PRELIMINARY PEN AND GRID CONFIGURATION BY AKVA

05 March 2020 Prepared by Mark Porter for Alison Undorf-Lay

Summary of Akva 'Atlantis, Pen Design

The Akva 'Atlantis' pen is designed to be a fully submersible structure. Moored to the seabed its flotation system can be flooded or inflated to raise and lower the structure as required. A surface fish containment net negates the requirement for thinner bird netting and poles.

Its specifications are as follows;

- Circumference 120m
- Side depth 20m with 25m to the bottom cone
- Volume of production capacity 27,000m^3
- Distance from seabed 30-60m depending on submerged depth
- Grid size 110m x 110m
- Mooring lines 320m using a 4:1 length to depth ratio
- Combined grid and pen area 26.16ha per farm

All daily husbandry tasks will be conducted below the water's surface with feeding performed at a minimum of 3m below the surface and submersible lighting will be set at a minimum depth of 5m. Underwater cameras and related sensors allow constant monitoring of the fish's environment including feeding behavior. A submersible remotely operated vehicle (ROV) can maintain and clean nets. An air dome provides continuous opportunity to regulate swim bladder inflation. Global positioning systems and strain gauges with telemetry back to base will be used to monitor movement of the grids and strain on moorings at all times.

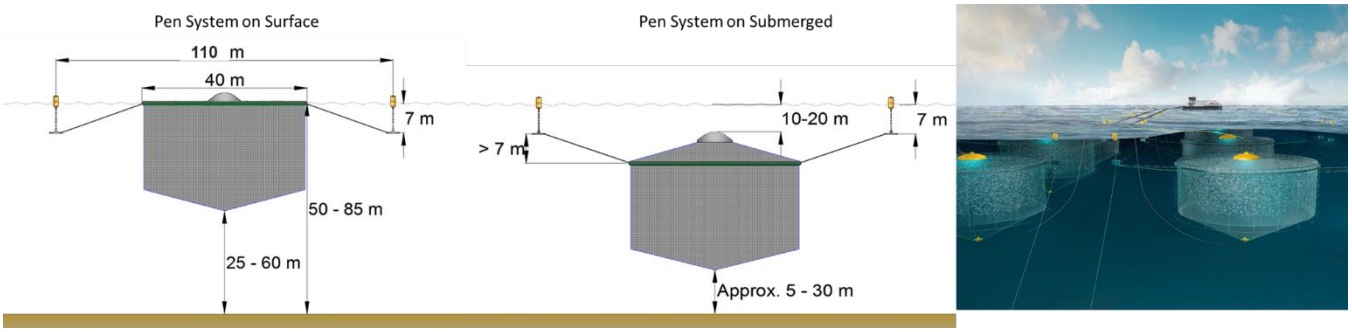

Figure 1. Diagram of Akva Atlantis 120m circumference pens

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Pen and Grid Configurations

Akva have supplied initial pen and grid configurations to provide a maximum grid and lease area required.

Key points;

1. Pen configuration of a 3x2 and 2x2 design to optimise grid strength and will sit 10-15° off the prevailing wind and wave direction to allow safe anchorage for large service vessels.
2. The barge will sit between the grids and parallel to the prevailing conditions
3. Initial pen size will be 120m circumference with an 110m² grid and mooring line ratio of 4:1 (320m max length). Total grid size of 1190m x 220m (total area 26.18ha) and total farm size including mooring lines of 1680m x 860m or 157.38ha (refer figure 2). This estimate uses current knowledge and Akva's experience with both trial systems and commercial farms located on high energy sites.
4. The barge will be located between the two grids and parallel to the prevailing conditions. The barge moorings will utilize the width of two pen bays (220m) and will require two mooring lengths in total (640m). This will ensure that both feeding systems and pen communications have a maximum distance of 650m to travel to the furthest pen which is well within current infrastructure (Akva feeding system) capabilities.
5.

