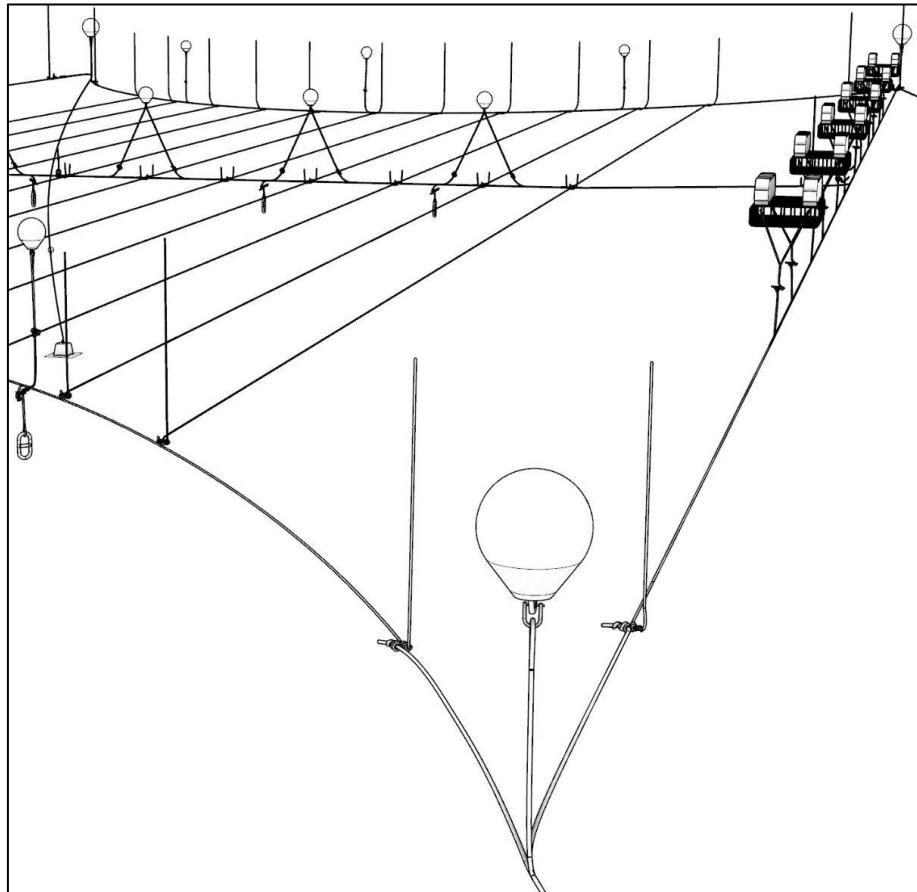
This manual should serve as a comprehensive guide for both industry professionals and individuals interested in exploring the seaweed farming space with the potential of starting their own small-scale project. Please keep in mind, that this manual is within the ethos of open source project, a working document where additional findings and community feedback is constantly added. This manual on seaweed cultivation provides an example of a seaweed farm designed for a specific location on the west coast of Scotland. It is strongly recommended to seek guidance from industry professionals when designing a farm to accommodate the unique requirements of any other site. This manual does not provide a warranty or guarantee for its content.

The legal landscape, including licensing requirements and regulations is not the main focus in this manual, since regional requirements can be very different, but it should be noted that designing an efficient and environmentally friendly farm respecting all regulations is the first crucial step. So please consult with the regulatory body or industry professionals within your region. The presented layout represents one version among many possible farm designs. Therefore, it is encouraged to explore different farm layouts that best fit regional infrastructure requirements, technology integration, and regulatory frameworks to optimize for the best results.

This exploration also involves understanding the budget and aligning it with the procurement process for seaweed farming equipment and materials. From selecting specific cultivation gear to sourcing sustainable construction materials, it is essential to ensure that you have the right resources for a successful operation.

The farm component section aims to provide a blueprint for turning plans into reality. Follow step-by-step instructions on constructing seaweed cultivation structures, installing equipment, and implementing efficient farm seeding techniques.

The seeding process begins at the nursery and continues through cultivation. Keep in mind the specific needs of different seaweed species and how to nurture them through their growth stages. Learn best practices for monitoring and maintaining a healthy crop.





Farm Scope:

2.76

Seabed footprint:

A-B: 209m

A-C: 79.35m

C-D: 218.35m

D-B: 825m

Mooring line length:

Line A: 66m

Line B: 67.5m

Line C: 69.1m

Line D: 70.8m

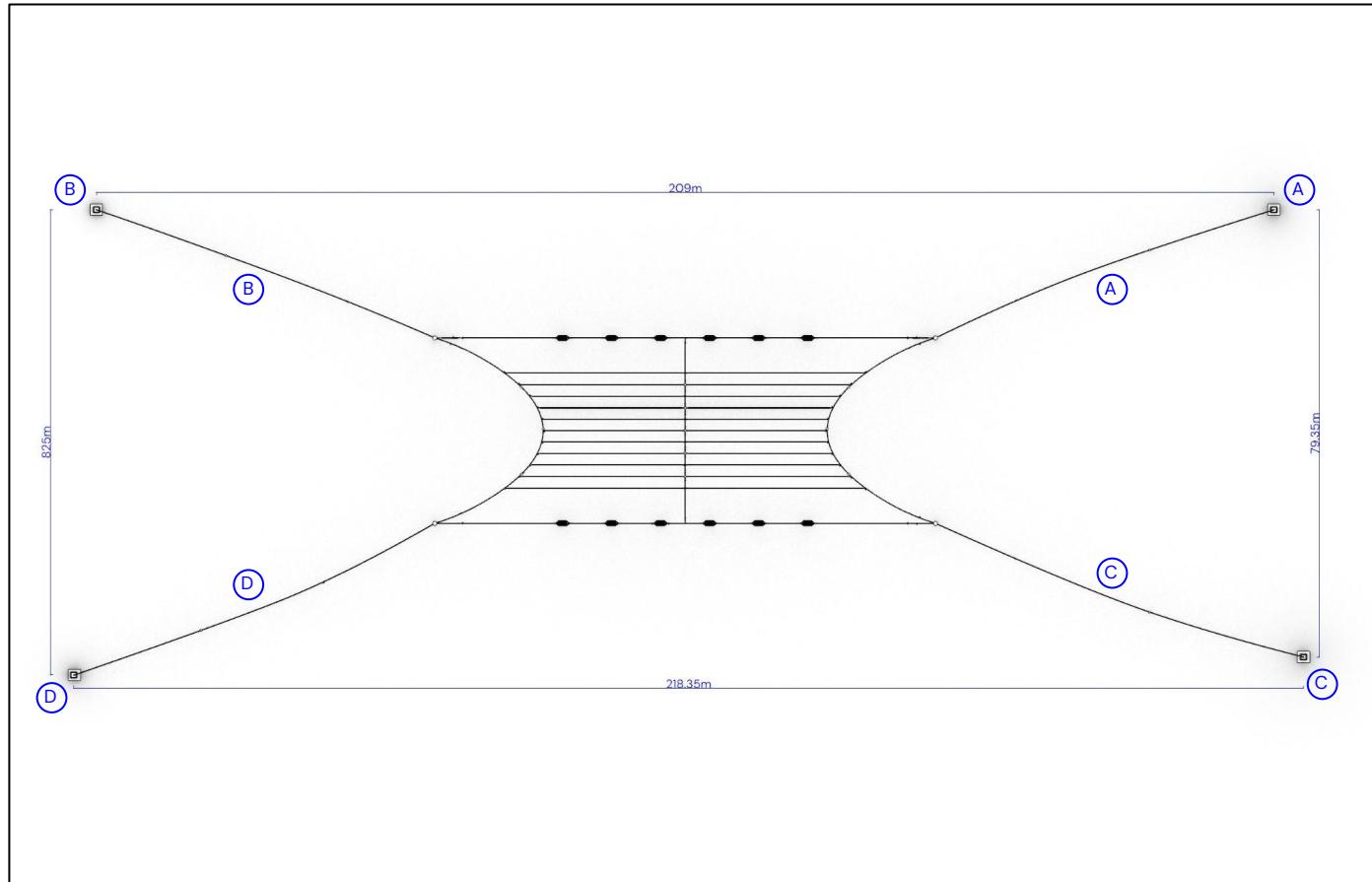
Growline length total:

Alaria esculenta: 100m

Saccharina latissima: 350m

Direct seed lines total:

Saccharina latissima: 100m





Farm Scope:

2.76

Seabed footprint:

A-B: 209m

A-C: 79.35m

C-D: 218.35m

D-B: 825m

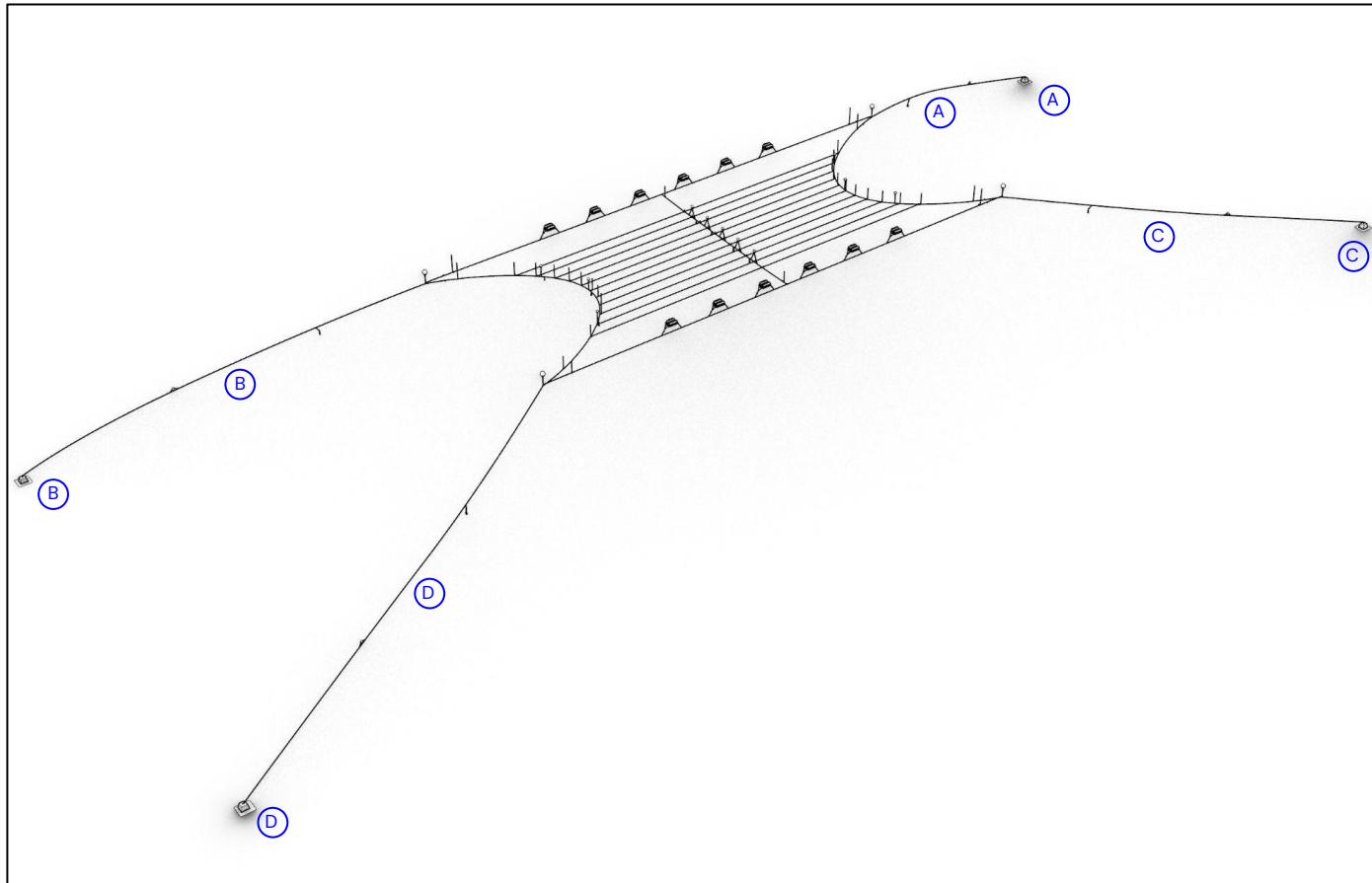
Mooring Line Length:

Line A: 66m

Line B: 67.5m

Line C: 69.1m

Line D: 70.8m



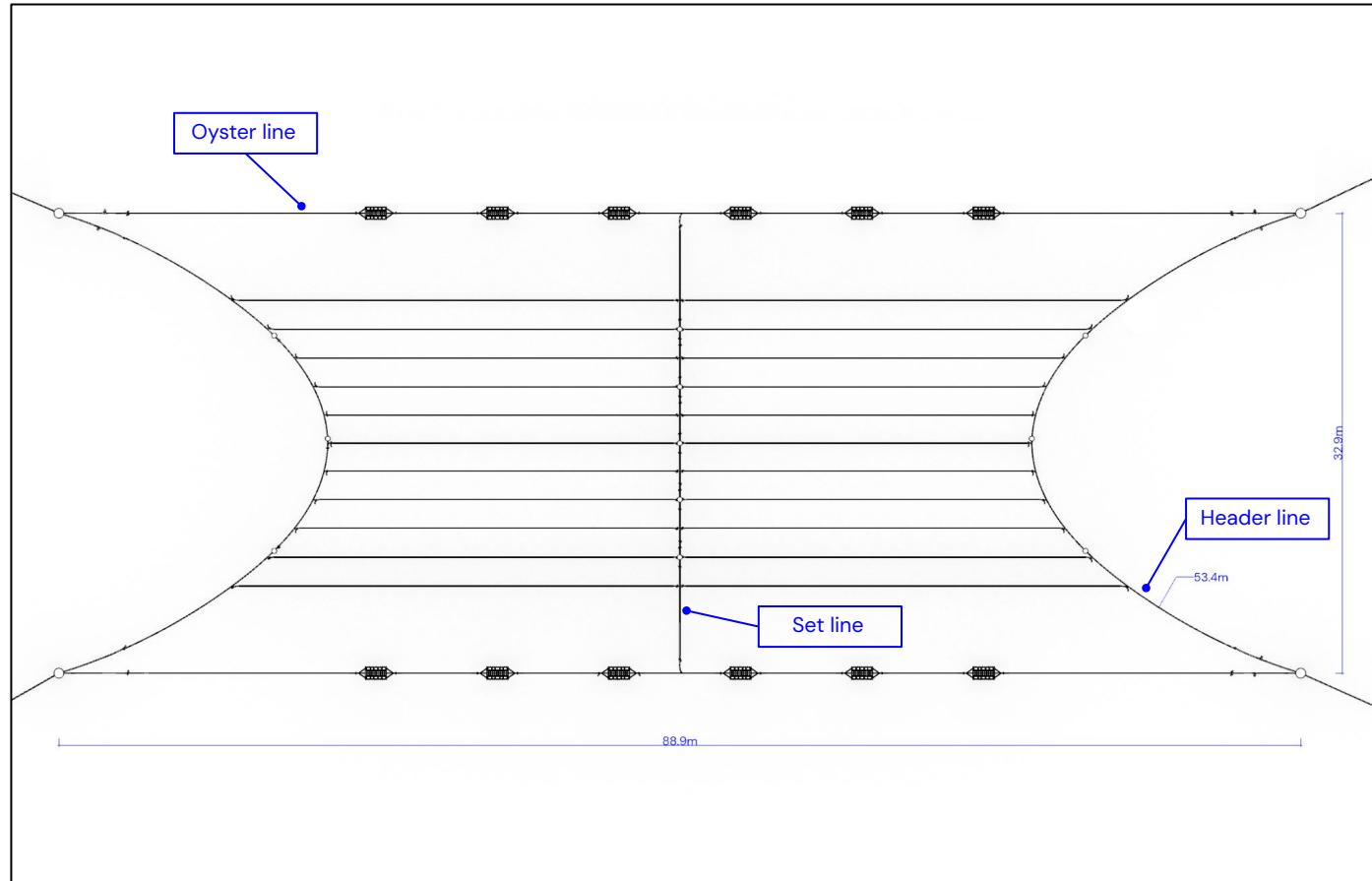


Frame lines and set line

Header line: 53.4m
18mm Polysteel (3 strand)

