



# Azamethiphos Dispersion Modelling

## Maol Ban, Caol Mor

### CAR/L/1009643

**Mowi Scotland Limited**  
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## **QUALITY ASSURANCE**

Mowi Scotland Ltd. maintains a Quality Manual which defines the Quality and Environmental Policy of Mowi Scotland Farming Limited and includes an overview of its processes and acts as a signpost to key elements of its Quality Management System according to the requirements of BS EN ISO 9001, BS EN ISO 14001, GLOBALG.A.P. and British Retail Consortium Global Standard Food. Note the BRC standard is relevant to Blar Mhor processing plant only.

## EXECUTIVE SUMMARY

Dispersion model simulations have been performed to assess whether bath treatments at Maol Ban salmon farm will comply with pertinent environmental quality standards. A realistic treatment regime, with 1 pen treatment per day, was simulated. Each treatment required 897 g of azamethiphos (the active ingredient in Salmosan, Salmosan Vet and Azure), resulting in a daily release of 897 g (Table 1) and a total discharge over 5 days of 5.38 kg. Simulations were performed separately for modelled neap and spring tides, and the sensitivity of the results to key model parameters was tested.

The model results confirmed that the treatment scenario proposed, with a daily release of no more than 897 g of azamethiphos should comfortably comply with the EQS. The peak concentration during the baseline simulation 72 hours after the final treatment was less than 0.1 µg/L, the maximum allowable concentration, and the area where concentrations exceeded the EQS of 0.04 µg/L was substantially less than the allowable 0.5 km<sup>2</sup>. The baseline simulation presented here was designed to be relatively conservative.

Simulations using the BathAuto spreadsheet for Deltamethrin resulted in a consentable quantity of 16 g.

*Table 1. Summary of Results*

| <b>Site details</b>                           |          |
|-----------------------------------------------|----------|
| Site Name:                                    | Maol Ban |
| Site Location:                                | Caol Mor |
| Peak Biomass (T):                             | 2,250    |
| <b>Pen details</b>                            |          |
| Number of Pens:                               | 6        |
| Pen Circumference (m):                        | 160      |
| Pen Depth (m):                                | 15       |
| Pen Group Configuration:                      | 2 x 3    |
| <b>Azamethiphos consent to be applied for</b> |          |
| Recommended 3-hour (kg):                      | 0.897    |
| Recommended 24-hour (kg):                     | 0.897    |
| <b>Deltamethrin consent to be applied for</b> |          |
| Recommended 6-hour (kg):                      | 0.016    |

## 1 INTRODUCTION

This report has been prepared by Mowi Scotland Ltd. to meet the requirements of the Scottish Environment Protection Agency (SEPA) for an application to increase the current consent of topical sealice veterinary medicines at the marine salmon farm Maol Ban, Isle of Skye (Figure 1). The current Azamethiphos consent for Maol Ban is for 224.7 g (3 hours) and 447.4 g (24 hours). The report presents results from coupled hydrodynamic and particle tracking modelling to describe the dispersion of bath treatments to determine EQS-compliant quantities for the current site biomass and equipment. The modelling procedure follows as far as possible guidance presented by SEPA in December 2023 (SEPA, 2023).

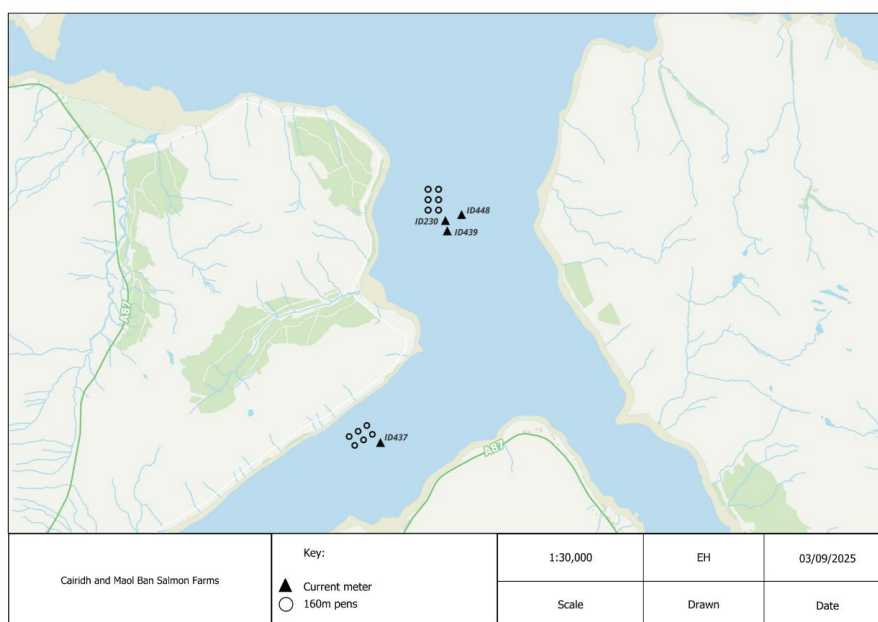


Figure 1. Location of the salmon farms at Maol Ban (north), and neighbouring site Cairidh (south), on Skye, including the locations of the ADCP deployments (▲) relative to the pen (○) positions.

### 1.1 Site Details

The site is situated in the Caol Mor area of the Isle of Skye (Figure 1). Details of the hydrographic data are provided in Table 2. The receiving water is defined as open water.

Table 2. Hydrographic Information

| Hydrographic Data                       | ID437          | ID448          | ID230          |
|-----------------------------------------|----------------|----------------|----------------|
| Site:                                   | Cairidh        | Maol Ban       | Maol Ban       |
| Current Meter Position:                 | 156270, 828862 | 157048, 831054 | 156893, 830997 |
| Depth of Deployment Position (m):       | 39             | 47.33          | 56.27          |
| Duration of Record (days):              | 68             | 85             | 76             |
| Start of Record:                        | 28/03/2024     | 10/04/2025     | 05/07/2018     |
| End of Record:                          | 04/06/2024     | 05/07/2025     | 20/09/2018     |
| Current Meter Averaging Interval (min): | 5              | 5              | 5              |
| Magnetic Correction to Grid North:      | 0.84318        | 1.01491        | -0.20299       |

## 2. MODEL DETAILS

### 2.1 Model Domain and Boundary Conditions

The unstructured mesh used in the model was adapted from the East Coast of Lewis and Harris (ECLH) sub-model mesh of the Scottish Shelf Model (SSM; Marine Scotland, 2016) (Figure 2). Model resolution was enhanced in the Caol Mor region particularly around the Mowi sites at Maol Ban and Cairidh (Figure 3). The spatial resolution of the model varied from 20 m in some inshore waters and round the farm pens to 5 km along the open boundary. The model consists of 50,649 nodes and 95,354 triangular elements. Model bathymetry (Figure 4) was also taken from the ECLH sub-model (SSM, MS 2016).