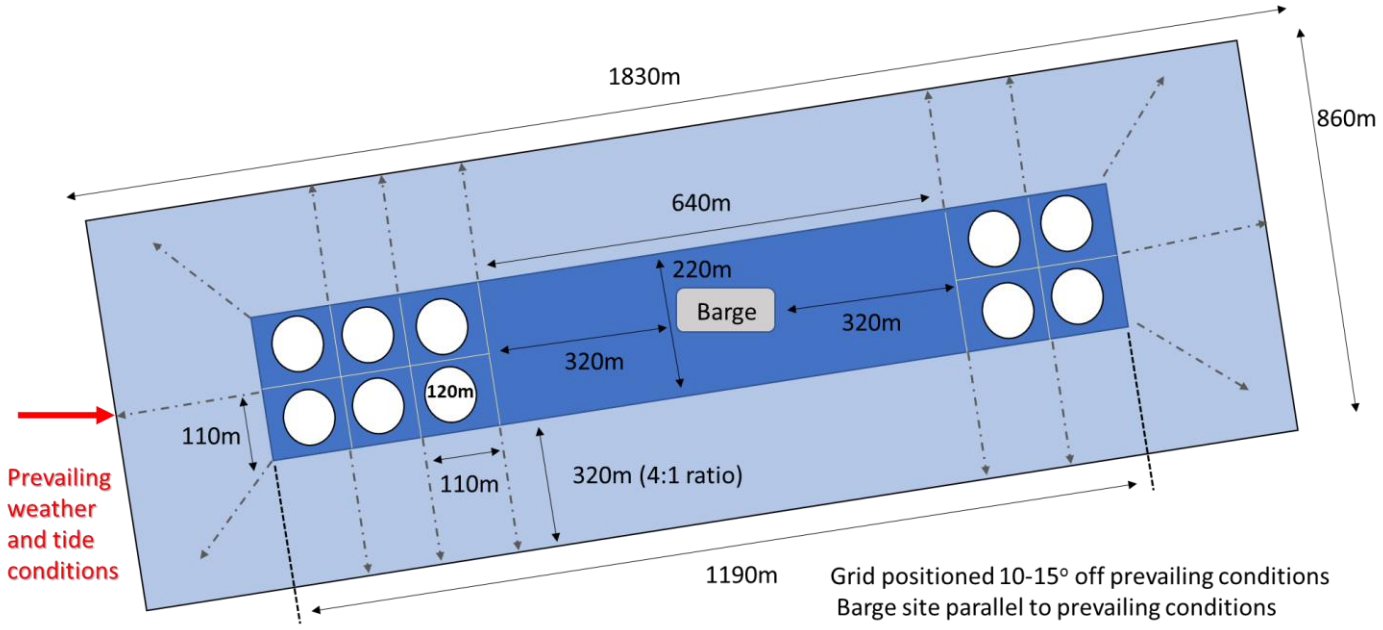

Figure 2. Atlantis 120m circumference pens with 80m pen bays and 4:1 mooring lines.

The total area requirement during stage 1 and 2 of the project development is shown in table 1 below. Stages 1 and 2 refer to the initial developmental stages and then the farm running at full capacity. Akva consider a stocking density of 15kg/m^3 rising to 18kg/m^3 just prior to harvest to be appropriate for this system

Table 1. Area requirements for Stages 1 and 2 of Project South.

AKVA GRID AND FARM AREAS	Stage 1	Stage 1 Area (hectares)	Stage 2	Stage 2 Area (hectares)
Pen Number	6	6	10	10
120m pens and 110m grid system	970m x 220m	21.34	1190m x 220m	26.18
120m pens and grid system plus moornings (4:1)	1290m x 860m	110.94	1830m x 860m	157.38

Grid Orientation and Farm Site

Additional pointes raised during discussions with Akva were that the pens would need to be raised every 2-3 weeks at a minimum. Farms currently using submerged technology are submerging cages when storm events are imminent. Using a 5x2 pen configuration is deemed very high risk as the elemental forces on this arrangement are exponentially higher than either a 2x2 or 3x2 set up (figure 4). In all high energy sites currently developed by Akva the grid lies at an angle of 10-15 degrees off the prevailing wind and tide conditions. While the barge and service vessels (well boat, feed supply vessels etc.) are moored parallel or facing into the prevailing conditions. This provides the most robust grid and mooring configuration while also ensuring the barge and service vessels are afforded maximum safety at anchorage. Akva engineers are working on the optimal site to run stage 1 however their thoughts to date are to use the deepest Farm with the most sheltered aspect to avoid the snatch strain on the system. This would negate the use of site A and more favour positions such as B or C however the actual site will be determined within the initial Akva report.