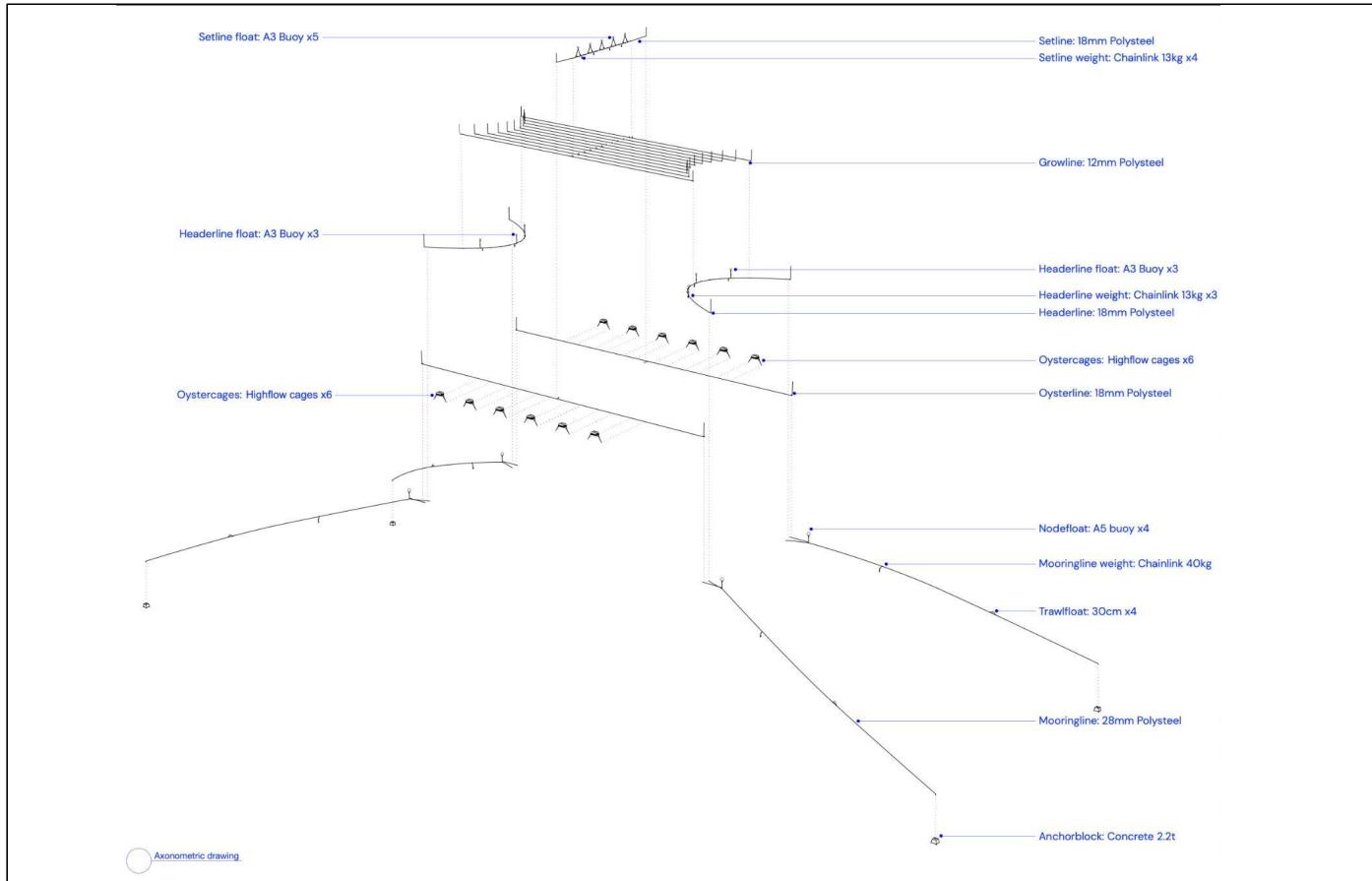
Oyster line: 88.9m
18mm Polysteel (3 strand)

Set line: 32.9m
18mm Polysteel (3 strand)



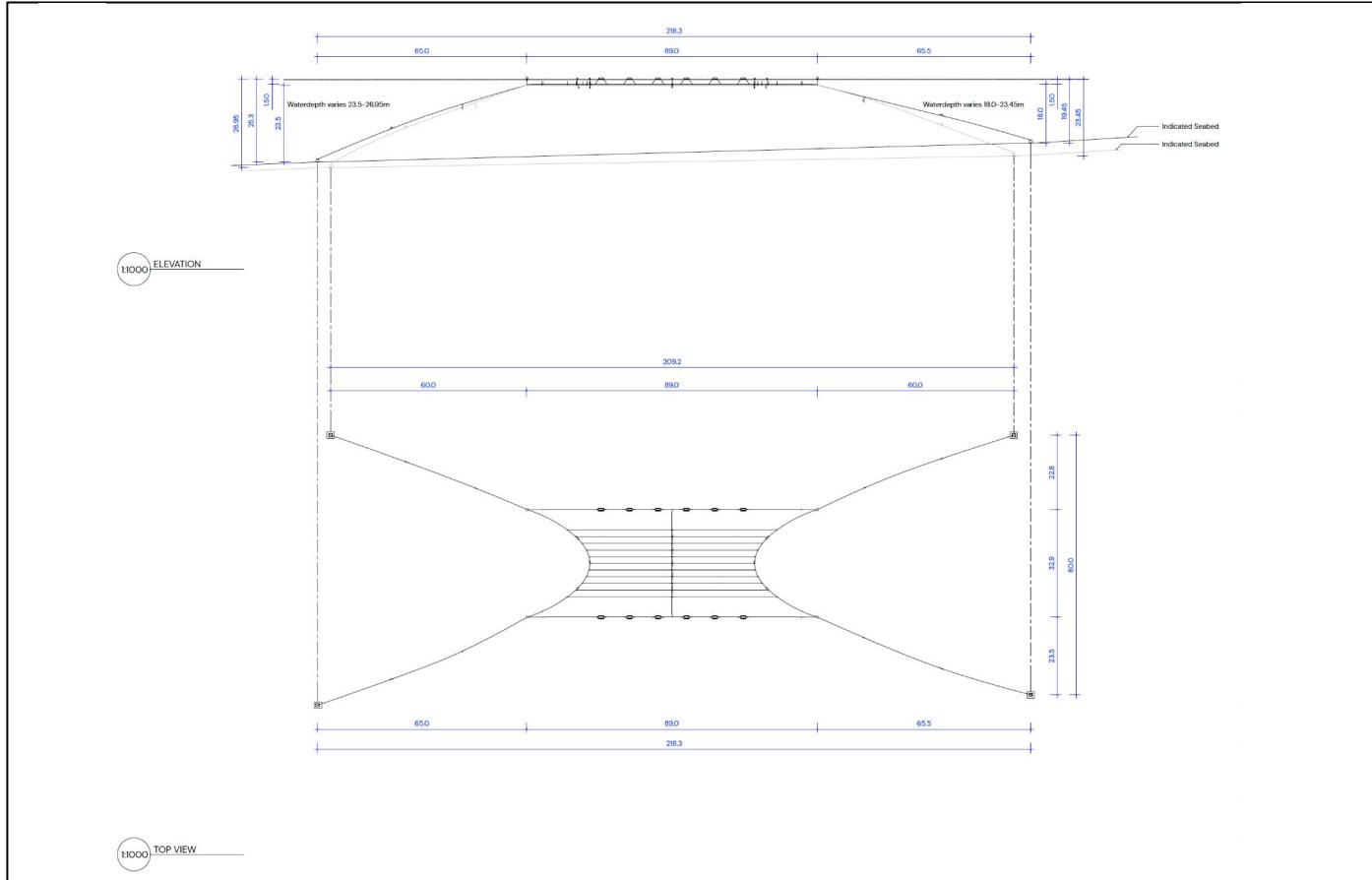


Axonometric drawing





Elevation and Top view





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Farm Components

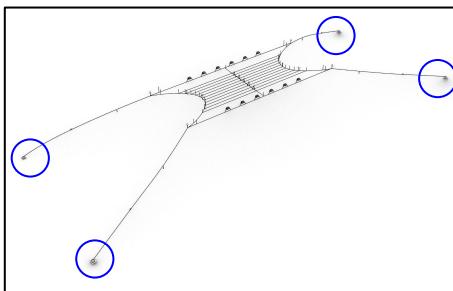
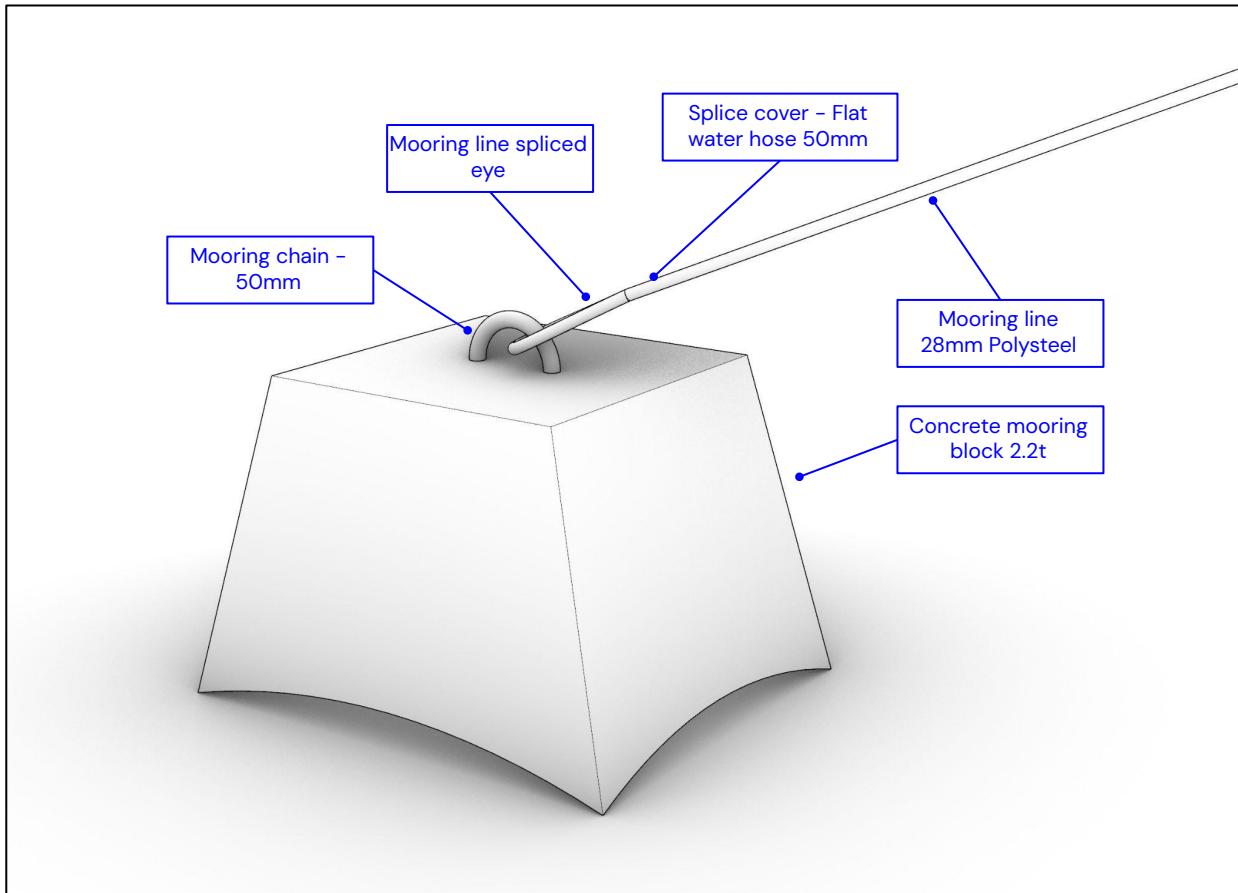


Mooring block

2.2t concrete block

Dimensions: 120x80x80cm

Mooring block





Mooring Line Length:

Line A: 66m

Line B: 67.5m

Line C: 69.1m

Line D: 70.8m

**Float attachment-
m from anchor:**

Line A 23.7m

Line B 27.1m

Line C 19.8m

Line D 25.7m

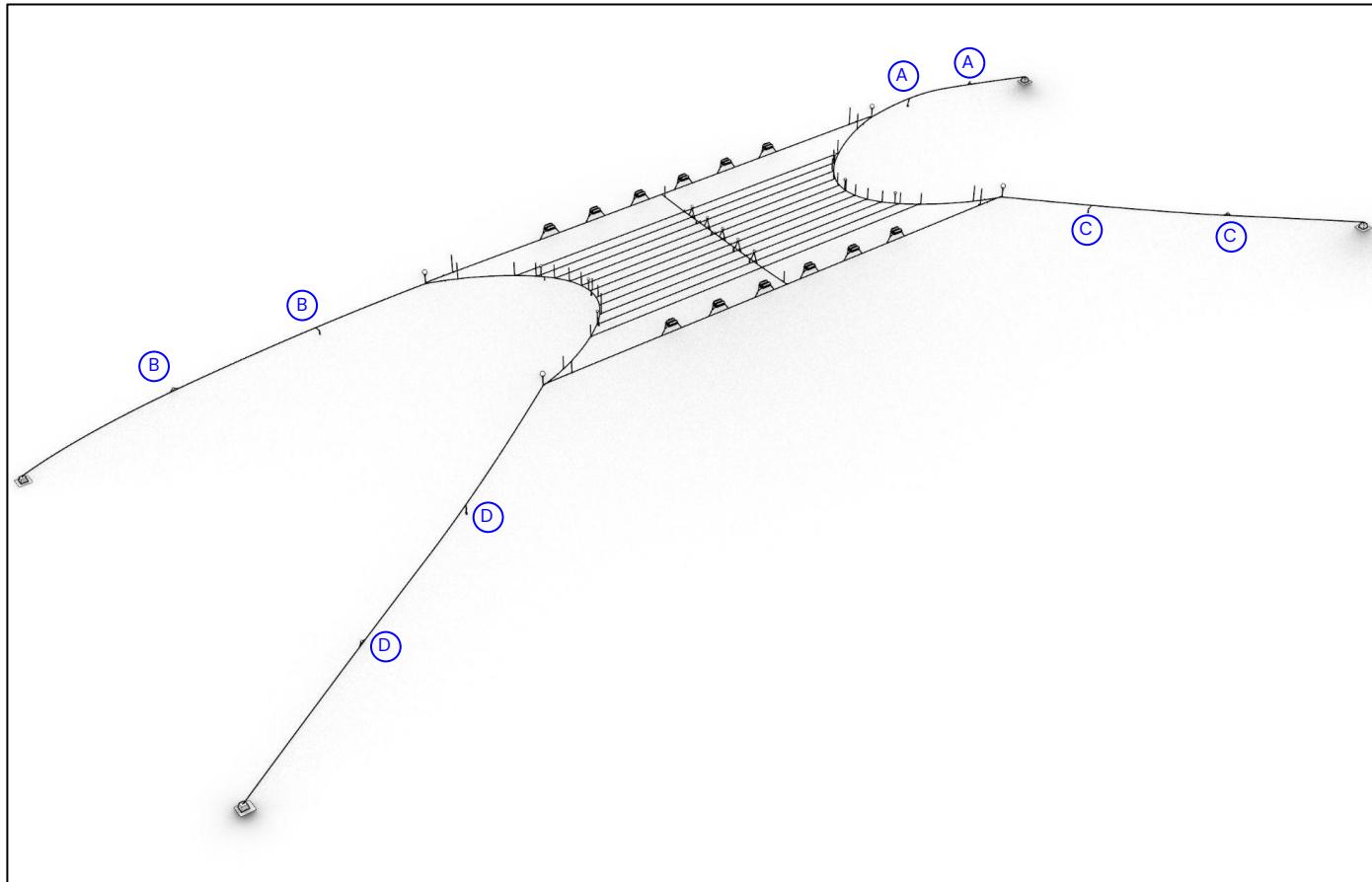
**Angel attachment-
m from anchor:**

Line A 50.4m

Line B 50.4m

Line C 50.4m

Line D 50.4m





Mooring line – Trawl float/ Chainlink weight

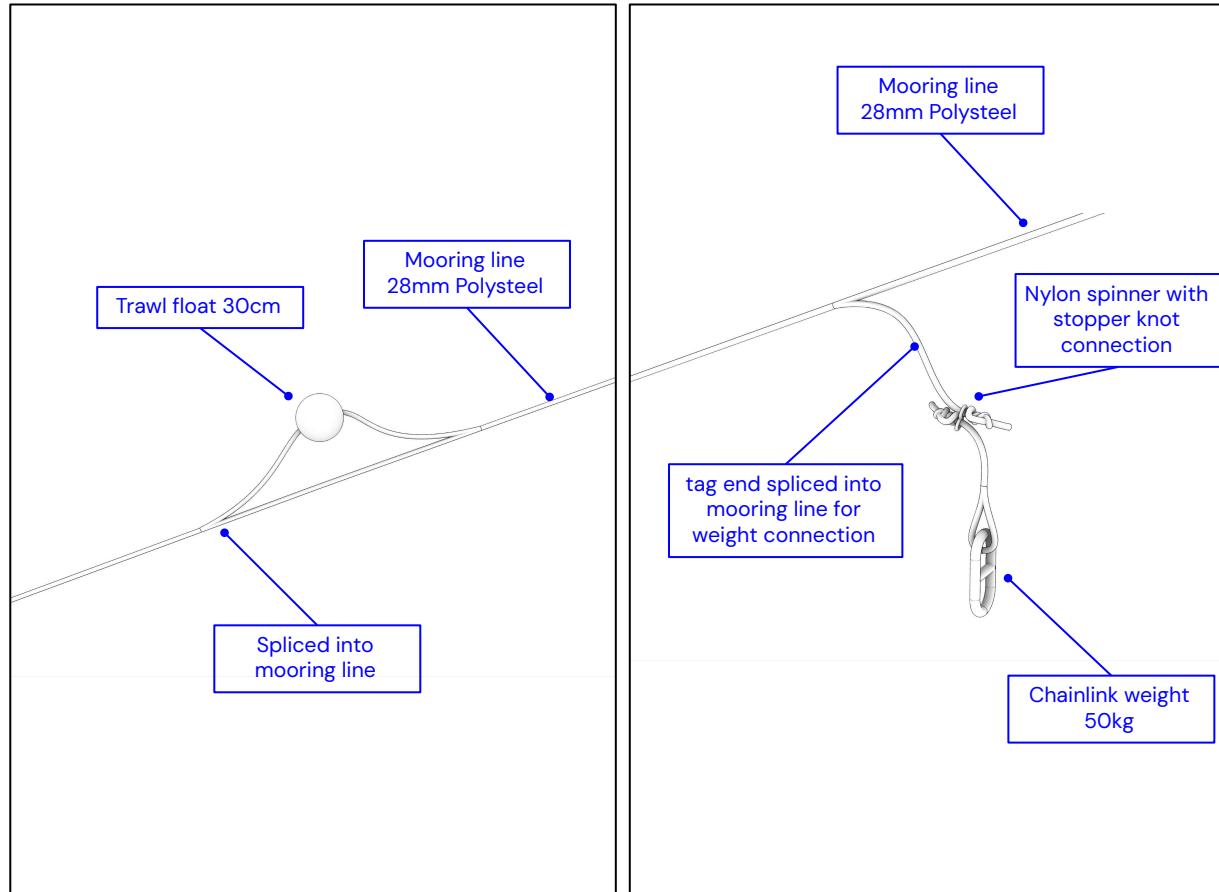
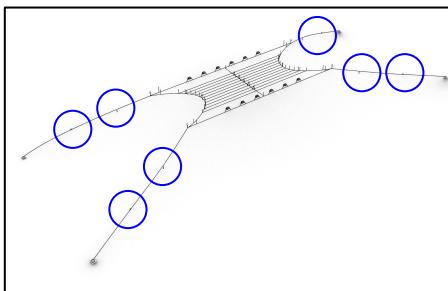
Mooring line:

28mm Polysteel (3 strand)

Trawl float: 30cm

Chainlink weight: 50kg

All four mooring lines should have a float to avoid damaging the mooring line, which can happen in low tide, by abrasion of the mooring line on the mooring block.