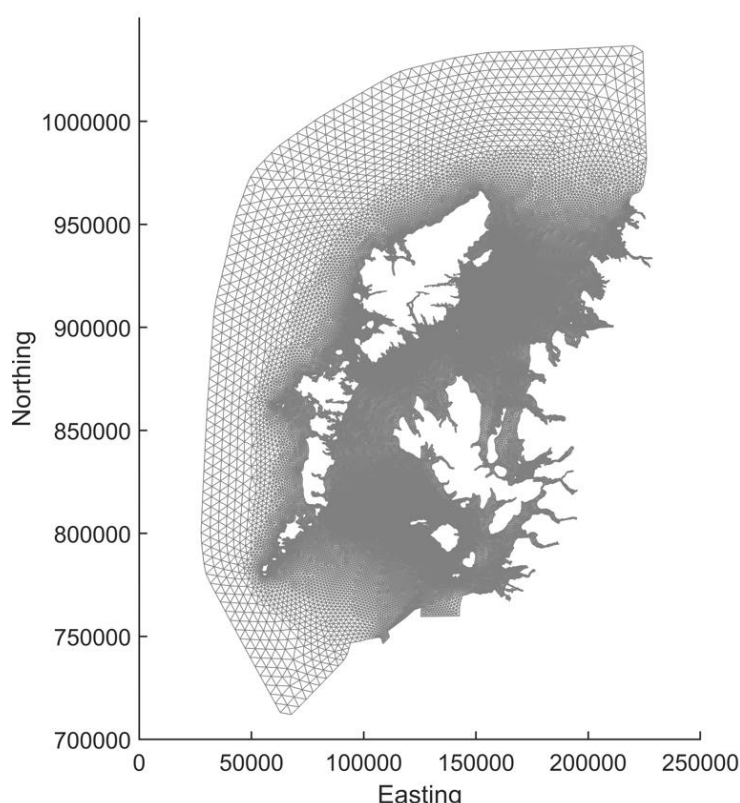


Figure 2. The mesh and domain of the modelling study, adapted from the ECLH sub-model.

The model was forced at the outer boundaries by 8 tidal constituents ( $M_2$ ,  $S_2$ ,  $N_2$ ,  $K_2$ ,  $O_1$ ,  $K_1$ ,  $P_1$ ,  $Q_1$ ) which were derived from tidal analysis (Pawlowicz et al., 2002) of the sea surface elevations at the closest nodes from the Scottish Shelf Model climatology (Marine Scotland, 2016). Spatially- and temporally-varying wind speed and direction data were taken from the ERA5 global reanalysis dataset (ECMWF, 2021) for the required simulation periods. Details of the hydrodynamic modelling that underpins the dispersion model are given in Mowi (2025).

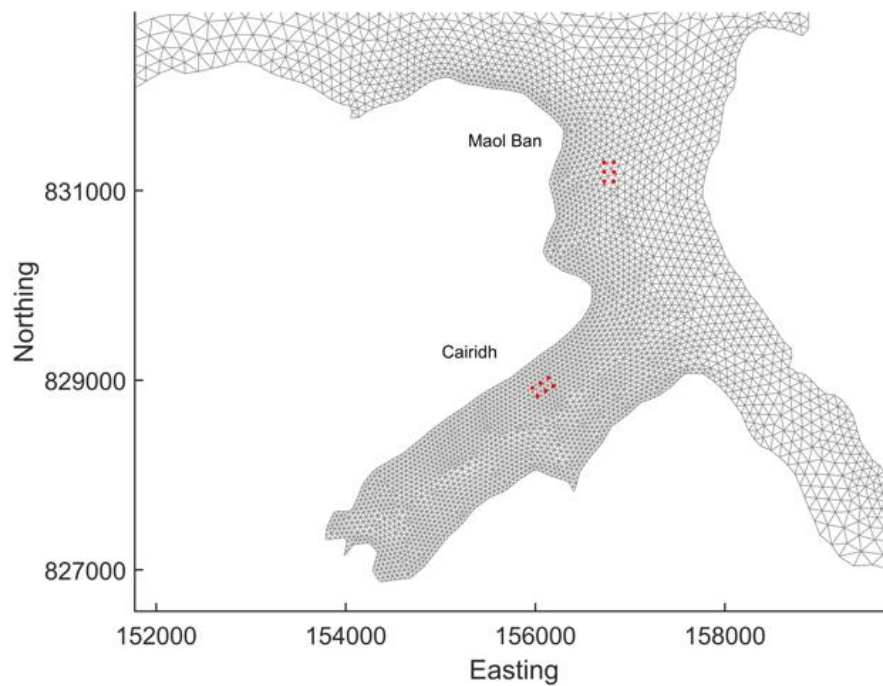


Figure 3. The unstructured mesh around the Maol Ban and neighbouring Cairidh sites in the modified model grid, with the pen locations indicated (●).

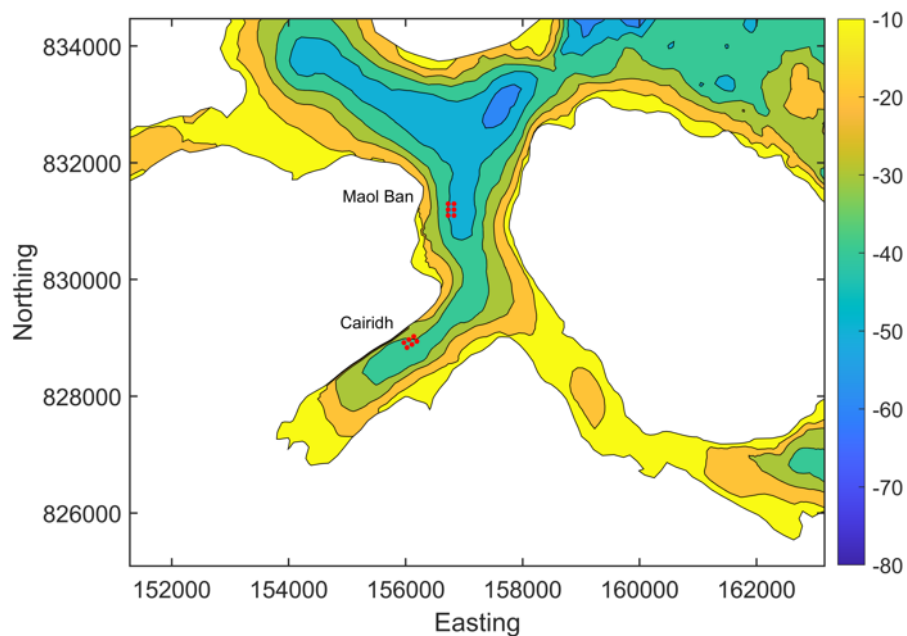


Figure 4. Model water depths (m) around the Maol Ban and neighbouring Cairidh salmon farms from the modified model. The pen locations indicated (●) and the ADCP deployments (▲).

## 2.2 Medicine Dispersion Modelling

The medicine dispersion modelling, performed using the UnPTRACK model (Gillibrand, 2022), simulates the dispersion of patches of medicine discharged from pens following treatment using tarpaulins. The UnPTRACK model uses the same unstructured mesh as the hydrodynamic model, and reads the flow fields directly from the hydrodynamic model output files. Therefore, no spatial or temporal interpolation of the current fields is required, although current velocities are interpolated to particle locations within UnPTRACK. The treatment scenario assumed 1 pen can be treated per day.

To simulate the worst-case scenario, the dispersion modelling was initially conducted using flow fields over a period of 9 days, centred on a small neap tidal range taken from the hydrodynamic model simulations. This is assumed to be the least dispersive set of ambient conditions, when medicine dispersion is least likely to meet the required EQS. Later simulations tested dispersion during spring tides.

A treatment depth of 3.7 m was chosen as a realistic net depth during application of the medicine for the 160 m pens. The initial mass released per pen was calculated from the reduced pen volume and a treatment concentration of  $\sim 100 \mu\text{g L}^{-1}$ , with a total mass of 5.38 kg of azamethiphos released during treatment (6 pens). Numerical particles were released from random positions within a pen radius of the centre and within the 0 – 5 m depth range. The simulations used  $\sim 538,000$  numerical particles in total, each particle representing 10 mg of azamethiphos.