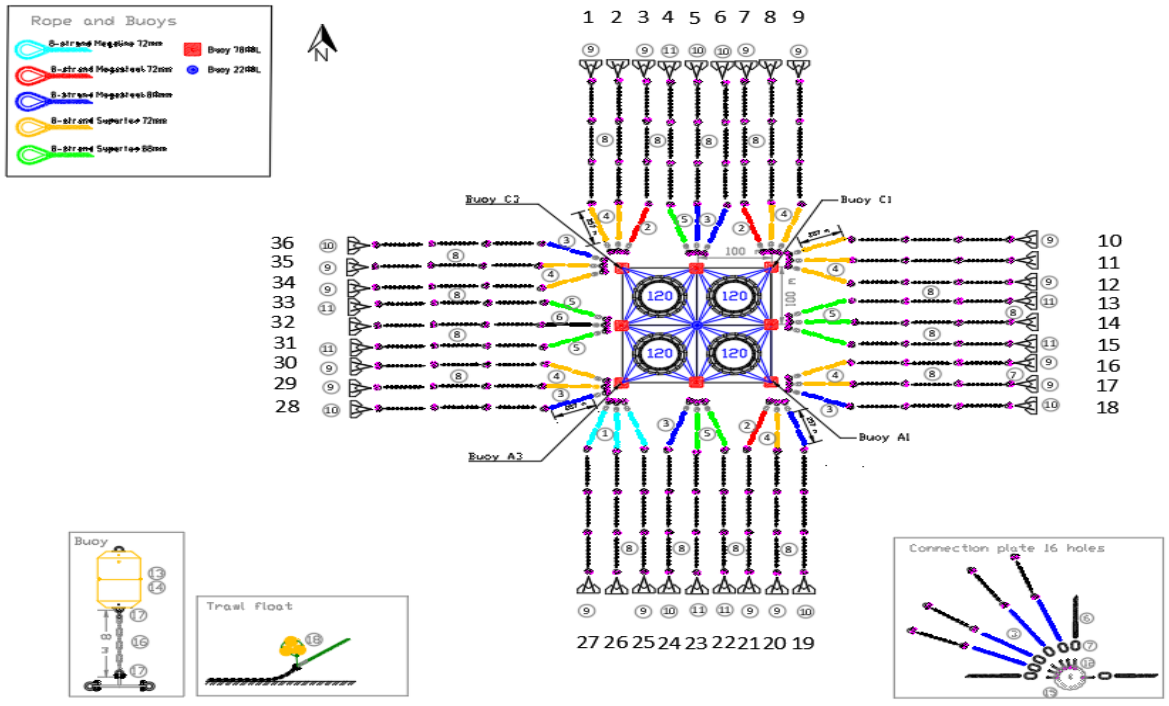

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Figure 4. Akva diagram of a 2 x 2 pen grid mooring system

Feeding and Lighting

Feeding on the Atlantis project is provided by Akva's own feeding system and lighting is also provides by submersible lights developed by Akva. For ease at this point of the project I suggest we use these to provide a turn key solution to the project requirements. Lighting should factor in 12x100 watt LED submersibles at this stage to ensure minimal maturation and hence the highest harvest volumes possible.

Net requirements

Akva have trialled a number of nets to date including Dyneema and Kikko. The best results to date have been achieved using HDPE nets designed and built by the Akva subsidiary Egersund. This net is being trialled in Tasmania with good results. It is suggested by Akva that initially the system would not use a predator net but instead rely on a heavy sinker ring to ensure the net is taught at all times during submerging and above surface use. However, Akva reserves the right to include a predator net during Stage 1 if required. All nets can be cleaned and inspected using Akva's FNC8 net cleaning ROV system. Bird nets have not been incorporated in any of the submerged cage trials to date and the use of bird netting is not thought to be feasible due to the rigor of the submerging/lifting process and conditions while underwater (figure 5). However, the use of the HDPE top net and 3m jump poles and netting are expected to inhibit predator ingress while the pend are on the surface or submerged. As has been evident in trials to date.

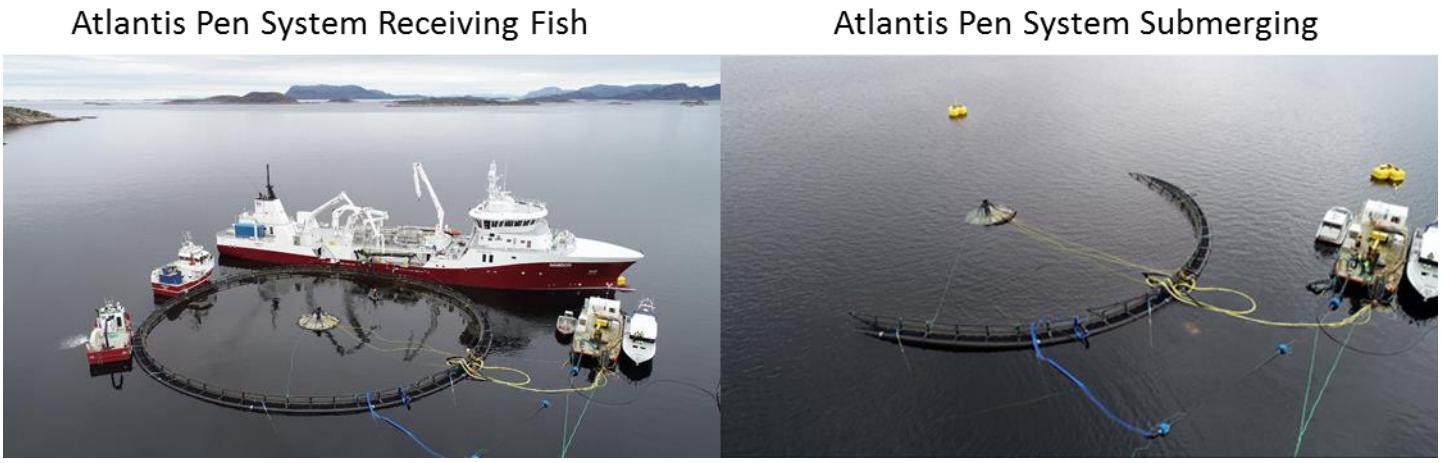

Figure 5. Atlantis Pens showing lack of bird netting during submerging process.

Summary

The Akva designed pen, grid and mooring system utilises 120m circumference pens with a 110m bay located on a 3x2 and 2x2 grid system. The pen size and type are constantly under development and whether the Atlantis or R500 offshore system finally employed in either 120m or 168m variants it will not impact the grid size or total mooring area of 157.38ha. All grid and mooring specifications are designed to provide maximum strength within the site's environmental parameters.