Corner nodes

Corner node:

Mooring line:

28mm Polysteel (3 strand)

Header line:

18mm Polysteel (3 strand)

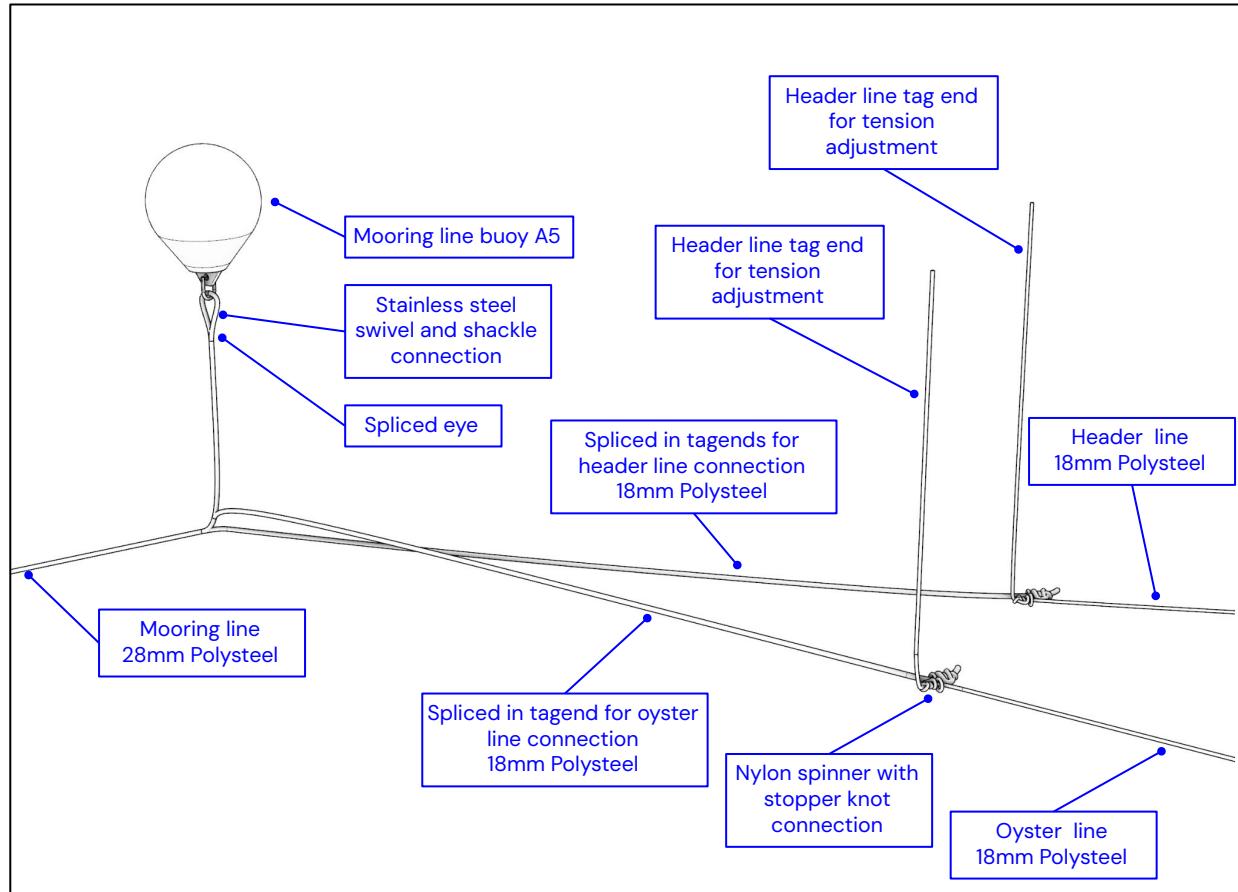
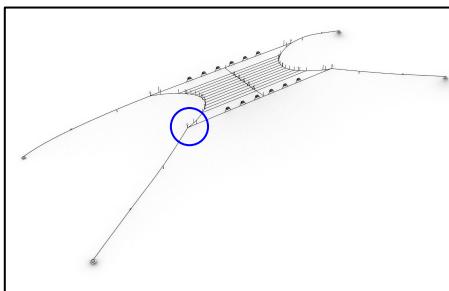
Oyster line:

18mm Polysteel (3 strand)

Connections:

XL Nylon Spinner with stopper knots on both sides of connected lines

Buoy: A5





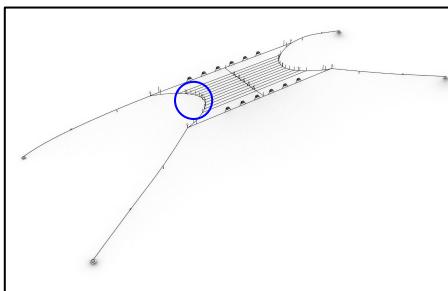
Header Line: 53.4m
18mm Polysteel (3 strand)

Connections:

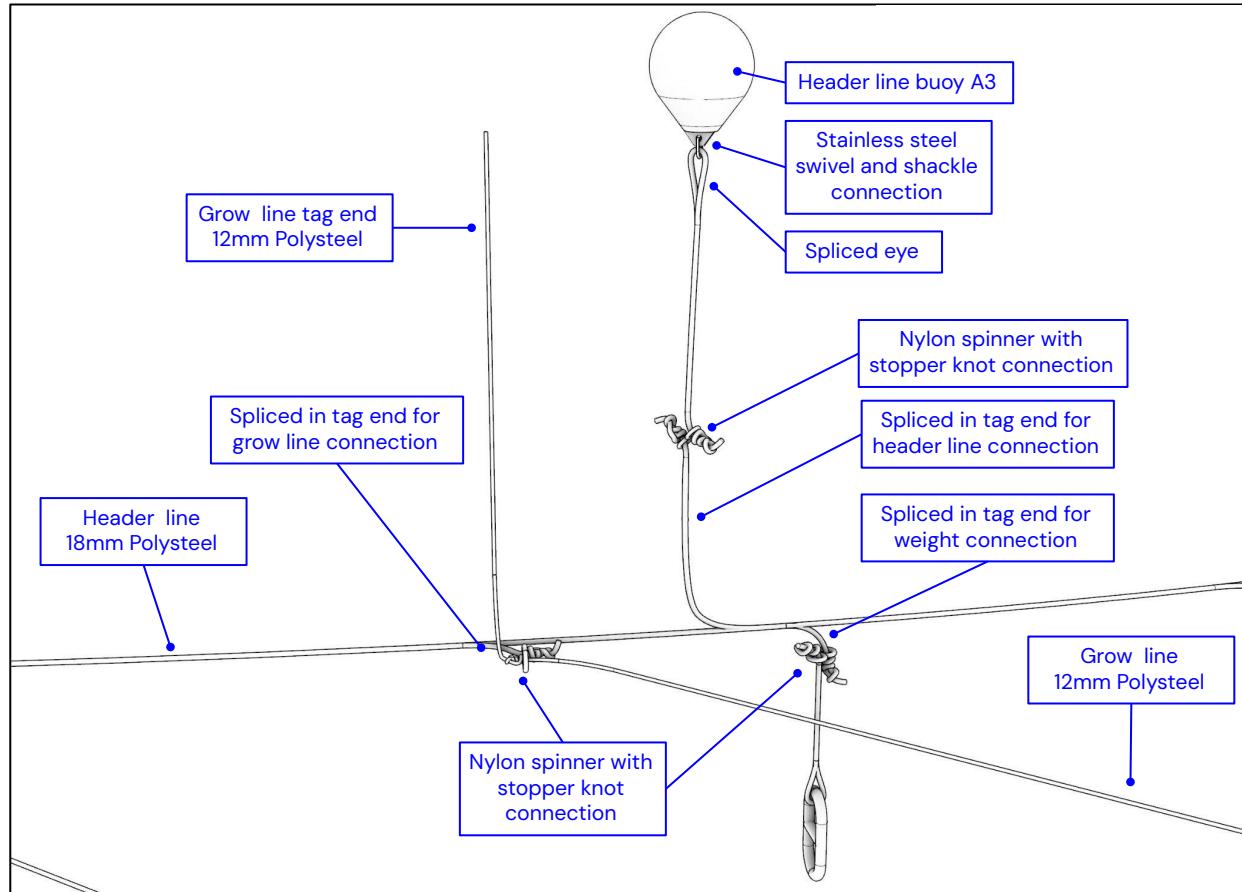
XL Nylon Spinner with stopper knots on both sides of connected lines

Buoy: A3

Weight: Chainlink 13kgx 3
Keep the chain ink weights as close as possible to the setline to avoid any interaction with the grow lines



Header line





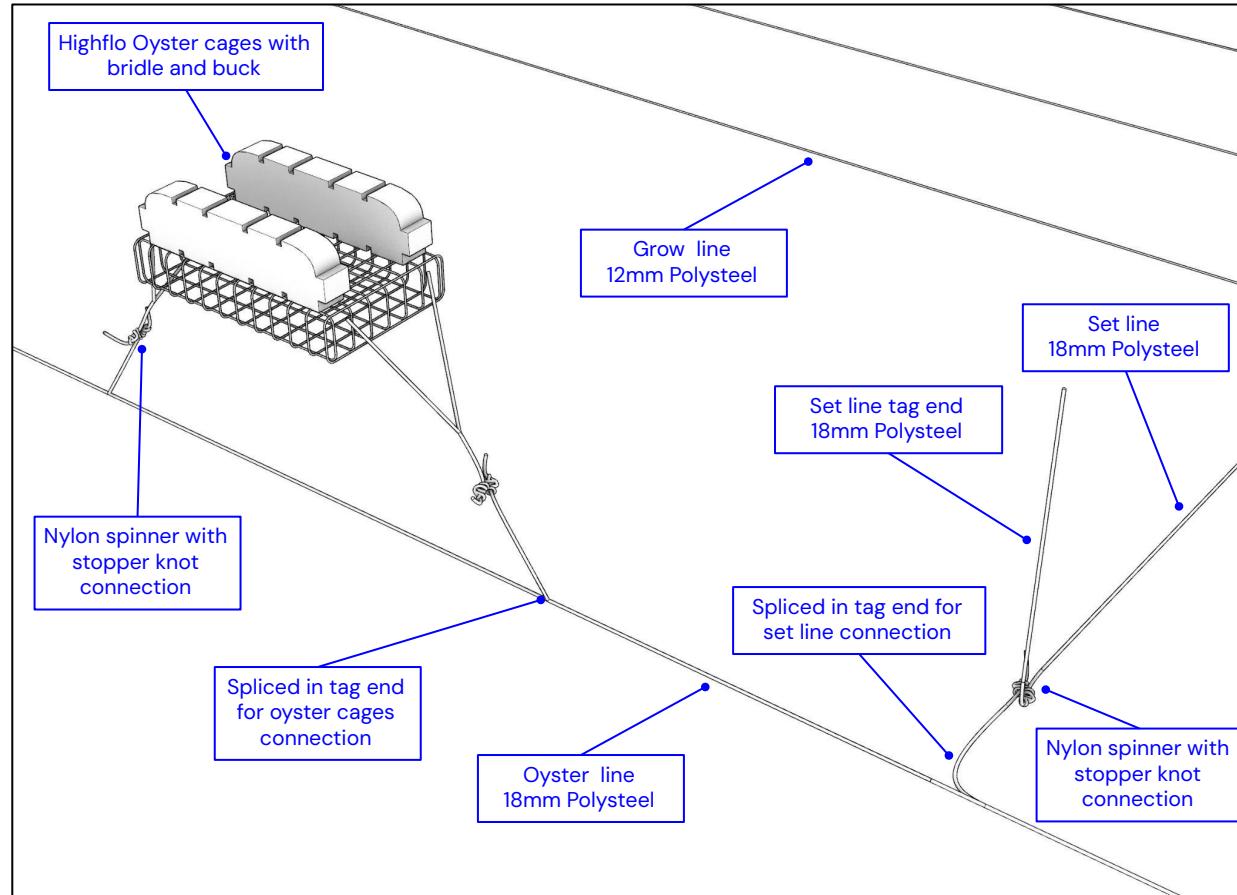
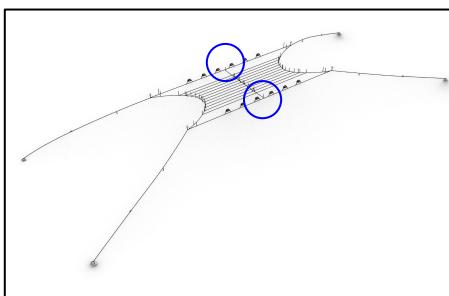
Oyster line- Oyster farming system

Oyster Line: 88.9m
18mm Polysteel (3 strand)

Connections:

XL Nylon Spinner with stopper knots on both sides of connected lines

Oyster farming system:
[OysterGro Highflo model](#)





Oyster farming system- positions

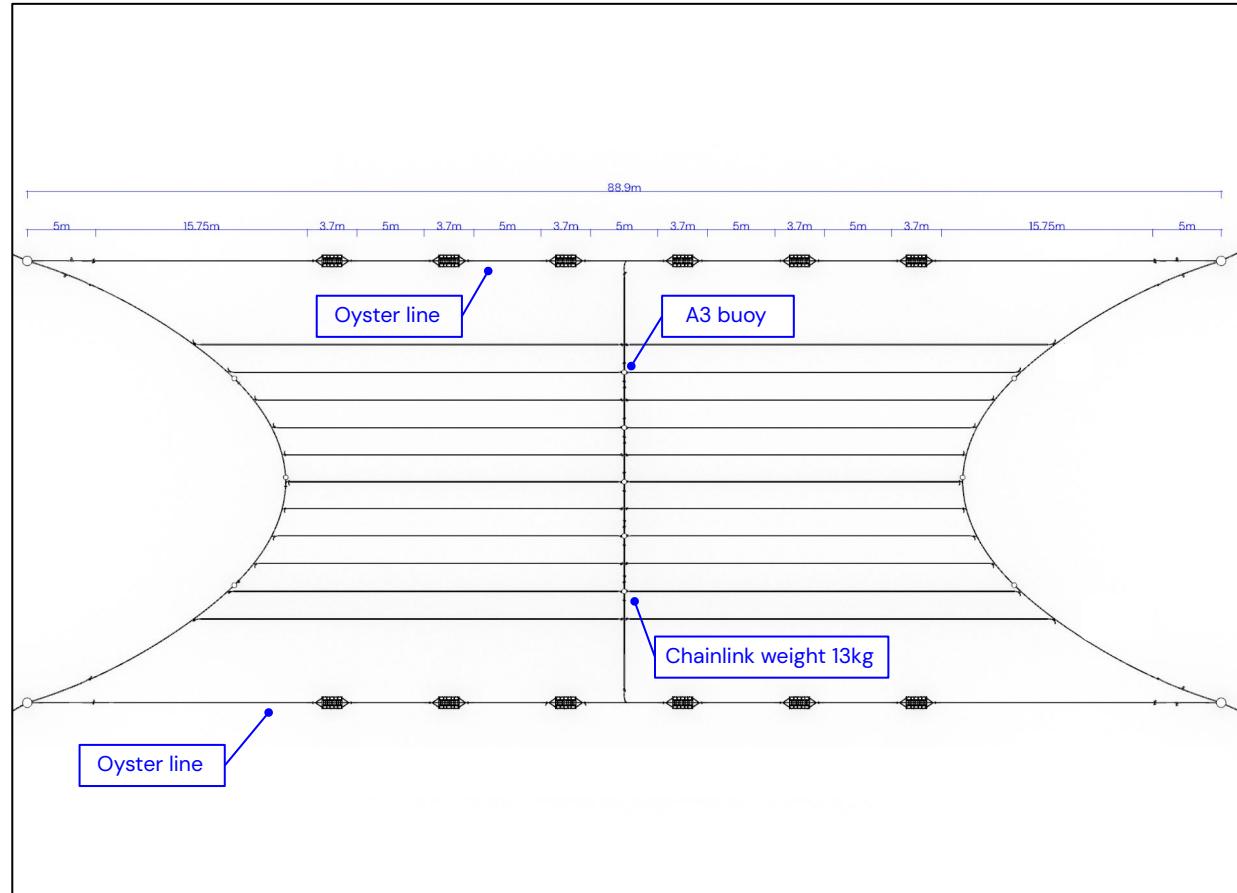
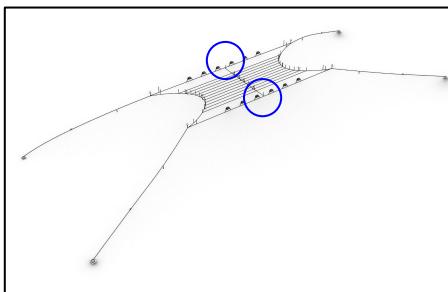
Oyster farming system:
[Oystergro Highflo model](#)