Each simulation ran for a total of 217 hours (9.1 days). This covered the treatment period (120 hours), a dispersion period to the EQS assessment 72 hours after the final treatment, and an extra 25 hours to check for chance concentration peaks. At every hour of the simulation, particle locations and properties (including the decaying mass) were stored and subsequently concentrations calculated. Concentrations were calculated on a grid of 50m x 50m squares using a depth range of 0 – 5 m. Using a regular grid for calculating concentrations means that a known, constant, accuracy and precision of the calculated values applies across the grid.

From the calculated concentration fields, time series of two metrics were constructed for the whole simulation:

- (i) The maximum concentration ( $\mu\text{g/L}$ ) anywhere on the regular grid; and
- (ii) The area ( $\text{km}^2$ ) where the EQS was exceeded.

These results were used to assess whether the EQS or MAC was breached after the allotted period (72 hours after the final treatment).

Sensitivity analyses were conducted to assess the effects of:

- (i) Horizontal diffusion coefficient,  $K_H$
- (ii) Vertical diffusion coefficient,  $K_V$

The dispersion simulations were performed separately over three separate neap tides to confirm the dispersion during the weakest tides, and a spring tide (Figure 5, Figure 6 and Figure 7).

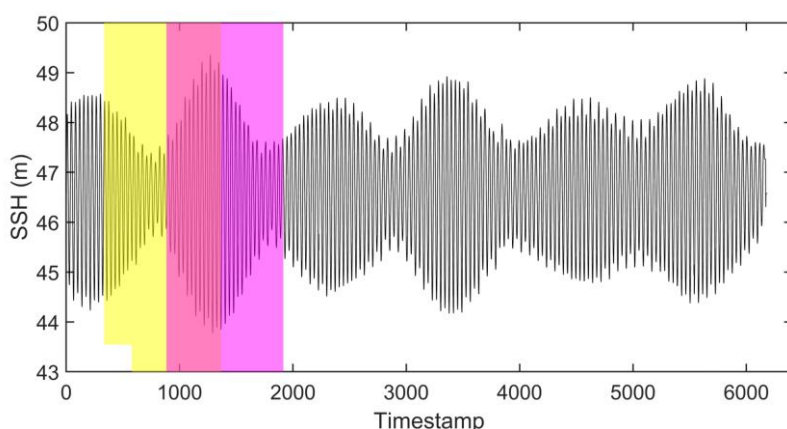


Figure 5. Sea surface height (SSH) at Maol Ban from 10<sup>th</sup> April to 5<sup>th</sup> July 2025 (ID448). Dispersion simulations were performed over neap tides (yellow, start day 2<sup>nd</sup> April 2025) and spring tides (magenta, start day 20<sup>th</sup> April 2025)

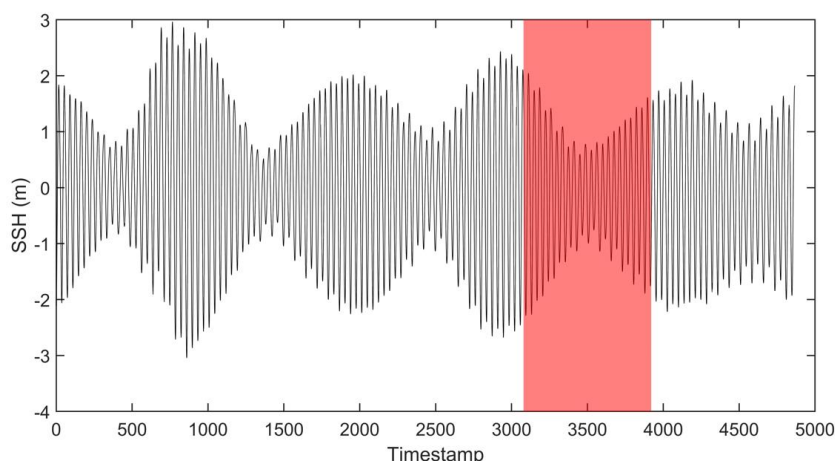


Figure 6. Sea surface height (SSH) at neighbouring site Cairidh from 28<sup>th</sup> March –13<sup>th</sup> June 2024 (ID437). Dispersion simulations were performed over neap tides (red, start day 12<sup>th</sup> May 2024)

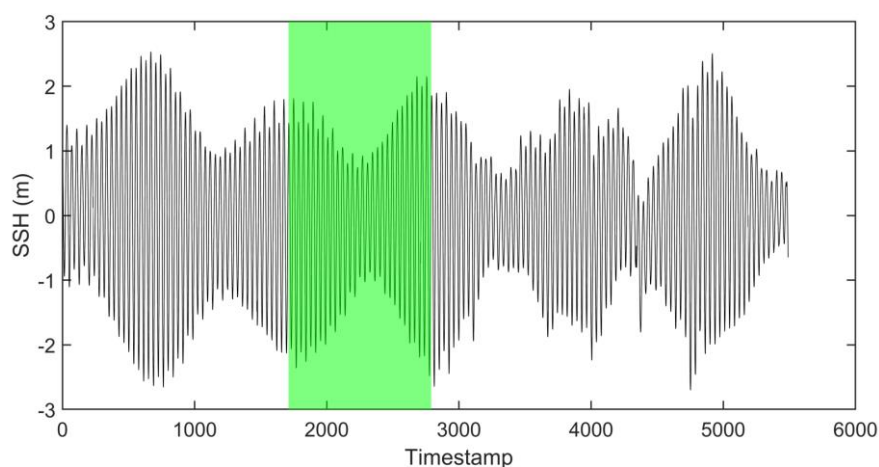


Figure 7. Sea surface height (SSH) at neighbouring site Maol Ban from 5<sup>th</sup> July to 20<sup>th</sup> September 2018 (ID230). Dispersion simulations were performed over neap tides (green, start day 1<sup>st</sup> August 2018)

## 2.3 Medicine Dispersion Simulations

The pen locations and details of the medicine source are listed in Table 3. The time of release is relative to the start of the neap or spring period highlighted in Figure 5, Figure 6 and Figure 7. All simulations used the release schedule and quantities outlined in Table 3.

*Table 3. Details of the treatment release simulated by the dispersion model. The release time is relative to the start of the neap or spring period highlighted in Figure 5, Figure 6 and Figure 7.*

| Pen | Easting | Northing | Net Depth (m) | Treatment Mass (kg) | Release Time (hours) |
|-----|---------|----------|---------------|---------------------|----------------------|
| 1   | 156727  | 831297   | 3.7           | 0.897               | 0                    |
| 2   | 156827  | 831297   | 3.7           | 0.897               | 24                   |
| 3   | 156727  | 831197   | 3.7           | 0.897               | 48                   |
| 4   | 156827  | 831197   | 3.7           | 0.897               | 72                   |
| 5   | 156727  | 831097   | 3.7           | 0.897               | 96                   |
| 6   | 156827  | 831097   | 3.7           | 0.897               | 120                  |

*Table 4. Dispersion model simulation details for the treatment of the 6 pens at Maol Ban.*

| Set                                                            | Run No. | T 1/2 (h) | Kh    | Kv    |
|----------------------------------------------------------------|---------|-----------|-------|-------|
| Neap Tides, Start day = 2 (12th April 2025, Maol Ban ID448)    |         |           |       |       |
| Baseline                                                       | 1       | 134.4     | 0.1   | 0.001 |
| Sensitivity                                                    | 2       | 134.4     | 0.139 | 0.001 |
| Spring Tides, Start day = 10 (20th April 2024, Maol Ban ID448) |         |           |       |       |
| Baseline                                                       | 3       | 134.4     | 0.1   | 0.001 |
| Sensitivity                                                    | 4       | 134.4     | 0.139 | 0.001 |
| Neap Tides, Start day = 45 (12th May 2024, Cairidh ID437)      |         |           |       |       |
| Baseline                                                       | 5       | 134.4     | 0.1   | 0.001 |
| Neap Tides, Start day = 26 (1st August 2018, Maol Ban ID230)   |         |           |       |       |
| Baseline                                                       | 6       | 134.4     | 0.1   | 0.001 |