Oyster Line: 88.9m
18mm Polysteel (3 strand)

Connections:
XL Nylon Spinner with
stopper knots on both
sides of connected lines

Buoy: A3x 5

Weight: Chainlink 13kgx 4





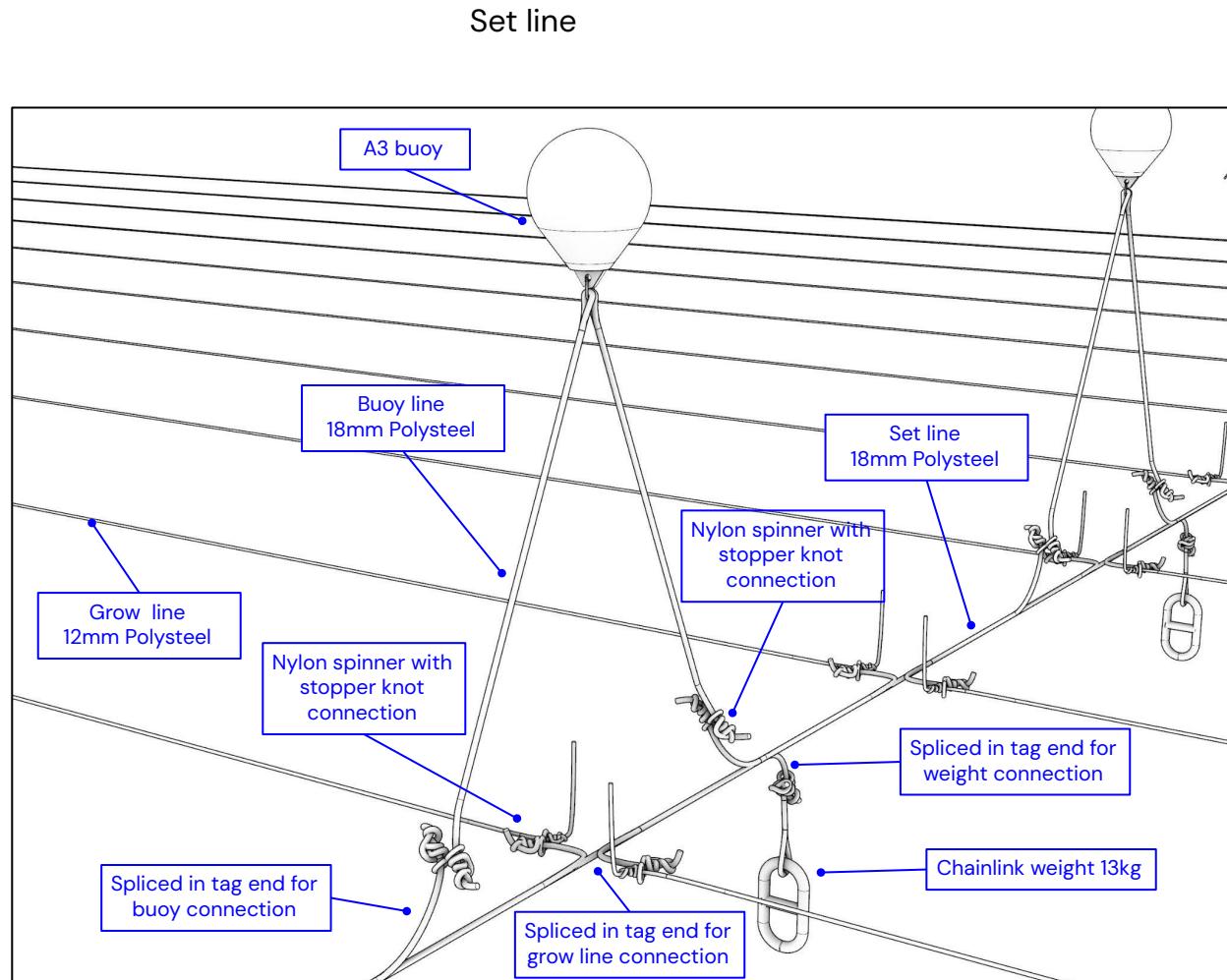
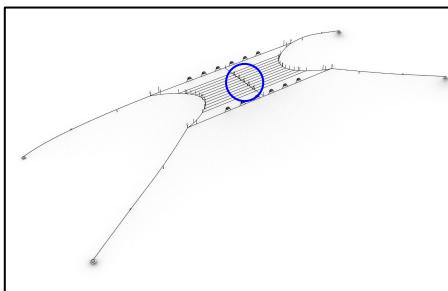
Set Line: 32.9m
18mm Polysteel (3 strand)

Connections:

XL Nylon Spinner with stopper knots on both sides of connected lines

Buoy: A3x 5

Weight: Chainlink 13kgx 4
Keep the chain link weights as close as possible to the setline to avoid any interaction with the grow lines





Grow line:

12mm Polysteel (3 strand) x 11

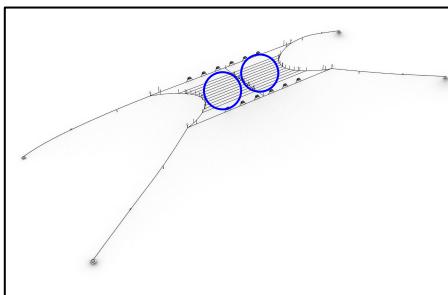
Connections:

XL Nylon Spinner with stopper knots on both sides of connected lines

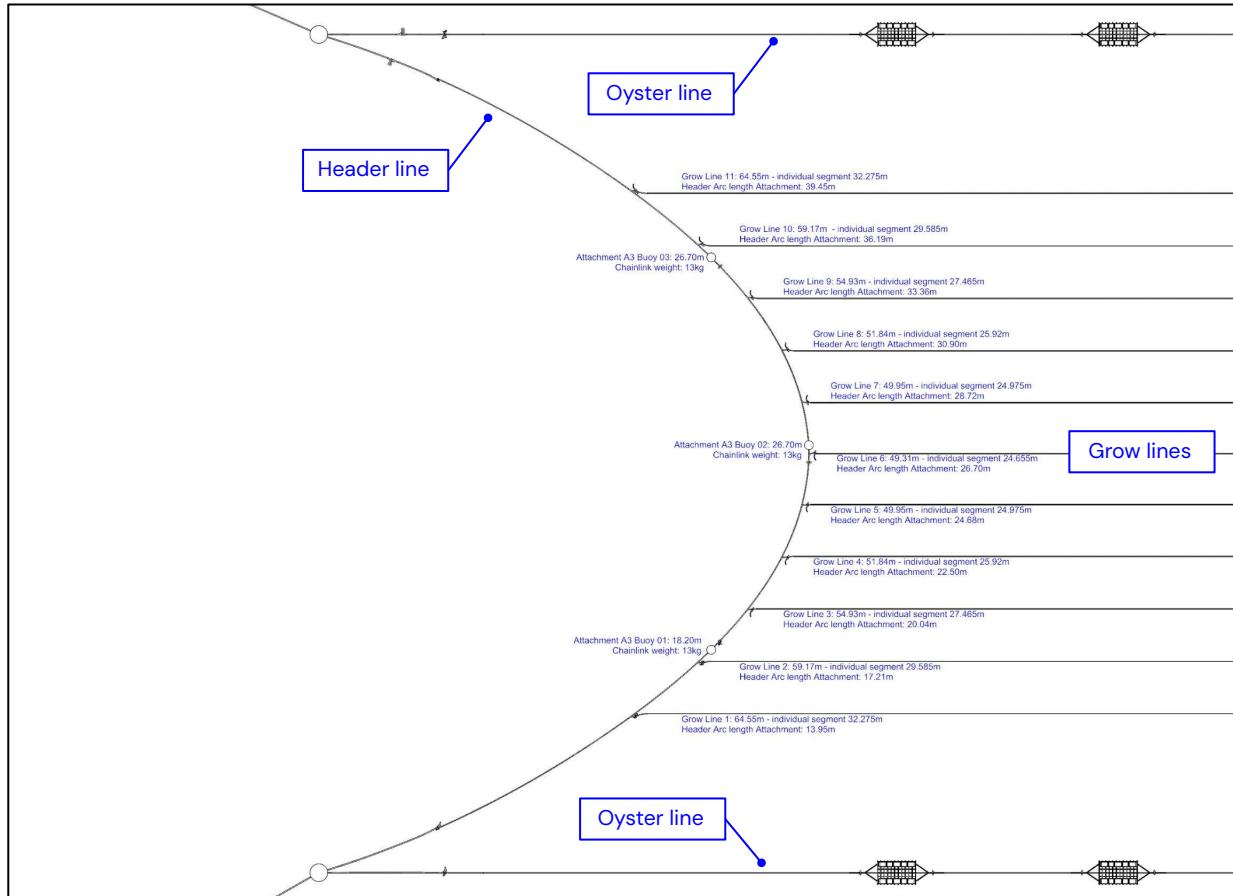
Buoy: A3 x3 , along header line

Weight: Chainlink 13kg x3 , along header line

Each grow line has a nylon spinner/stopper knot connection, which allows for easy tension adjustment and attaching or detaching of the line. The grow lines are in two individual segments, the center ends are connected to the set line.



Grow line





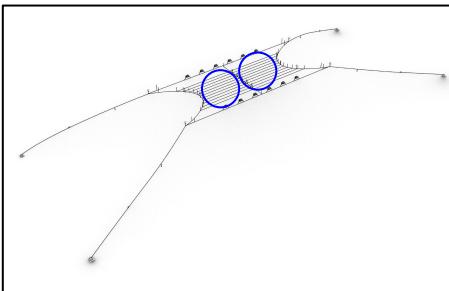
Grow line:

12mm Polysteel (3 strand) x 11

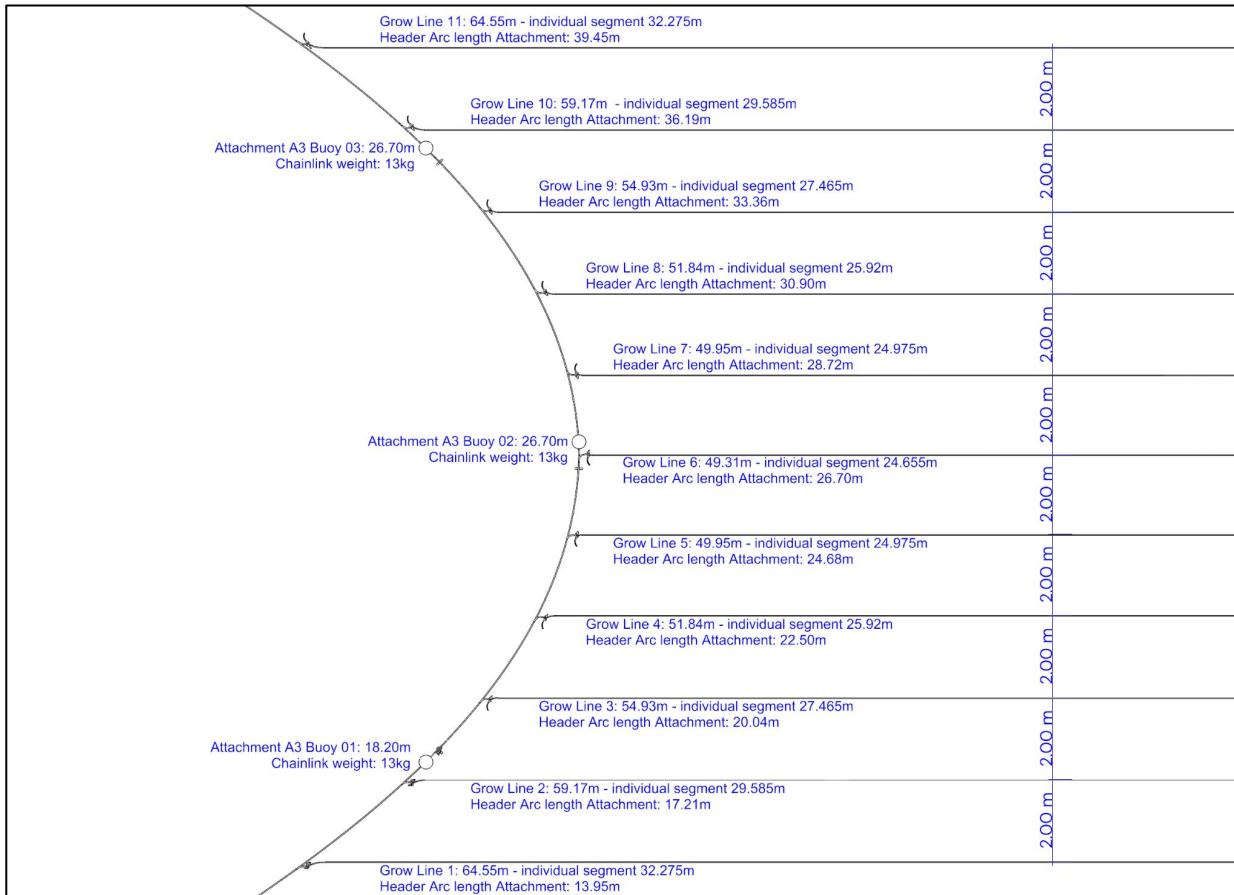
Growline length total: 550m

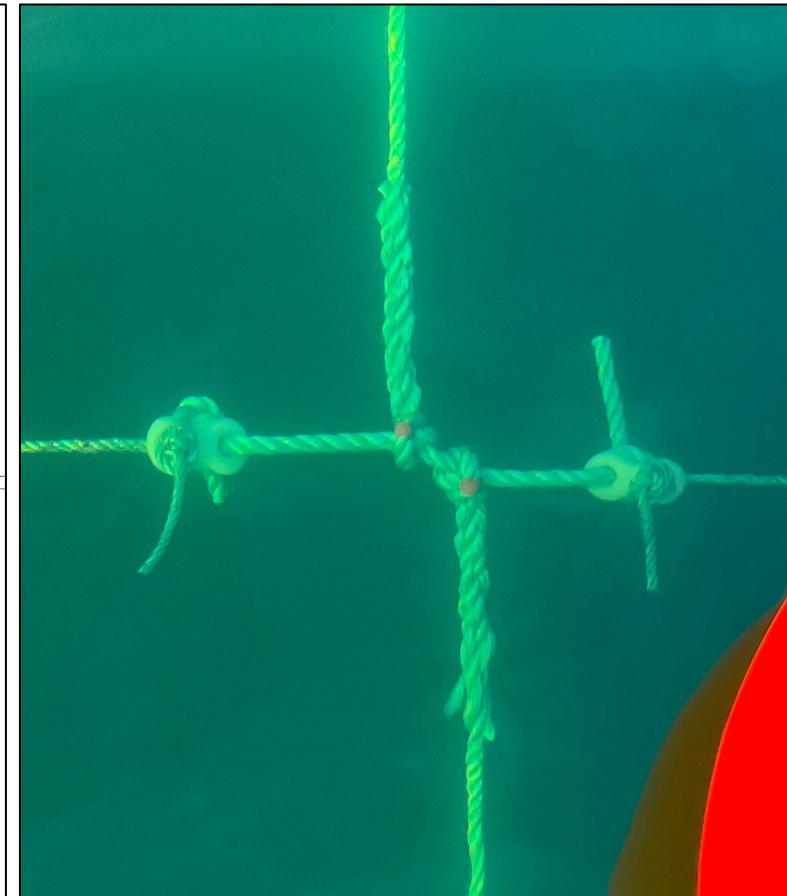
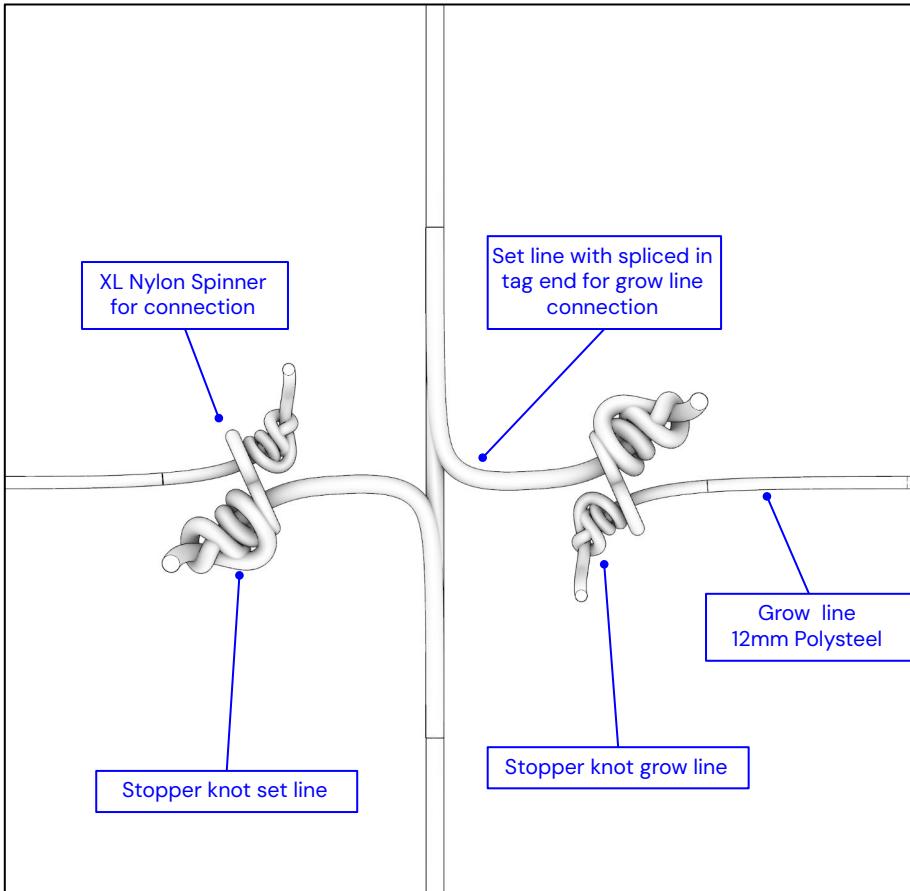
The design works for both standard seeded line with twine or direct seed lines.

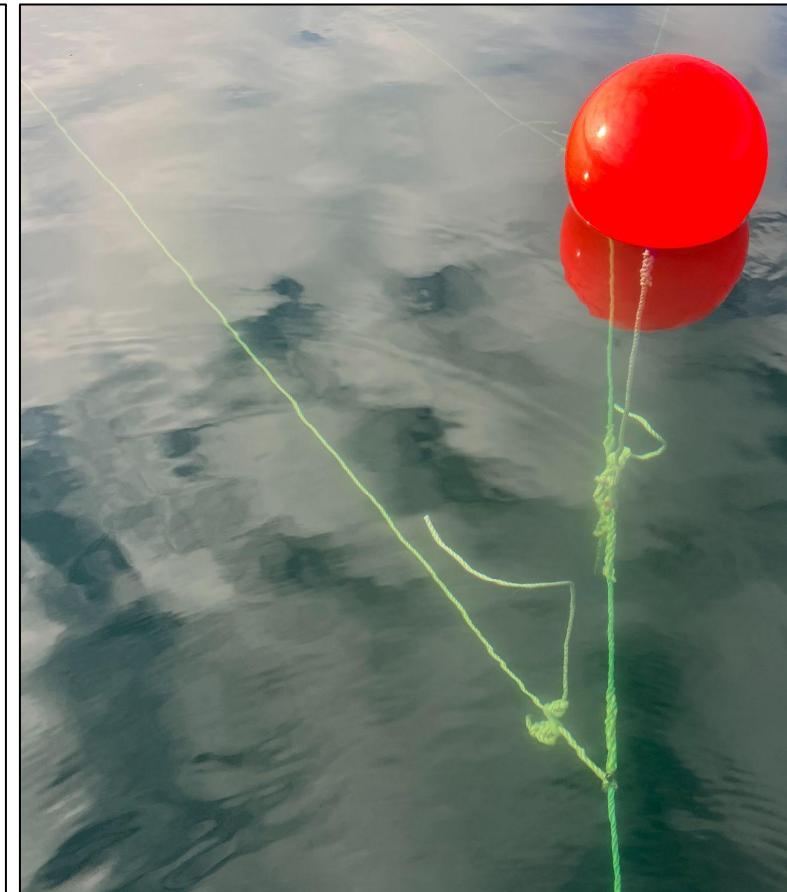
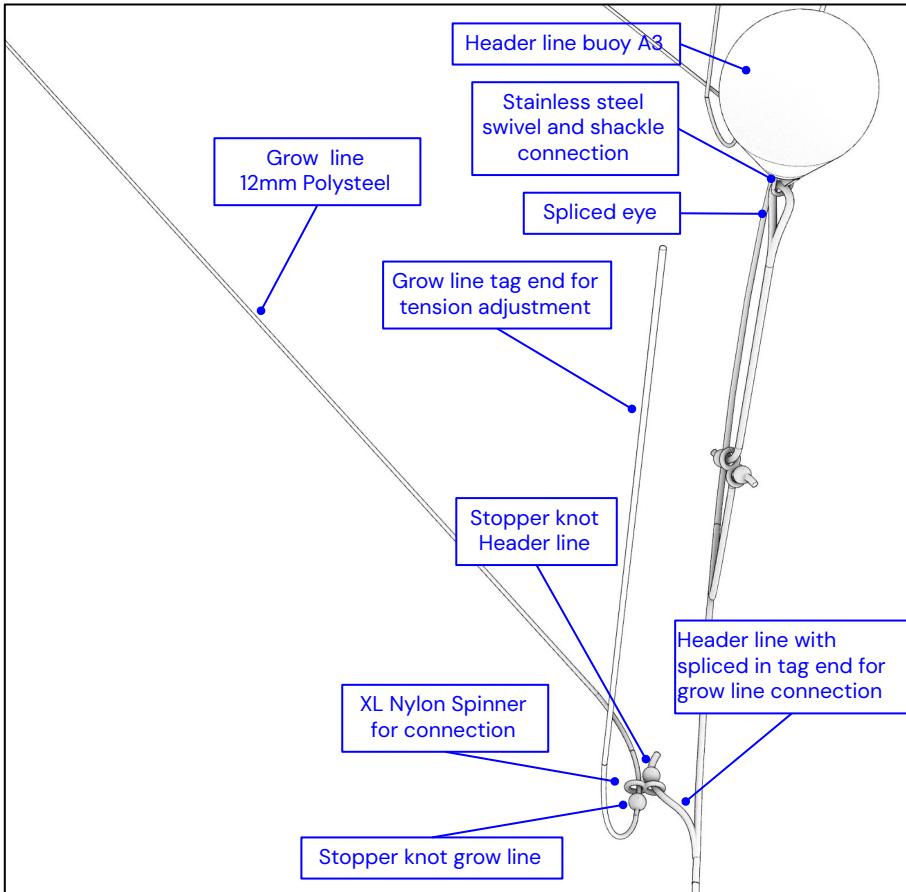
Each grow line has a nylon spinner/stopper knot connection with the header line, which allows for easy tension adjustment and attaching or detaching of the line. The grow lines are in two individual segments, the center ends are connected to the set line. The individual grow lines are 2m apart.



Grow line









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Farm seeding



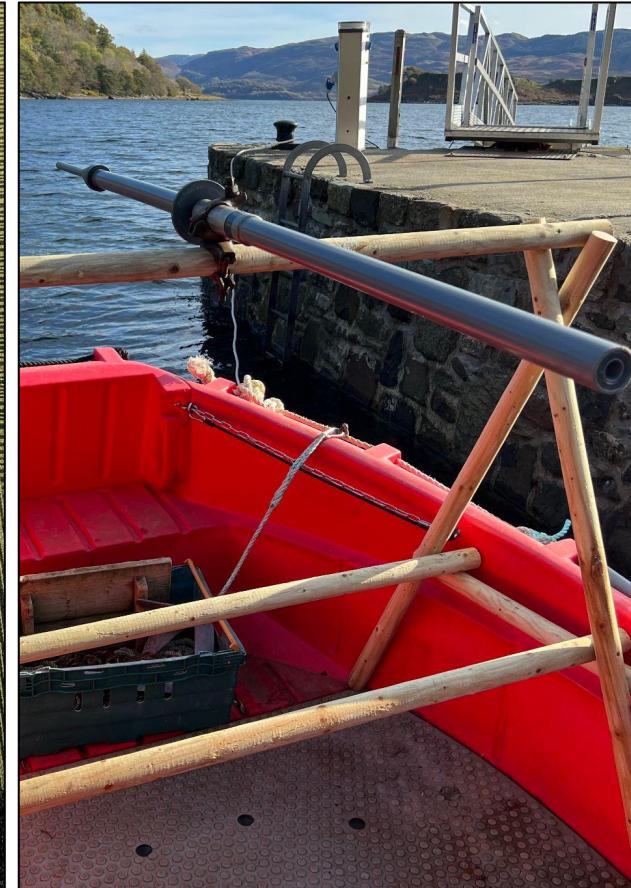
Farm seeding- Seeding tool

Seeded twine:

For the application of the seeded twine we recommend a seeding tool, see image on the left. A seeding tool can be any tube which allows the seeded twine spool to be mounted onto it. The combined seeding tool tube with the seeded twine spool should be able to rotate around another tube. This will help to release some initial tension from the seed lines when applied onto the grow lines, additionally the seeded twine will wrap nicely around the grow lines during the application.

left image:
seeded twine wrapped around a plastic tube.

right image:
seeding tool without a seeded twine tube on it.





Seeded twine:

left image:

seeding tool with a seeded twine tube placed on it. The grow line runs through the tool, at the beginning of it the seeded twine should be attached. Keep an offset of roughly 2m for tag ends and stopper knot.

right image:

seeded twine is wrapped nicely around the grow lines, the ends of the twine should be again fixed with a knot onto the grow line.





Grow lines- applied seeded twine

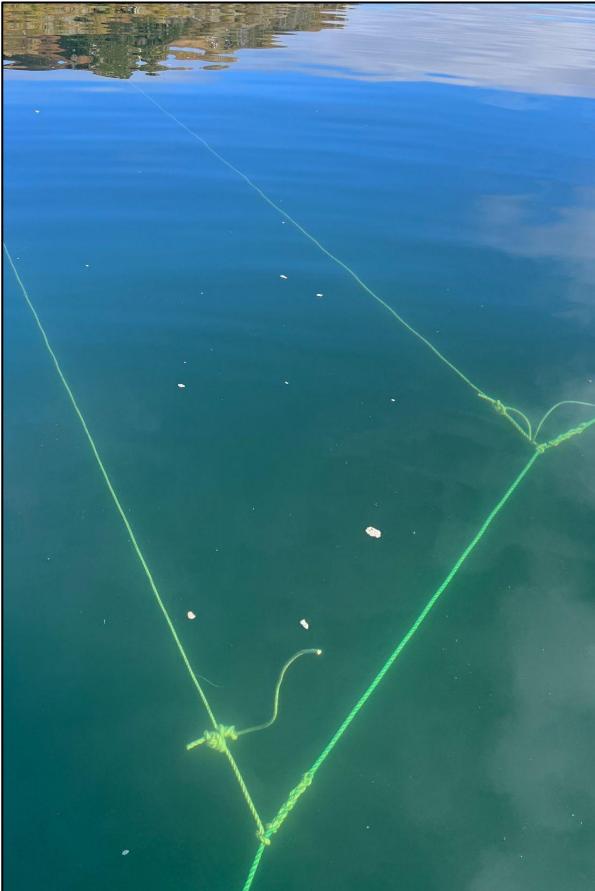
Seeded twine:

left image:

Grow lines with already applied seeded twine, the twine is visible close to the stopper knot connection of the grow line and the header line.

right image:

Grow lines with seeded twine wrapped around them.





Farm marine engineering



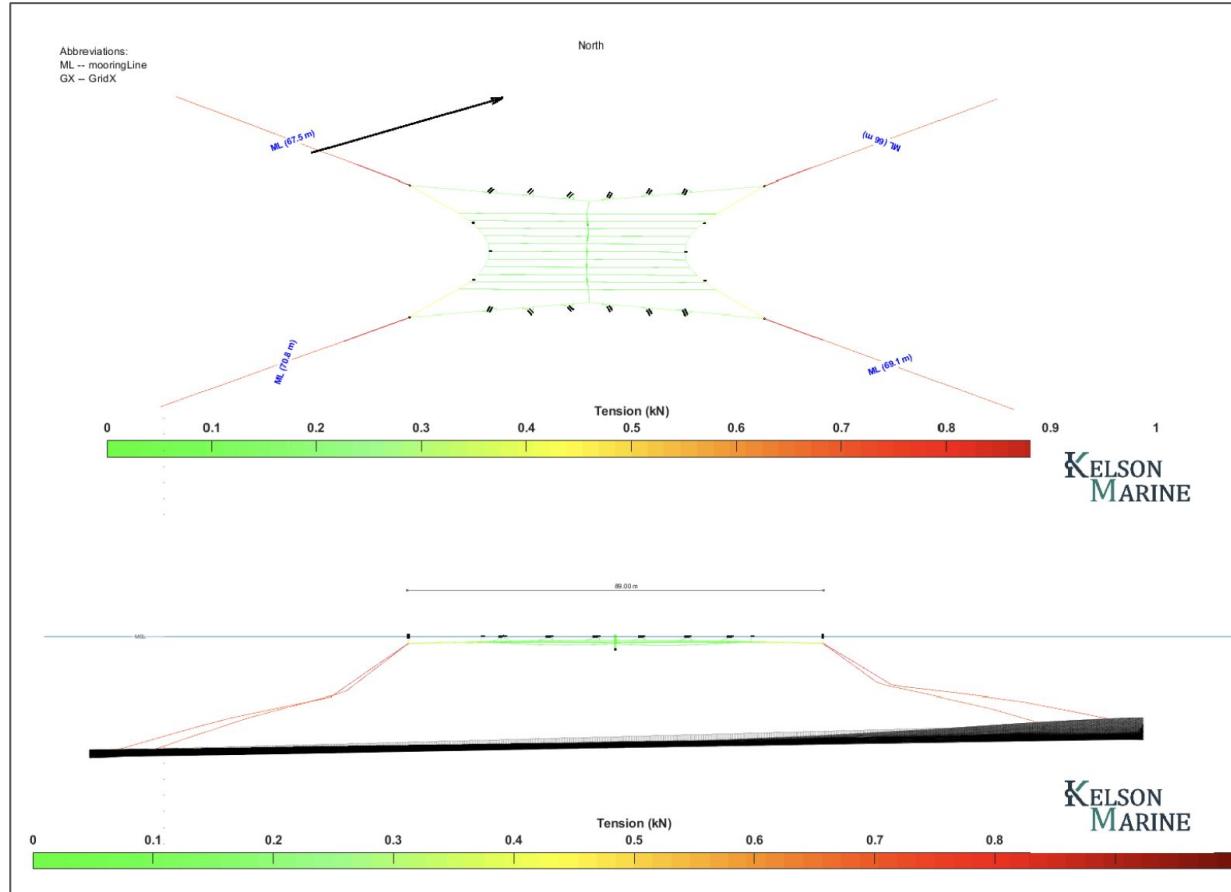
Introduction to engineering report:

This report is calculated and simulated for a specific site on the west coast of Scotland, it is highly advisable to consult an engineer while designing a farm to address all specific structural conditions of a farm.

The report should include simulations of various characteristic load cases to analyze how the proposed system would respond to fluctuations in current, wave, wind, and tidal conditions to optimize the performance and operability of the envisioned aquaculture farm system.

The engineering report should entail the computation of extreme current, wave, and wind conditions associated with a storm that has a 50-year recurrence interval (referred to as the 50-year storm). This calculation utilizes a hindcast model based on current and wave data, which has been validated through comparisons with nearby ocean observations.

This report was developed by Kelson Marine, all materials in the following section are published with allowance by Kelson. For the report please refer to our GitHub account or [click the link](#).





Farm maintenance



Introduction to the farm maintenance:

Seaweed farming demands careful attention to various factors, while specific circumstances may vary, the principles outlined here provide a foundational framework that can be adapted to suit the unique requirements of the farm. It is crucial to conduct regular maintenance checks to ensure optimal growth, health, and productivity of the seaweed farm.

Preliminary assessment:

This should be a thorough examination of the overall farm installation including diving for inspecting the anchors, all lines from mooring lines to grow lines, floatations, and all connections. Take note of any signs of damage, wear and tear to prevent damage, or potential environmental stressors. An installation of a monitoring sensor such as an underwater data logger to access data like water temperature, salinity or light exposure is highly recommended. The data logger should be placed as central as possible to achieve representable data. The retrieved data logs can be used as environmental monitoring, scientific research or industrial purposes.





Introduction to the farm maintenance:

Water quality analysis:

Regular assessment of the water quality parameters to guarantee an ideal environment for seaweed growth. Test for salinity, pH levels, temperature, light and nutrient concentrations. Adjustments may be necessary to maintain an optimal condition for seaweed cultivation.

Seaweed health inspection:

Examine the seaweed blades for any signs of discoloration, pests, or disease. Monitor growth rates and evaluate overall seaweed health. If anomalies are detected, prompt action is essential to prevent the spread of issues throughout the farm.

Infrastructure Check:

Especially after big events such as storms or a potential boat damage, inspect all farm infrastructure, including buoys, ropes, connections and anchor points. Ensure that they are secure and functioning as intended. Address any wear and tear promptly to prevent damage to equipment and potential disruptions to farm operations.