## 2.4 Azamethiphos 3-hour EQS

In addition to the main simulations described above to assess compliance with the 72-hour EQS, simulations were also performed to assess compliance with the 3-hour EQS (SEPA, 2023). The 3-hour EQS is applied as a mixing zone EQS, whereby the area where concentrations exceed the EQS of 250 ng L<sup>-1</sup> after 3 hours must be less than the 3-hour mixing zone. The 3-hour mixing zone is primarily a function of mean near-surface current speed at the site, and has traditionally been calculated by the BathAuto Excel spreadsheet. For calculation of the mixing zone, a mean surface current speed of 6.14 cm s<sup>-1</sup> was used from ID448 surfaced referenced data (Table 5).

For the 3-hour EQS assessment, the baseline runs for neap and spring tides (Runs 1 and 2 in Table 4) were repeated, but with results output every 20 minutes and the runs were truncated, lasting only until 3 hours after the final treatment. The area of the medicine patch for each individual treatment was then calculated over the 3-hour period following its release, and the area exceeding 0.25 µg L<sup>-1</sup> determined. Concentrations from these simulations were

calculated on a 10m x 10m grid (rather than a 50m x 50m grid) in order to more accurately calculate the smaller areas of medicine over the initial 3-hour period.

*Table 5. Parameter values used in the calculation of the 3-hour mixing zone ellipse area and the resulting area*

| Parameter                                                  | Value           |
|------------------------------------------------------------|-----------------|
| Mean current speed ( $\text{ms}^{-1}$ )                    | 0.061           |
| Area of 160 m pen ( $\text{km}^2$ )                        | 0.00203718      |
| Distance from shore (km)                                   | 0.555           |
| Mean water depth (m)                                       | 47              |
| Treatment Depth (m)                                        | 3.7             |
| <b>Mixing zone ellipse area (<math>\text{km}^2</math>)</b> | <b>0.096821</b> |

## 2.5 Deltamethrin 6-hour EQS

Deltamethrin dispersion was modelled using the BathAuto Excel spreadsheet. The same current data from Maol Ban, ID448, was used as input to the spreadsheet, and the same treatment depth of 3.7 m. The completed spreadsheet is included with the application files.

## 2.6 Interactions with Special Features

Four types of near-by PMF features of interest have been identified (SEPA, 2025) which are thought to be at potential risk from medicine influence and hence must be considered when modelling the treatment releases from Maol Ban. Table 6 and Table 7 shows details of the features of interest, and the locations are indicated in Figure 8. Due to the sensitivity of the Native Oyster beds, the locations of these will not be disclosed.

Predicted concentrations of azamethiphos at the PMF locations during the simulation periods were extracted from the model results. These calculations were made using a 5 m thick layer immediately above the seabed, since all types of the special features are benthic habitats.

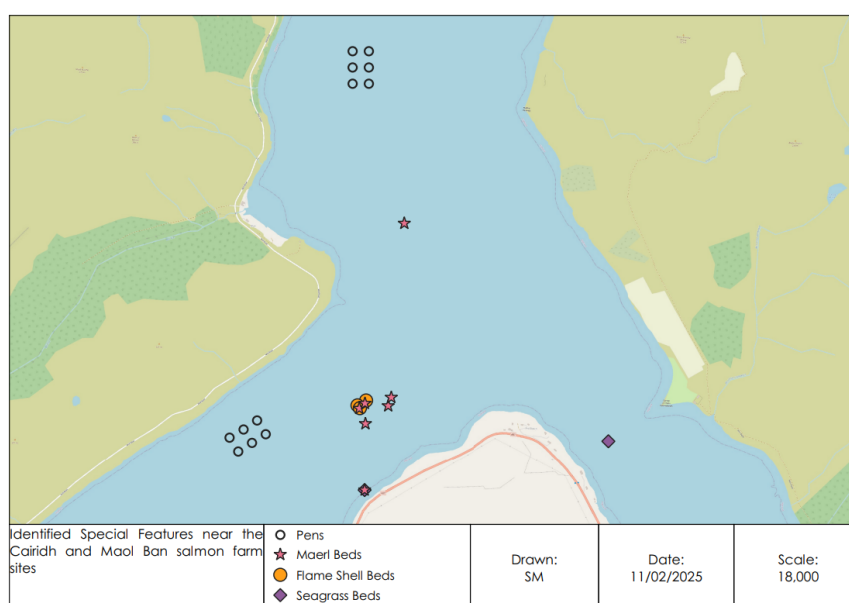


Figure 8. Identified special features near the Maol Ban and neighbouring Cairidh salmon farms.

Table 6. Details of identified special features

| Feature Name     | Feature Type | Reason for Identification   |
|------------------|--------------|-----------------------------|
| Maerl Beds       | PMF          | At risk from bath influence |
| Flame Shell Beds | PMF          | At risk from bath influence |
| Seagrass Beds    | PMF          | At risk from bath influence |
| Native Oysters   | PMF          | At risk from bath influence |

Table 7. Locations of each of the identified features (excluding Native Oysters).

| Name             | Easting | Northing |
|------------------|---------|----------|
| Flameshell Bed 1 | 156810  | 829148   |
| Flameshell Bed 2 | 156757  | 829118   |
| Flameshell Bed 3 | 156772  | 829101   |
| Maerl 1          | 156801  | 828597   |
| Maerl 2          | 156806  | 829005   |
| Maerl 3          | 156946  | 829115   |
| Maerl 4          | 157045  | 830238   |
| Maerl 5          | 156965  | 829167   |
| Maerl 6          | 156768  | 829099   |
| Maerl 7          | 156803  | 829130   |
| Seagrass 1       | 158301  | 828897   |
| Seagrass 2       | 156801  | 828597   |

### 3 RESULTS

#### 3.1 Dispersion During Neap Tides, April 2025 (ID448)

A standard treatment of six 160 m pens, with a reduced net depth of 3.7 m and assuming 1 pen can be treated per day at a treatment concentration of  $\sim 100 \mu\text{g/L}$ , resulted in a treatment mass per pen of azamethiphos of 897 g and a total treatment release of 5.38 kg over 120 hours. The dispersion of the medicine during and following treatment from Run001 (Table 4) is illustrated in Figure 9. After 48 hours, as the third treatment was discharged, discrete patches of medicine are evident from the first two treatment releases from the first and second day. The maximum concentration at this time is roughly  $100 \mu\text{g/L}$ , due to the release of the third treatment. After 96 hours, as the fifth treatment is discharged, discrete patches of medicine from the previous treatment releases are still evident, but the patches of medicine have rapidly dispersed and are already down to concentrations of the same order as the EQS ( $0.04 \mu\text{g/L}$ ). The maximum concentration at this time was again around  $100 \mu\text{g/L}$ , due to the release of the fifth treatment.