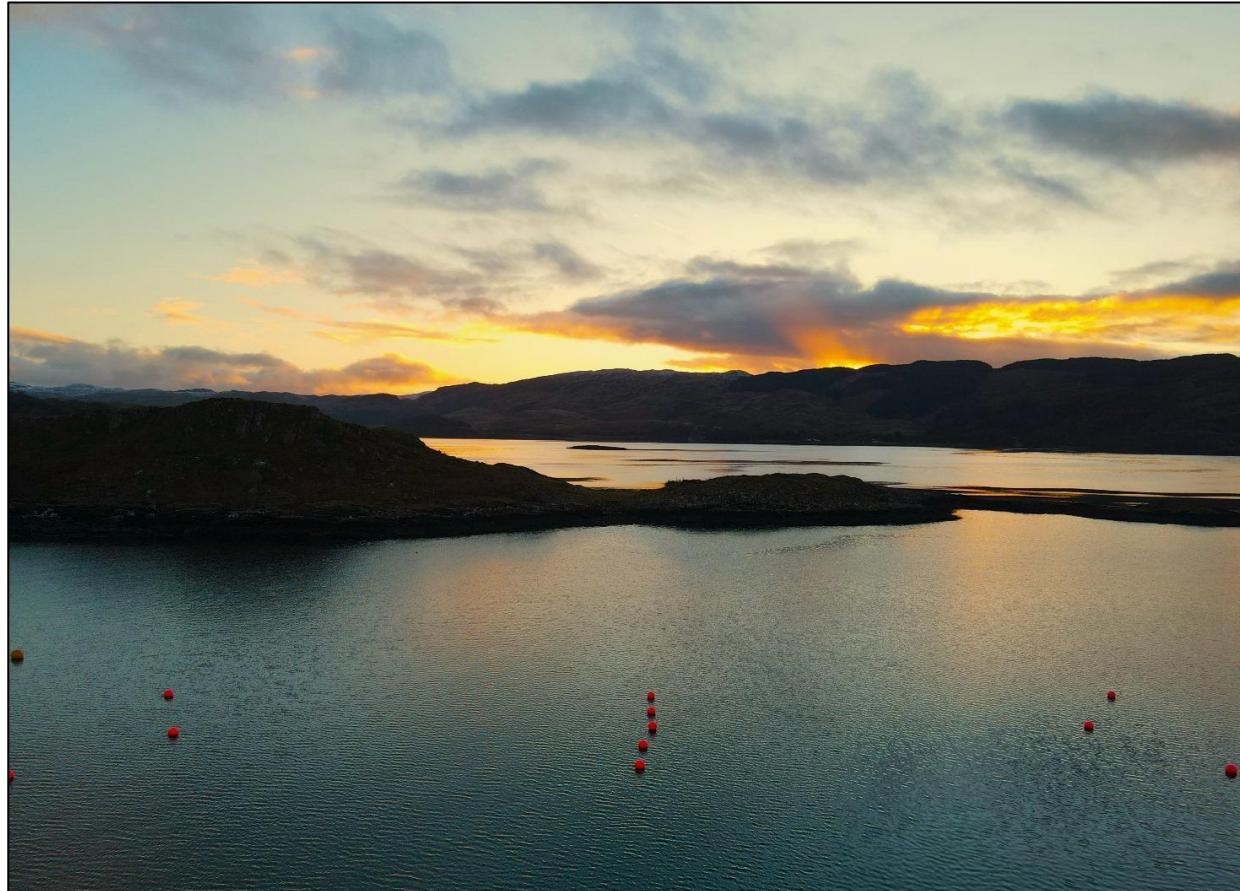
Introduction to the farm maintenance:

Harvesting Readiness Assessment:

Evaluate the readiness of seaweed for harvesting. Consider factors such as size, color, overall quality and targeted market. Implement a systematic harvesting plan to optimize yield while ensuring the sustainability of the seaweed.

Documentation:

Maintain detailed records of all observations, measurements, and corrective actions taken during the maintenance check-in. This documentation is essential for tracking the farm's performance over time and making informed decisions for future cultivation cycles. As always, "what gets tracked, gets improved."





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Farm harvest



Introduction to the farm harvest:

The harvesting chapter is divided into two main parts:

Firstly the near-shore harvesting on the water, with a large vessel with crane for a single line harvest.

Secondly the on-shore harvesting segment in a warehouse to safely remove the seaweed from the grow lines.

This approach eliminates constraints such as limited deck space on a boat and dependency on longer good weather windows. Additionally it reduces the labor time and fuel consumption of the boats.

This Seaweed Farm Harvest Protocol serves as a framework designed to facilitate responsible practices for a novel full single line harvesting methodology.

By outlining procedural guidelines and considerations, this protocol aims to mitigate potential environmental and labor risks while maximizing the efficiency of the harvesting process through reduced time spent on the water.





About the equipment list:

This equipment list is tailored to meet the specific needs of our crew, the intricacies of the site, and the expected yield per meter of grow line. Depending on your seaweed type you might need to break up the grow lines to fit them into the harvest tubs. For reference, we have managed to store around 200 kg of seaweed, the grow line with extra seawater and ice in one 1000 L tub. It is strongly advised to consult industry professionals or local communities when compiling an equipment list. Please note that this list does not guarantee or warrant a successful harvest.

Two boats were used for this harvest, a large boat with a crane and a small boat as a delivery boat for the grow lines. The large boat had a team of five people, a captain, a crane operator and three people to handle the incoming grow lines. The small boat had a team of two people, one person to operate the boat and the other person to handle and deliver the grow lines to the large boat.

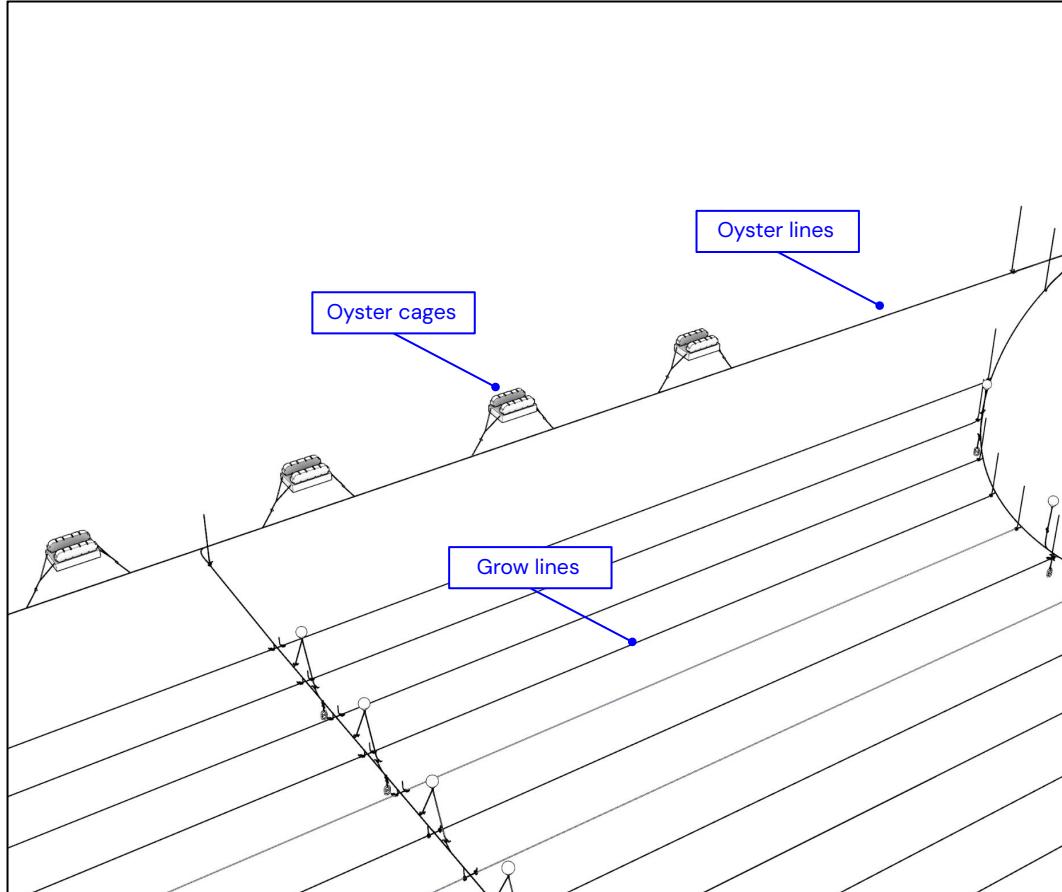
In addition, we recommend spare parts for all smaller items to ensure a more efficient workflow without interruptions for replacement or decontamination.

Equipment list harvest on boat		
Item Name	Amount	Description
1000 L Fishtub including lid	34	32 tubs for 16 growlines, 2 tubs for ice
Liners for tubs	34	Bigger than the tubs, will use them as layer between seaweed and ice and lid
Harvest knives	4	Two on each boat
Spare pieces of rope	6	12mm nylon, soft rope, for additional knots, prusik
Boat hook	2	Pull grow line to crane hook
Ice for cooling	2	2 tubs, as mentioned above
mid size shovel and buckets	2	For ice
Virkon Disinfectant	5kg	Disinfectant for potential contamination of surfaces or equipment
PPE for staff		
Hard hats	7	5 Big boat, 2 Small boat
Lifevest	7	5 Big boat, 2 Small boat
Working gloves	7	5 Big boat, 2 Small boat
Sturdy shoes	7	5 Big boat, 2 Small boat
Robust outfit - Oilskins	7	5 Big boat, 2 Small boat
Equipment list harvest at warehouse		
Tarp for floor	1	15x5m
Tarp for A frames	1	2x1m to cover A frames
Forklift	1	Deliver tubs on the tarp
Trailer	1	Drive tubs from dock to the warehouse
A frames	1	hold mount grow line while cutting
re-usable cable ties	100	Tie whatever we need
Scale	1	To weigh bags
Paper and pen	1	Note taking



Step 01

Preparation of oyster line:



Steps:

- Prepare oyster line for big boat
- Remove Oyster cages from Oyster line
- Attach connection lines to oyster line for big boat

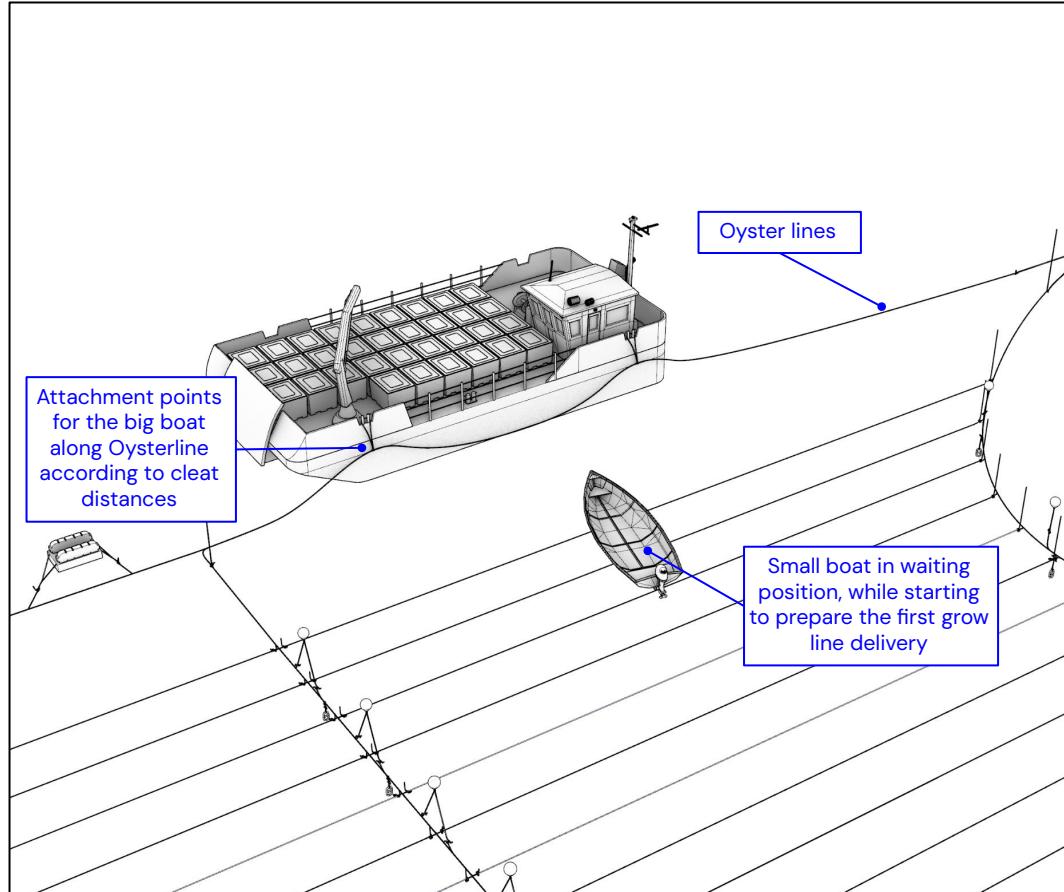
Equipment:

- 2 x Life Vest- small boat
- 2 x Working gloves- small boat
- 2 x Robust outfit and shoes- small boat
- 2 x Harvest knives- small boat
- 3 Spare pieces of rope- small boat
- 2 x Boat hooks- small boat



Step 02

Attachment of big boat to oyster line:



Steps:

- Prepare attachment points along oyster line to attach big boat.
- Longitudinal attachment of big boat to oyster lines.
- Start the harvest with grow line closest to the big boat.
- Prepare tubs on deck, add liners
- Keep lids on tubs to avoid contamination
- Prepare shovel and ice tub

Equipment:

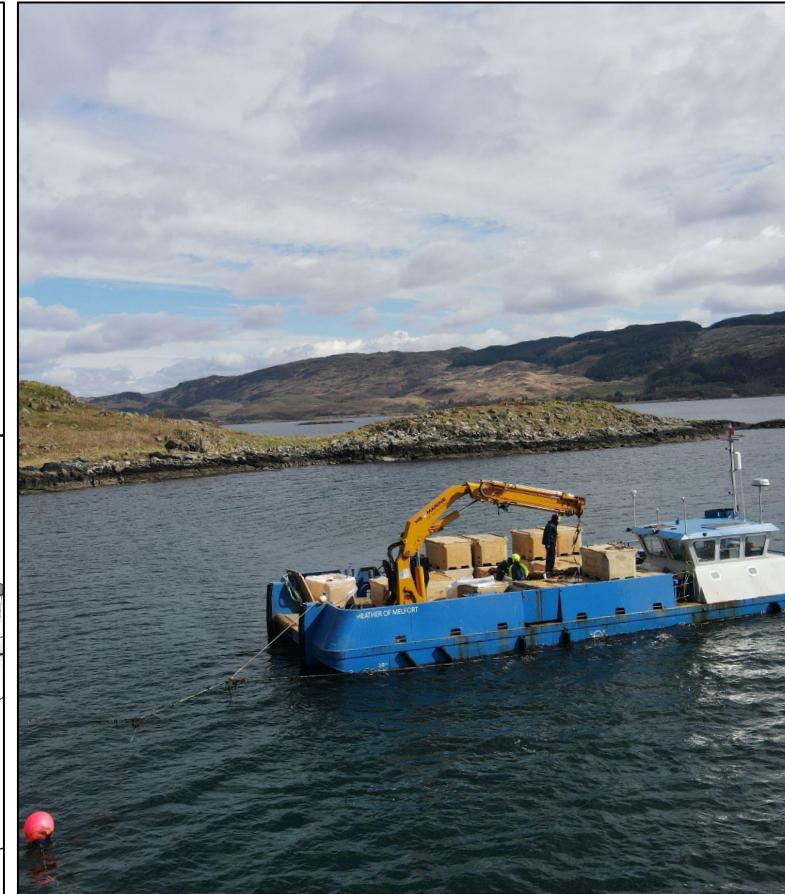
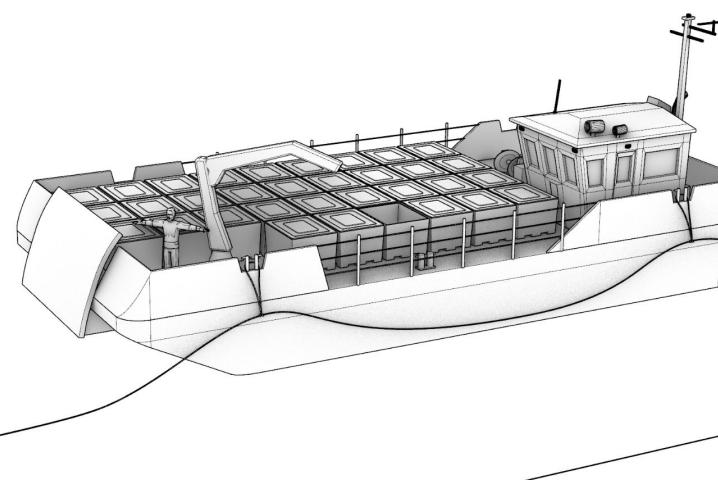
- 7 x Hard heads- both boats
- 7 x Life Vest- both boats
- 7 x Working gloves- both boats
- 7 x Robust outfit and shoes- both boats
- 4 x Harvest knives per boat- 2 each boat
- 32 x Tubs including lid- big boat
- 32 x Liners for tubs- big boat
- 1 x mid size shovel for ice- big boat
- 1 x Virkon Disinfectant 5L- big boat
- 4 Spare pieces of rope- both boats
- 2 x Boat hooks- small boat



Open Climate Solutions

Step 02

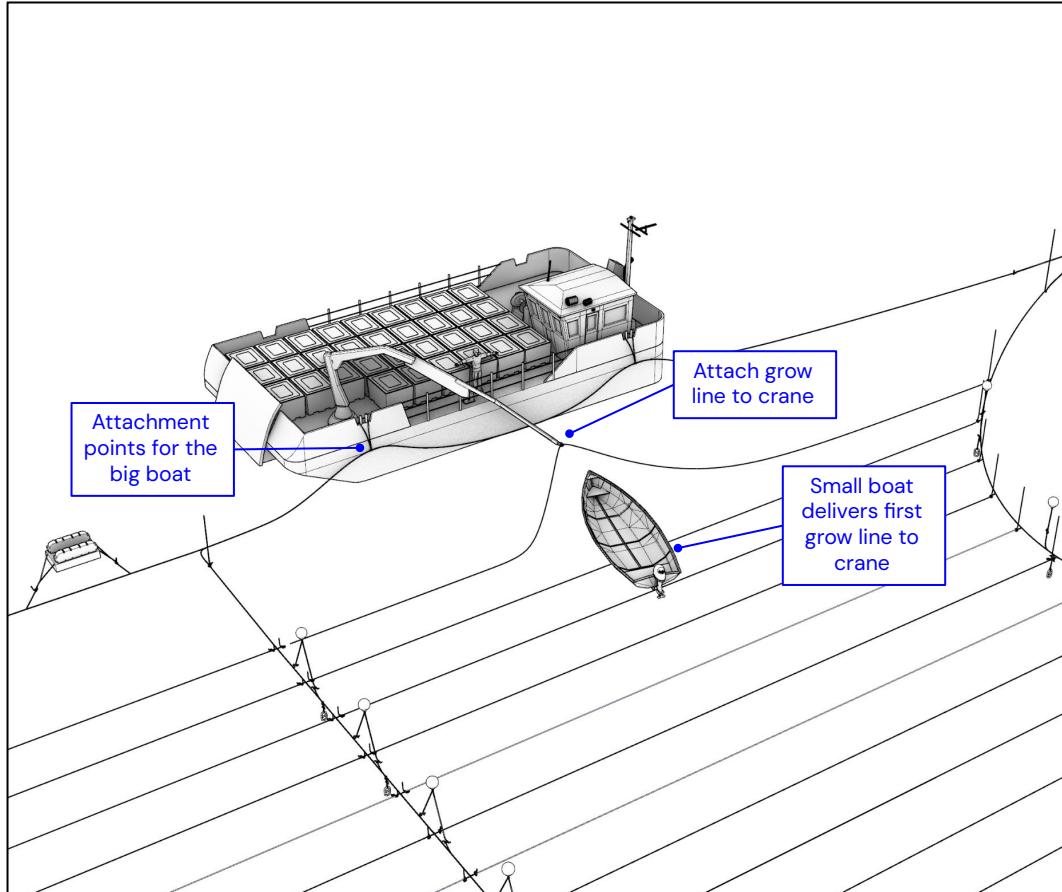
Attachment of big boat to oyster line:





Step 03

Preparation and delivery of grow line:



Steps:

- Small boat starts detaching grow lines from header line and set line.
- Small boat delivers first detached grow line to big boat crane arm
- Attach grow line to crane arm and signal to crane operator to raise arm slowly
- Check if grow line is well attached to arm
- Small boat leaves attachment area
- Crane slowly starts lifting and pulling inwards of grow line, let the seaweed rinse

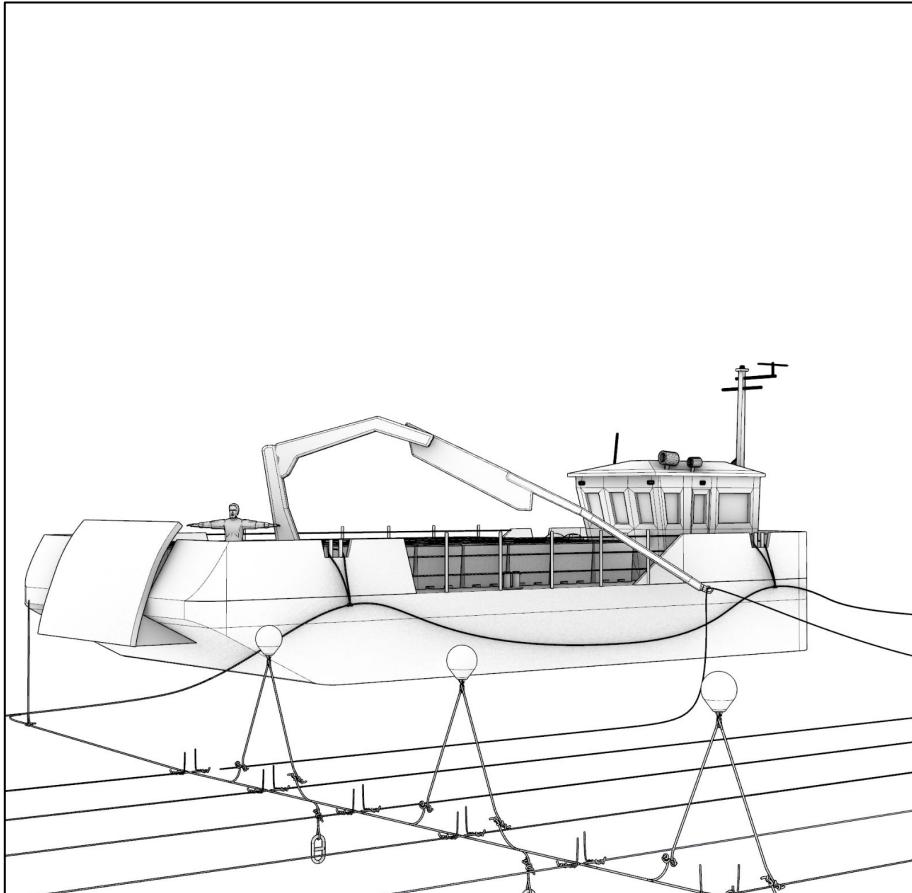
Equipment:

- 7 x Hard heads- both boats
- 7 x Life Vest- both boats
- 7 x Working gloves- both boats
- 7 x Robust outfit and shoes- both boats
- 4 x Harvest knives per boat- 2 each boat
- 32 x Tubs including lid- big boat
- 32 x Liners for tubs- big boat
- 1 x mid size shovel for ice- big boat
- 1 x Virkon Disinfectant 5L- big boat
- 4 Spare pieces of rope- both boats
- 2 x boat hooks- small boat



Step 03

Preparation and delivery of grow line:

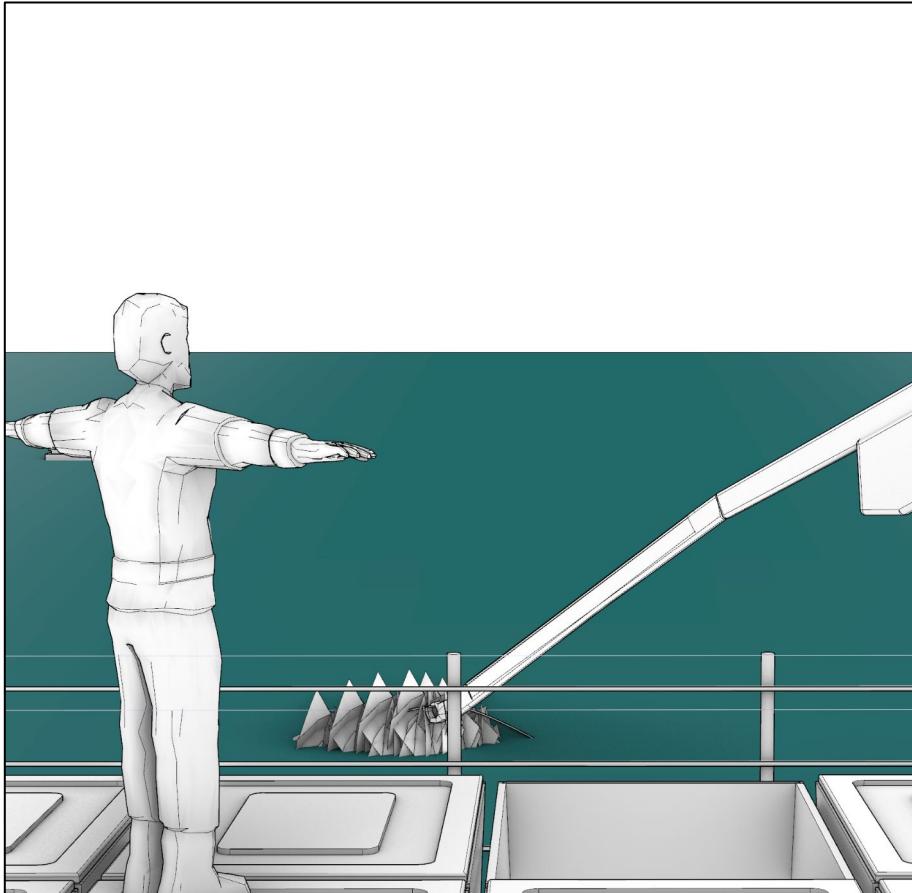




Open Climate Solutions

Step 03

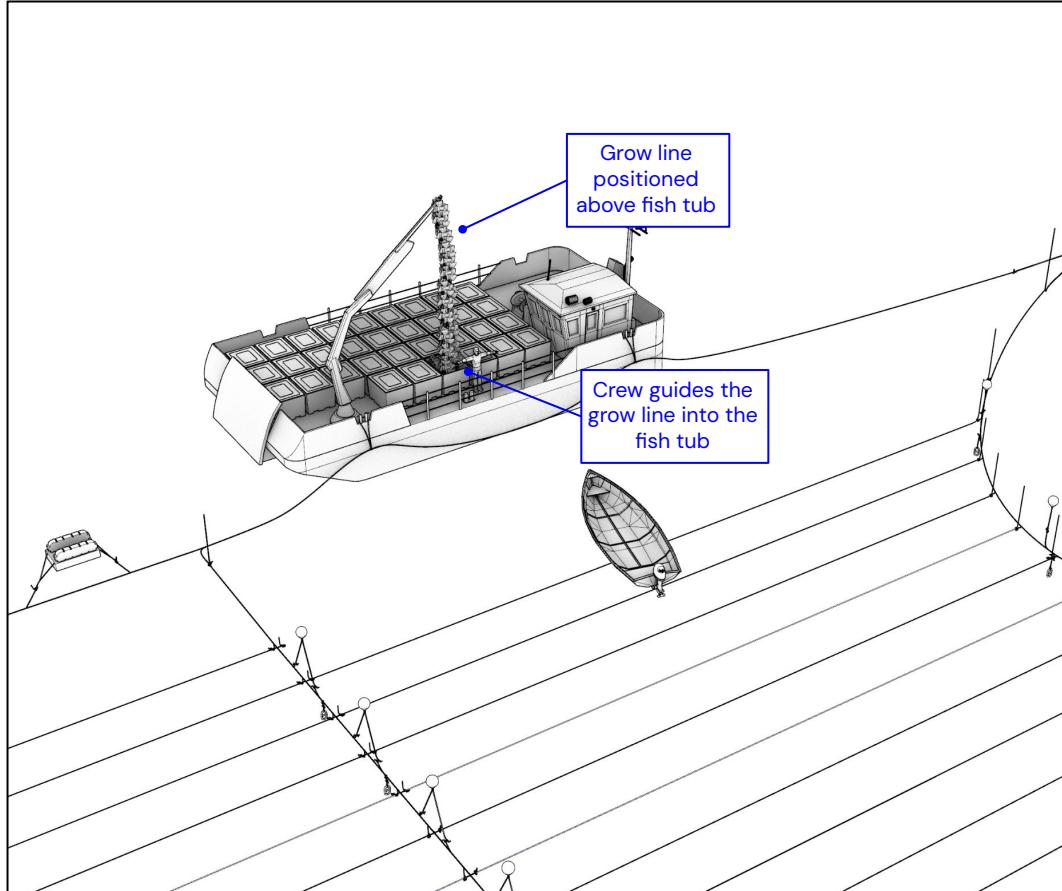
Preparation and delivery of grow line:





Step 04

Delivery of grow lines into big tubs



Steps:

- Crane positions full grow line above tub
- Attach ends of grow line with a simple knot to corner hooks of tubs
- Signal to crane operator to slowly drop grow line into the tubs
- Guide the dropping grow line into the tub
- Detach grow line from crane hook when grow line is in the tub
- Cover the seaweed with the extra liner
- Add some ice on top
- Close the tub with the lid

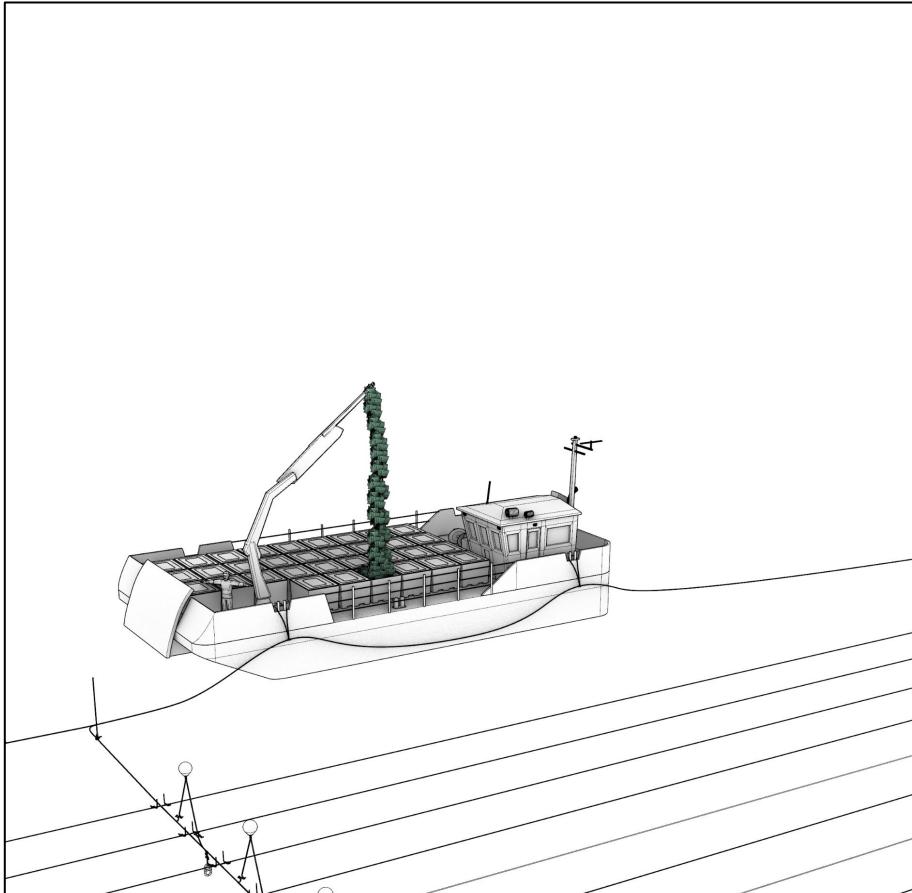
Equipment:

- 7 x Hard heads- both boats
- 7 x Life Vest- both boats
- 7 x Working gloves- both boats
- 7 x Robust outfit and shoes- both boats
- 4 x Harvest knives per boat- 2 each boat
- 32 x Tub^s including lid- big boat
- 32 x Liners for tubs- big boat
- 1 x mid size shovel for ice- big boat
- 1 x Virkon Disinfectant 5L- big boat
- 4 Spare pieces of rope- both boats
- 2 x boat hooks- small boat



Step 04

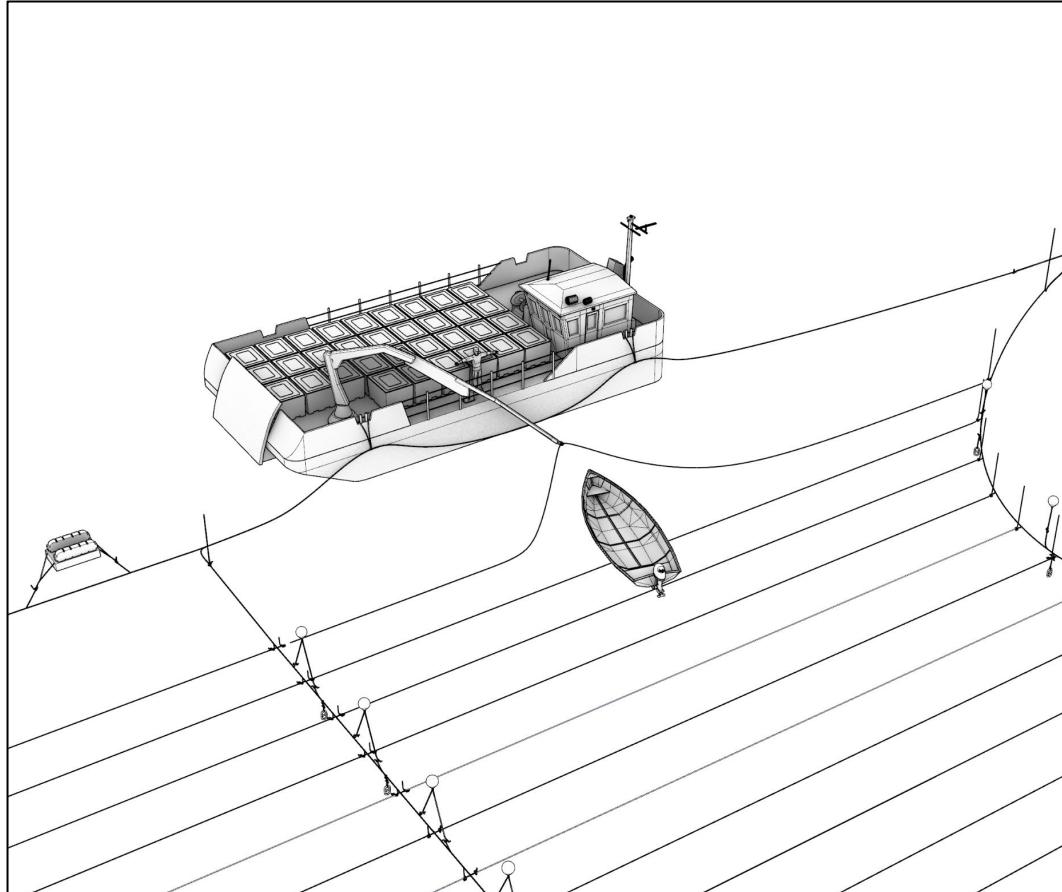
Delivery of grow lines into big tubs





Step 05

Repeat steps



Steps:

- Small boat waits with another detached grow lines.
- Deliver detached grow line with the small boat to big boat crane arm
- Attach grow line to crane arm and signal to crane operator to raise arm slowly
- Check if grow line is well attached to arm
- Small boat leaves attachment area
- Crane slowly starts lifting and pulling inwards of grow line