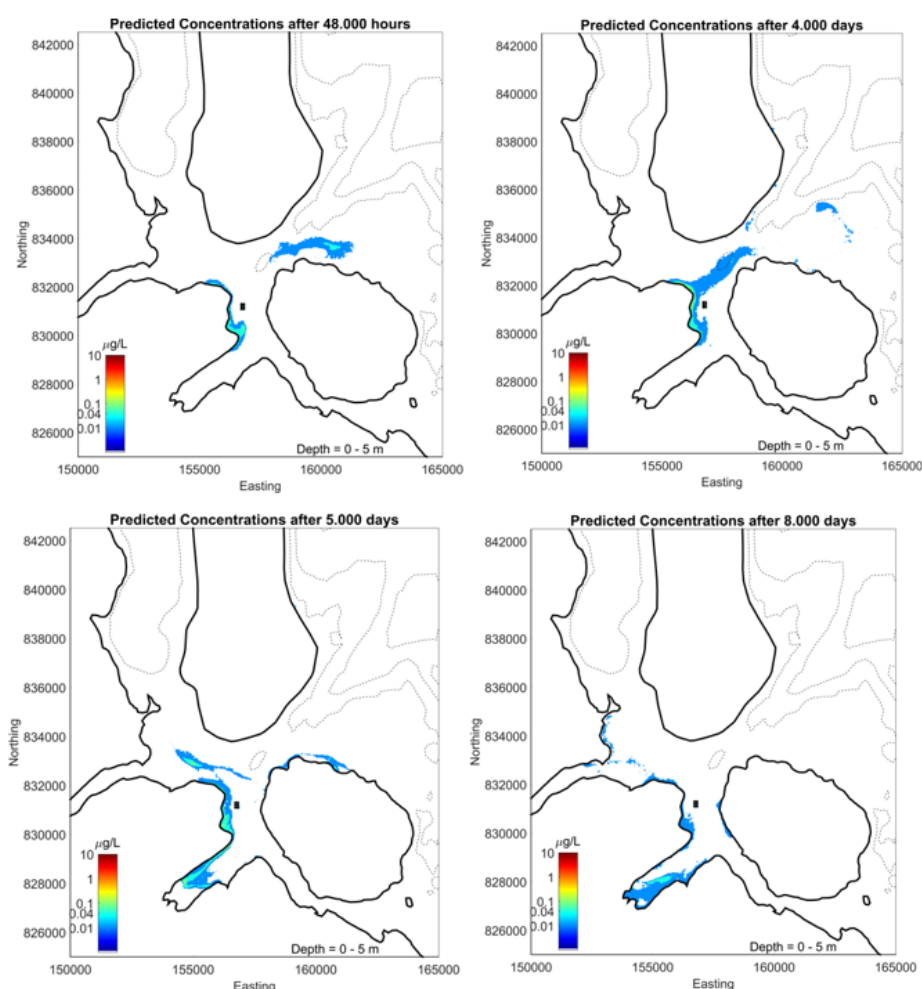


Figure 9. Predicted concentration fields for a dispersion simulation at neap tides after 48 hours (top left), 96 hours (top right), 120 hours (bottom left) and 192 hours (bottom right).

The treatment schedule completed after 120 hours (5 days). At this stage, the medicine released on earlier days has already dispersed. It is noticeable that dispersion of the medicine does not happen in a gradual “diffusive” manner, but is largely driven by eddies and horizontal shear in the spatially-varying velocity field, which stretches and distorts the medicine patches and enhances dispersion. 72 hours after the final treatment (192 hours elapsed), the treatment patches were dispersed and concentrations had rapidly fallen away below the EQS. Remnants of medicine are seen but at concentrations below the MAC.

The time series of maximum concentration from this simulation is shown in Figure 10 (blue). The 6 peaks in concentration of  $\sim 100 \mu\text{g/L}$  following each treatment event over the first 5 days are evident. Following the final treatment after 120 hours, the maximum concentration fell steadily away (Figure 10). A default half-life of 134.4 hours (5.6 days) was used. The maximum concentration 72 hours after the final treatment (time = 192 hours) was well below  $0.1 \mu\text{g/L}$ , the maximum allowable concentration (MAC).

The area where the EQS of  $0.04 \mu\text{g/L}$  was exceeded peaked at about  $1 \text{ km}^2$  following the final treatment, but had fallen well below the  $0.5 \text{ km}^2$  threshold immediately after; by 72 hours after the final treatment, the exceeded area was close to zero (Figure 9 and Figure 10).

These results indicate that, with a horizontal diffusion coefficient of  $0.1 \text{ m}^2 \text{ s}^{-1}$ , and a medicine half-life of 134.4 hours, the environmental quality standards are achieved. In the following sections, the sensitivity of the model results to the horizontal diffusion coefficient is examined.

### 3.2 Sensitivity to the Horizontal Diffusion Coefficient

The model results were tested for sensitivity to the horizontal diffusion coefficient used. The horizontal diffusion coefficient used for the standard runs was  $K_H = 0.1 \text{ m}^2 \text{ s}^{-1}$ . Simulations were also performed with higher value of  $K_H$ , specifically  $K_H = 0.139 \text{ m}^2 \text{ s}^{-1}$  which was calculated from the dye and drogue study results. The time series of maximum concentration and area exceeding the EQS are shown in Figure 10. The MAC and EQS were both comfortably met.

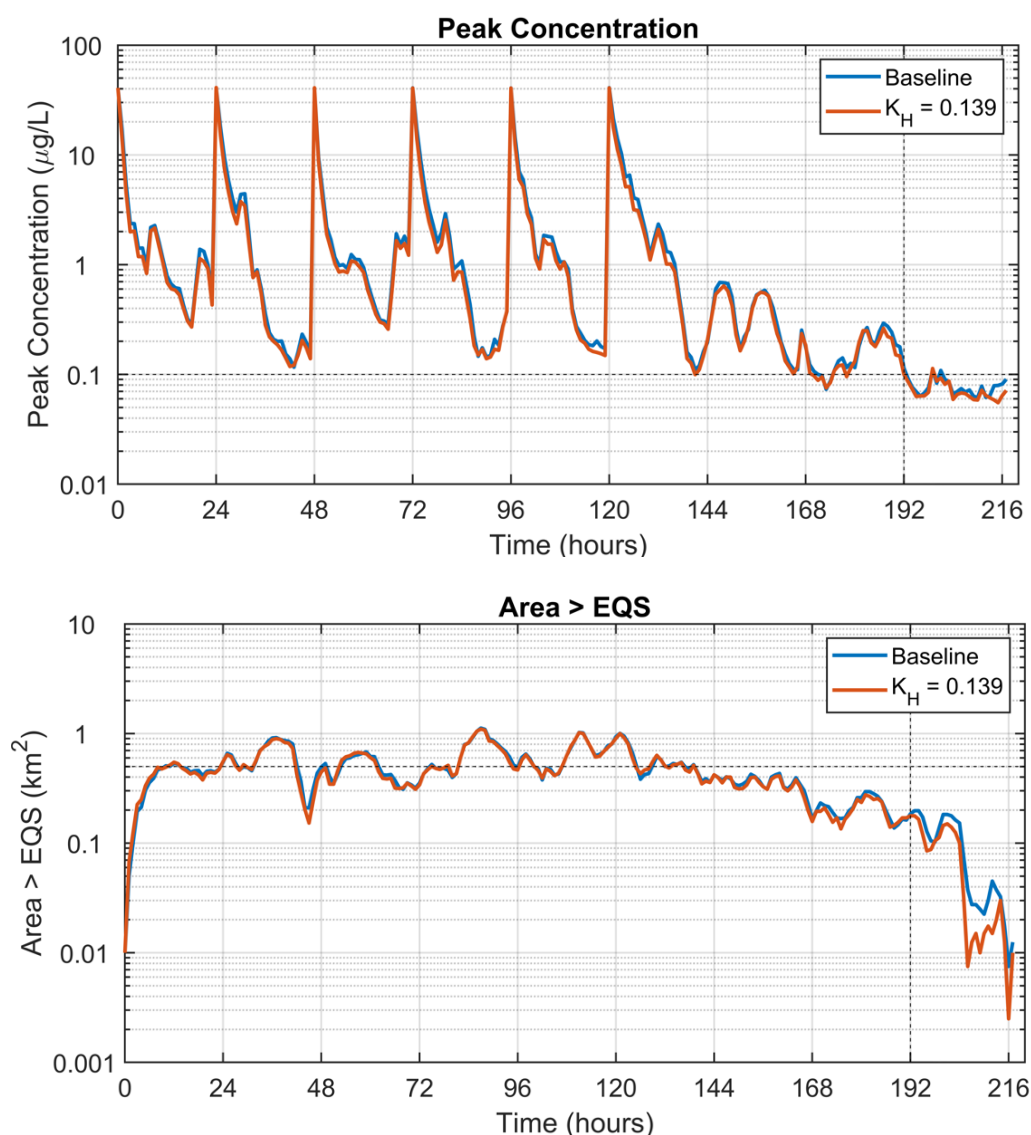


Figure 10. Time series of maximum concentration (top) and area exceeding the EQS (bottom) from the first and second model runs (Table 4). The model was run during neap tide with varying horizontal diffusion coefficient  $K_H$  ( $m^2 s^{-1}$ ). The MAC and area limit 72 hours after the final treatment (Time = 192 h) of 0.1 µg/L and 0.5 km<sup>2</sup> are indicated by the horizontal dashed lines.

### 3.3 Dispersion during Spring Tides, May 2025 (ID448)

Dispersion simulations were carried out during modelled spring tides in May 2025 (Figure 5), repeating the main set carried out for neap tides (Table 4). The same treatment scenario of 1 treatment per day was simulated, with each treatment using 897 g of Azamethiphos. Both simulations showed passes for both the MAC and EQS (Figure 11).

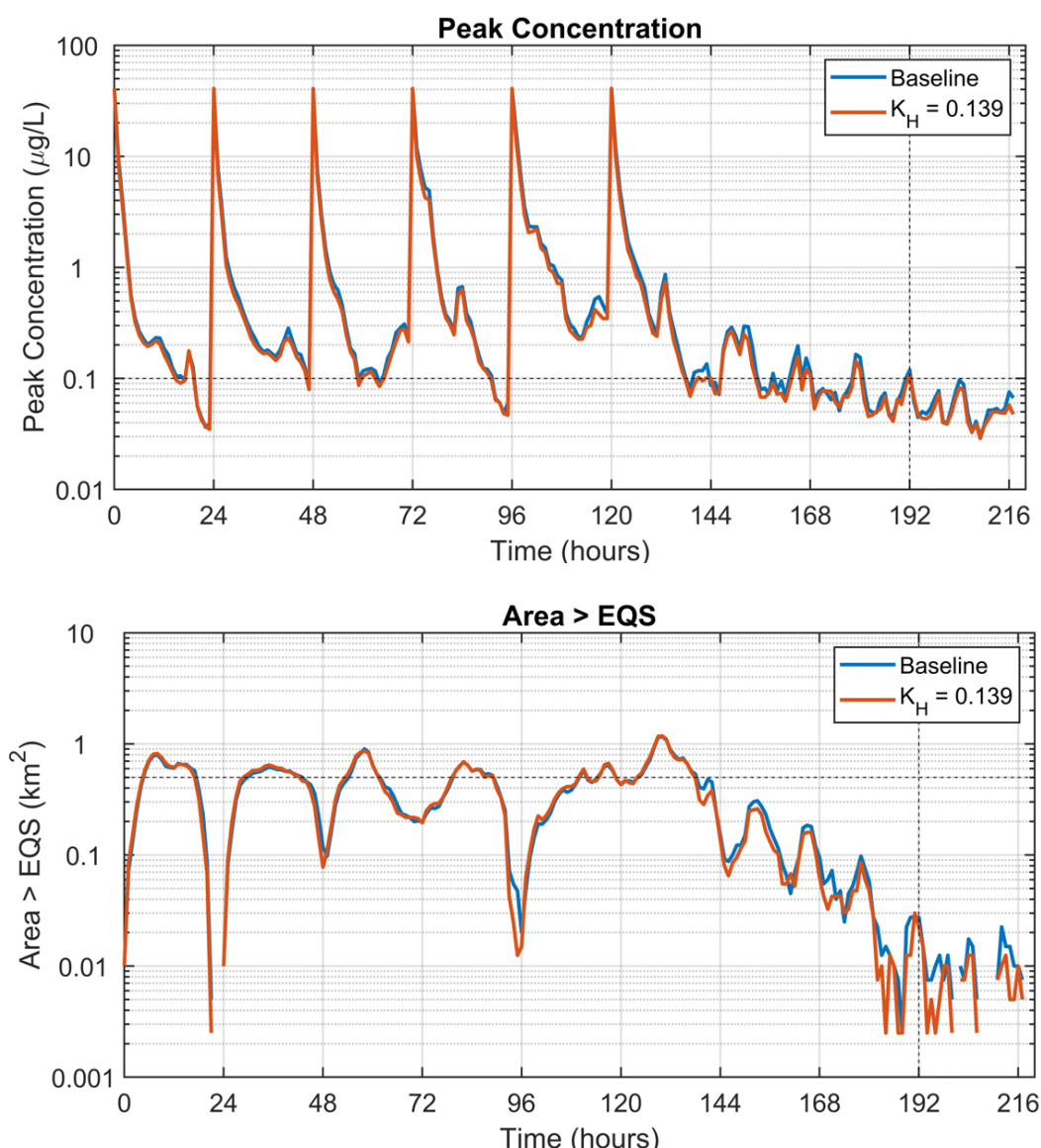


Figure 11. Time series of maximum concentration (top) and the area where concentrations exceeded the EQS (bottom) from the third and fourth set of model runs (Table 4). The model was run at spring tides with varying horizontal diffusion coefficient  $K_H$  ( $m^2 s^{-2}$ ). The MAC and area limit 72 hours after the final treatment (Time = 195 h) of 0.1 µg/L and 0.5 km<sup>2</sup> are indicated by the horizontal dashed lines.

### 3.4 Dispersion During Neap Tides, May 2024 and August 2018 (ID437 & ID230)

A further set of dispersion simulations during modelled neap tides in May 2024 and August 2018 (Figure 6 and Figure 7) were carried out (Figure 12), repeating the baseline (Table 4). The same treatment scenario of 1 treatment per day was simulated, with each treatment using 897 g of Azamethiphos. These simulations both pass the 72-hour EQS and hence these model runs demonstrate again that the modelled treatment regime will meet the EQS criteria.