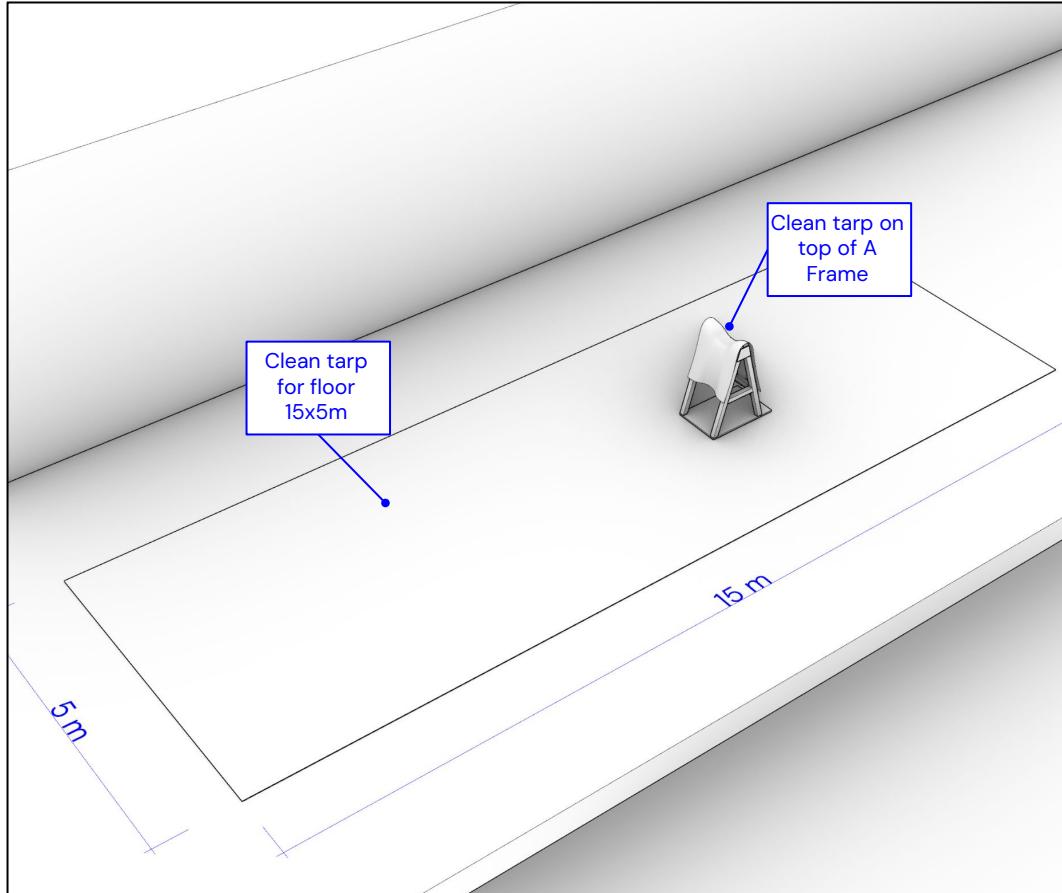
Equipment:

- 7 x Hard heads- both boat
- 7 x Life Vest- both boats
- 7 x Working gloves- both boats
- 7 x Robust outfit and shoes- both boats
- 4 x Harvest knives per boat- 2 each boat
- 32 x Tubs including lid- big boat
- 32 x Liners for tubs- big boat
- 1 x mid size shovel for ice- big boat
- 1 x Virkon Disinfectant 5L- big boat
- 4 Spare pieces of rope- both boats
- 2 x Boat hooks- small boat



Step 01

On shore harvest



Steps:

- Position tarp to protect seaweed from any contamination and adhere to HSAP guidelines
- Position A frames on the tarp and cover it with small tarp to adhere HSAP guidelines
- Make sure all materials, surfaces and equipment are disinfected and without contamination to fulfill HSAP requirements.

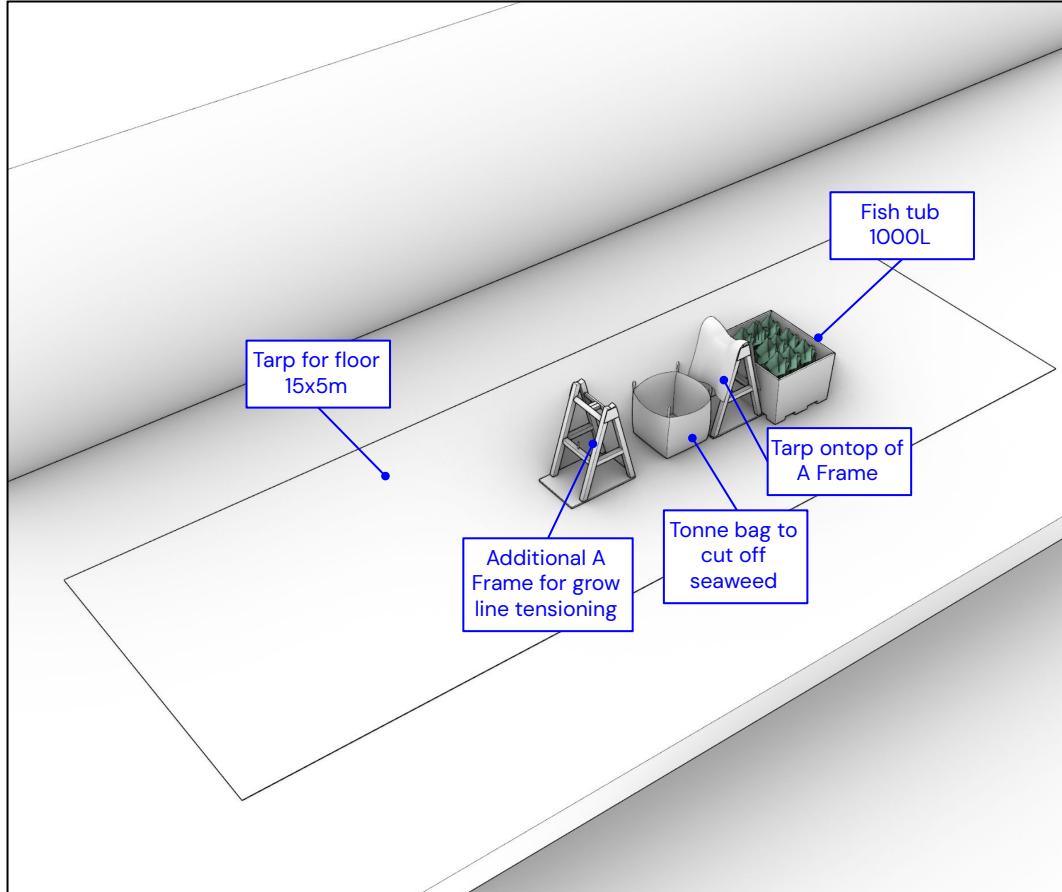
Equipment:

- Tarp for floor 15x5m
- 1x A Frame for easier handling of the seaweed on the grow line.
- Working gloves
- Robust outfit and shoes
- 1x Harvest knives



Step 02

On shore harvest



Steps:

- Carefully position first tub on tarp with forklift
- Remove forklift
- Position tonne bag on the other side of the A frame
- Make sure all materials, surfaces and equipment are disinfected and without contamination to fulfill HSAP requirements.

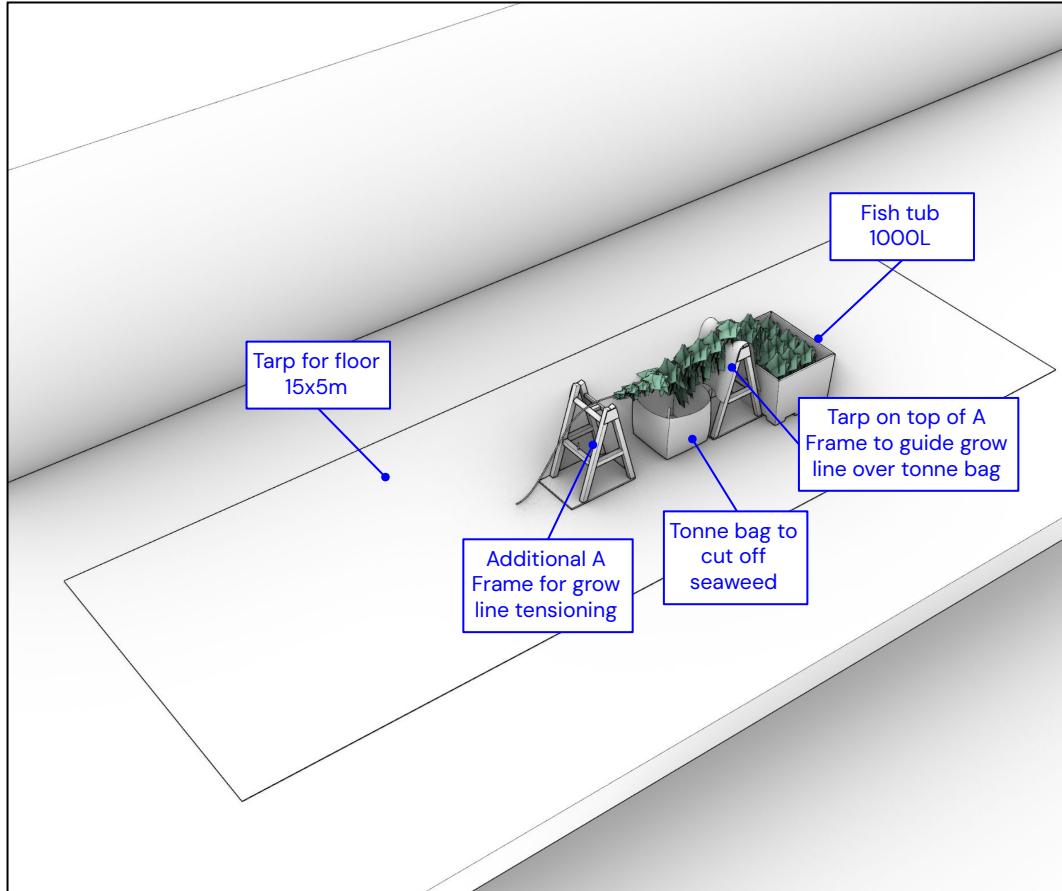
Equipment:

- Tarp for floor 15x5m
- 1 x Tarp for A frames 2x1m
- 1 x A Frame
- 1 x Tonne bag
- First tub with grow line and seaweed
- Working gloves
- Robust outfit and shoes
- 1 x Harvest knives



Step 03

On shore harvest



Steps:

- Deliver end of grow line over A frame with tarp and above tonne bag
- Make sure all materials, surfaces and equipment are disinfected and without contamination to fulfill HSAP requirements.

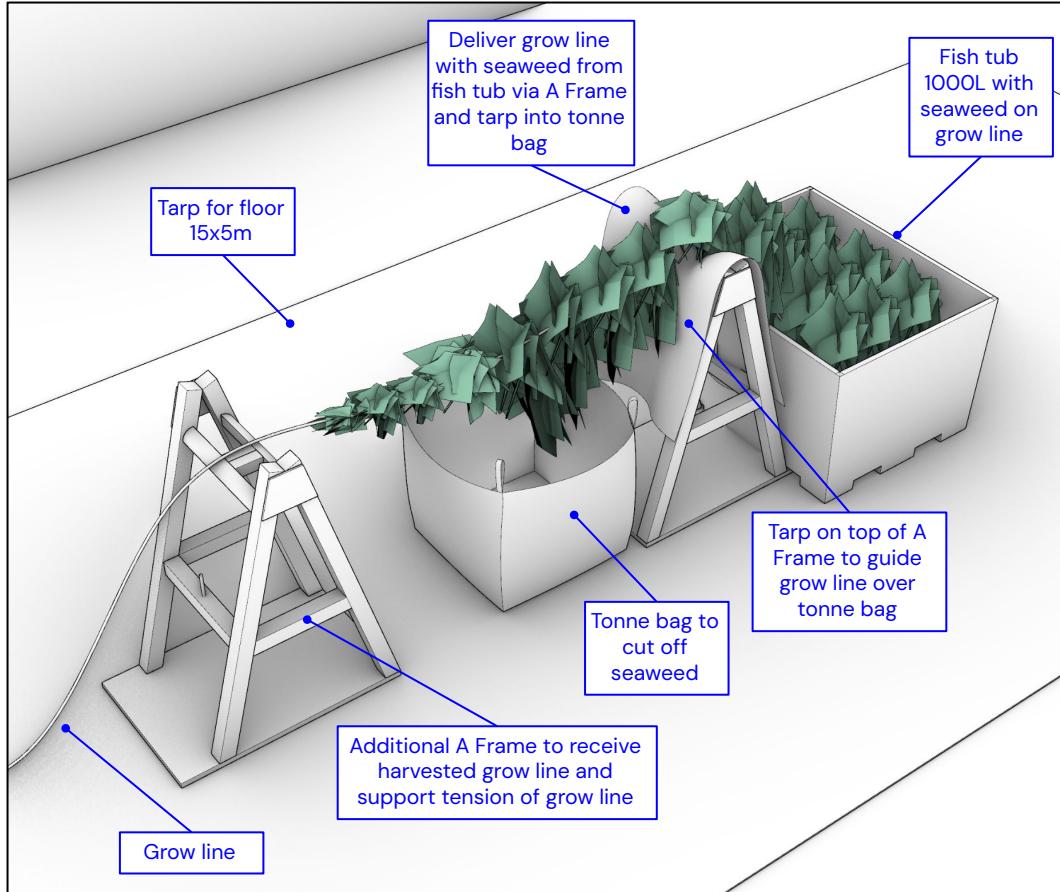
Equipment:

- Tarp for floor 15x5m
- 1x Tarp for A frames 2x1m
- 1x A Frame
- 1x Tonne bag
- First tub with grow line and seaweed
- Working gloves
- Robust outfit and shoes
- 1x Harvest knives



Step 04

On shore harvest



Steps:

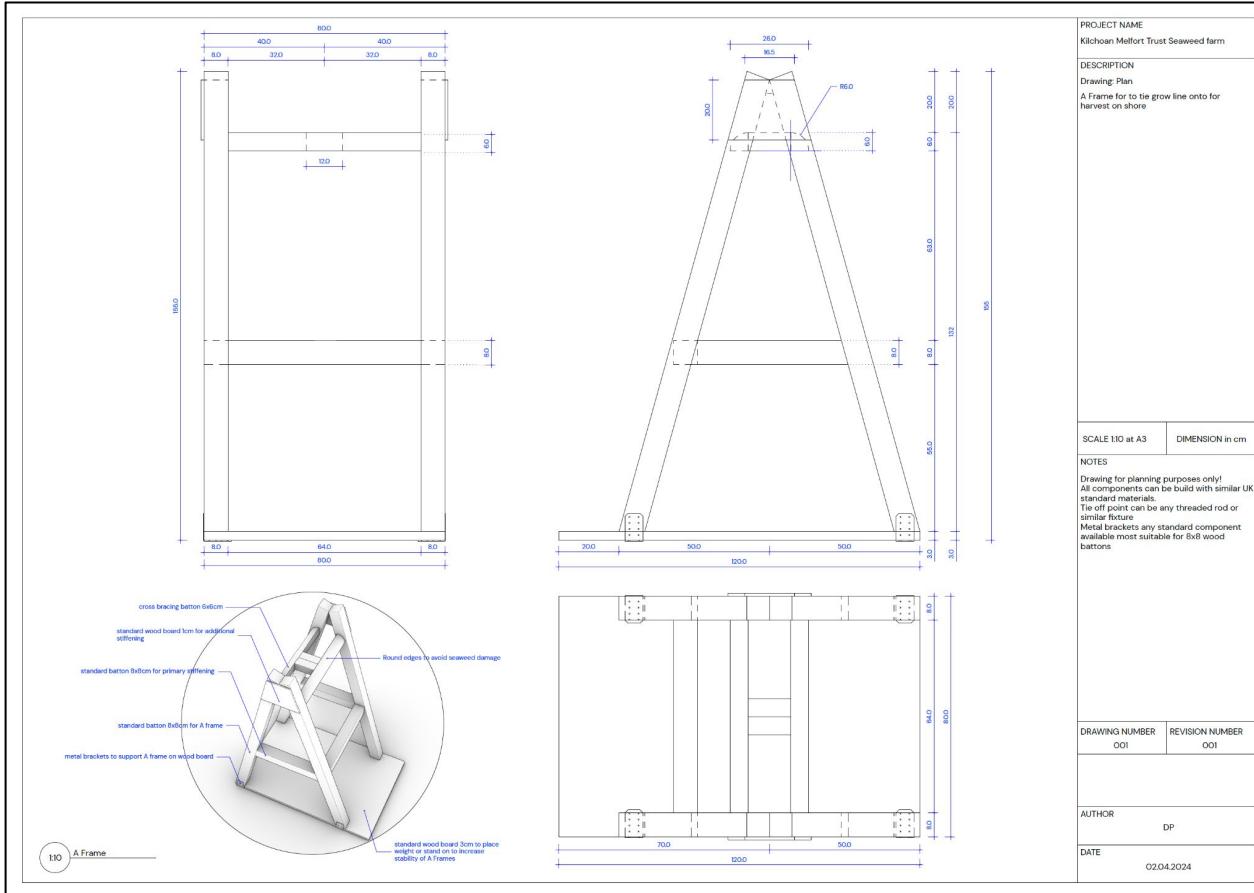
- Deliver ends of grow line over tonne bag and keep the tension with support of the second A Frame
- Start cutting the seaweed into tonne bag
- Deliver harvested grow line along and onto the tarp on the floor
- Make sure all materials, surfaces and equipment are disinfected and without contamination to fulfill HSAP requirements.
- REPEAT FROM STEP 01 on shore harvest

Equipment:

- Tarp for floor 15x5m
- 1x Tarp for A frames 2x1m
- 2 x A Frame
- 1x Tonne bag
- First tub with grow line and seaweed
- Working gloves
- Robust outfit and shoes
- 1 x Harvest knives



A Frames for harvest on shore

**A Frame detail**

- Round edges at mounting point to prevent seaweed damage
- This A Frame is custom build to support the manual on shore harvest in a warehouse or shed
- Cover A Frame with a disinfected tarp to fulfill HSAP standards
- Each material and component should be procured from locally available sources and dimensions can be adjusted to these.