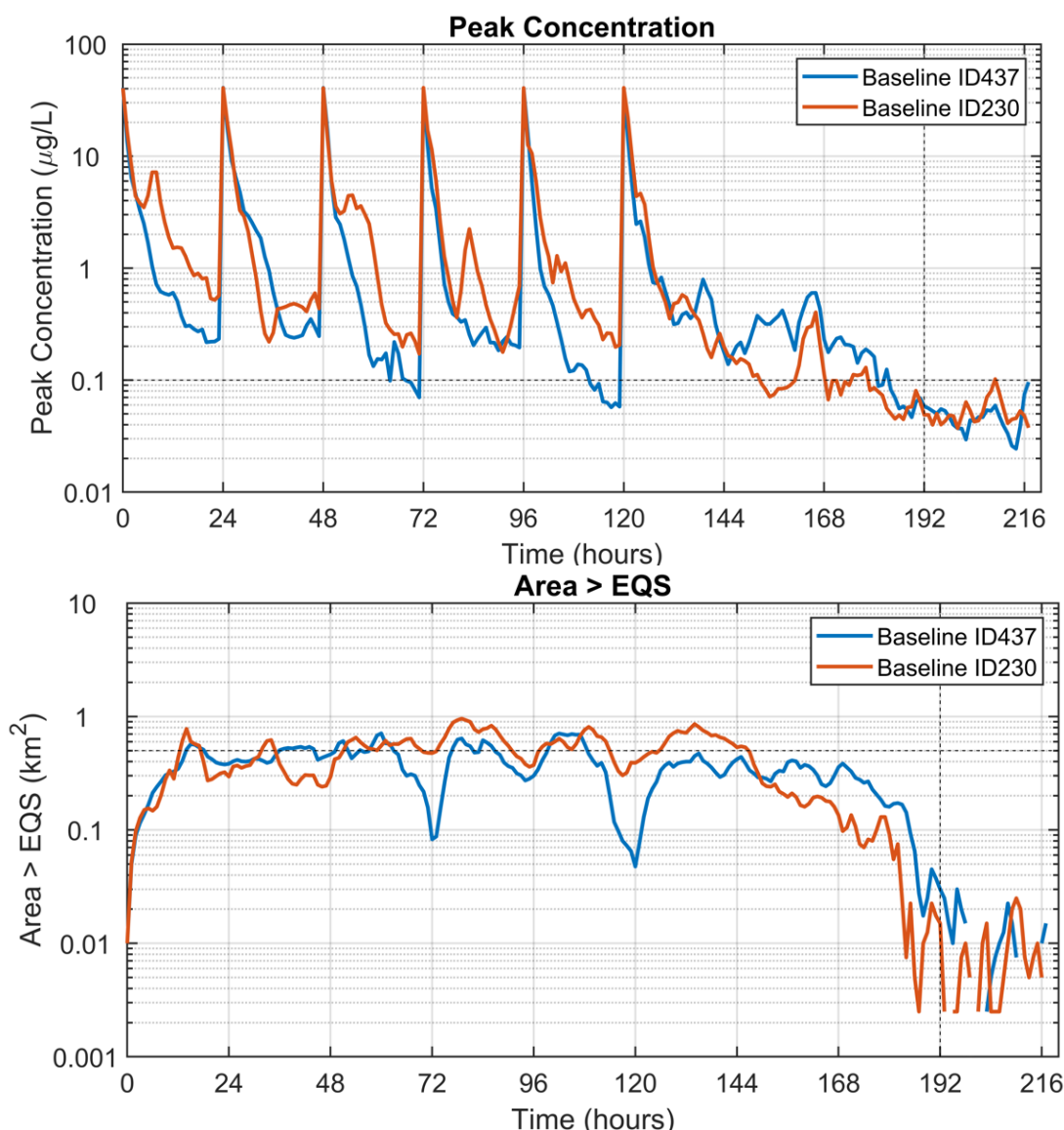


Figure 12. Time series of maximum concentration (top) and the area where concentrations exceeded the EQS (bottom) from the fifth and sixth set of model runs (Table 4). The model was run at neap tides from May 2024 and August 2018 with varying horizontal diffusion coefficient  $K_H$  ( $m^2 s^{-2}$ ). The MAC and area limit 72 hours after the final treatment (Time = 195 h) of 0.1  $\mu g/L$  and 0.5  $km^2$  are indicated by the horizontal dashed lines.

### 3.5 3-Hour EQS

The 3-hour mixing zone is primarily a function of mean near-surface current speed at the site, and has traditionally been calculated by the BathAuto Excel spreadsheet. For calculation of the mixing zone, a mean surface current speed of  $6.14 \text{ cm s}^{-1}$  was used from ID448 (Table 1) which was thought to be a representative value for the surface 0 – 5 m layer at Maol Ban. The parameter values used in the calculation of the 3-hour mixing zone ellipse area are shown in Table 5.

The time series of the areas where the 3-hour EQS of 250  $\mu g/L$  is exceeded for a single selected pen treatment at neap tide (first release on 13<sup>th</sup> April 2025) are shown in Figure 13.

The single pen treatment selected was the 4<sup>th</sup> release which is one of the closest to the centre of the neap tide and hence is discharged during what is thought to be the least dispersive conditions. The area exceeding the EQS was less than the allowable mixing zone (0.096821 km<sup>2</sup>) after 3 hours.

For spring tide releases (first release on 20<sup>th</sup> April 2025), the area where concentrations exceeded the 3-hour EQS also complied with the allowable area (Figure 13). This demonstrates that the discharge quantity of 897 g of Azamethiphos from each of the six 160 m pens at Maol Ban should not breach the 3-hour Environmental Quality Standard.

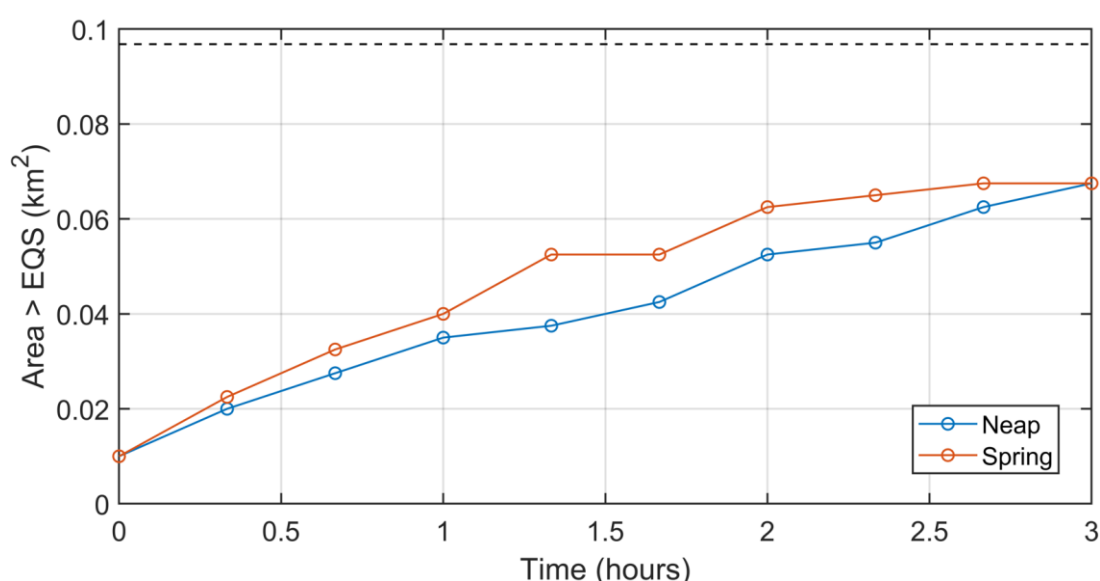


Figure 13. Time series of the area exceeding the 3-hour EQS for the third (middle) pen treatment during the 3 hours following release at neap and spring tide. The 3-hour mixing zone area is indicated (---).

### 3.6 Deltamethrin 6-hour EQS

The conservative BathAuto excel spreadsheet, using input data from the ID448 deployment at Maol Ban (surface referenced), was utilised to calculate a maximum consentable quantity of Deltamethrin. The results gave a permitted Deltamethrin mass of 16 g, which allows for 1 pen to be treated in 6 hours.

### 3.7 Interactions with Special Features

Figure 14 to Figure 16 show the hourly peak concentrations at each of the identified special feature locations (SEPA, 2024) for a 5 m thick layer above the seabed. The concentrations are minimal throughout at both neap and spring tide, staying well below the EQS level for the whole simulation.

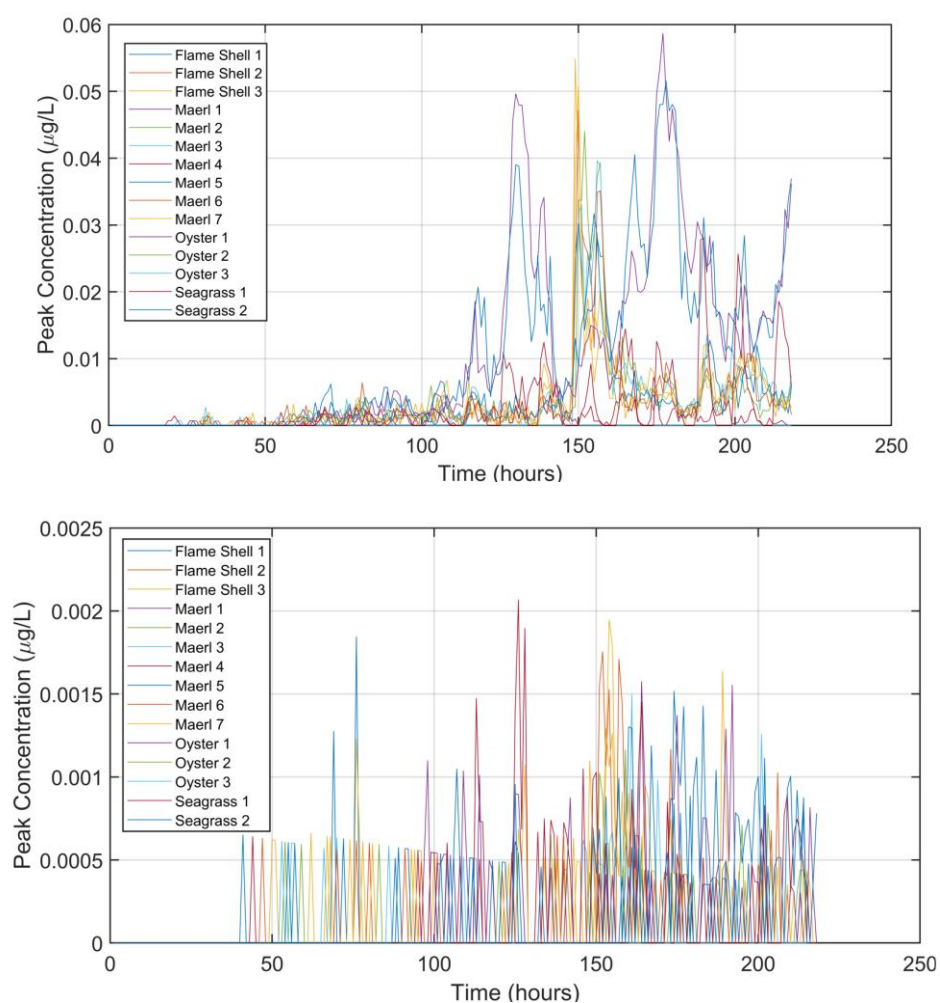
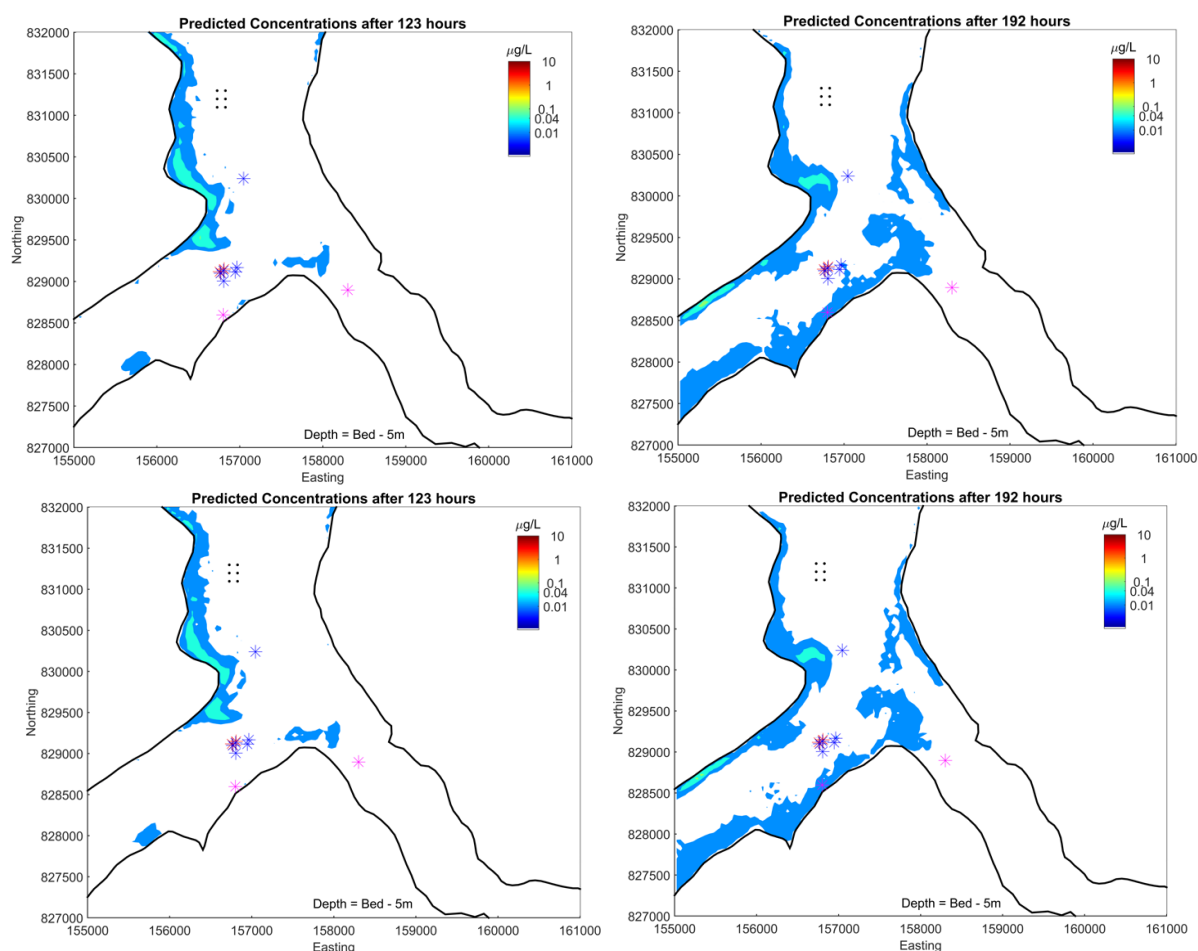


Figure 14. Peak concentrations at all identified PMF locations over neap (top) and spring (bottom) tides



*Figure 15. Predicted concentration fields for a baseline neap (top) and spring (bottom) tide dispersion simulation at 3 (left) and 72 (right) hours after the final treatment at Maol Ban. Specified special features are shown, Flame Shell beds (red), Mearl bed (blue) and Seagrass bed (magenta).*

Figure 15 shows the concentrations around the site and specified special features for the 5 meter layer above the seabed. Concentrations 3 hours after the final treatment do not exceed 0.04  $\mu\text{g/L}$  and are well below the 3-hour MAC. 72 hours after the final treatment, concentrations are below the 72-hour MAC. There are areas with remnants of low concentrations of medicine but not in the areas where the special features are found. Due to their sensitivity, the positions of the Native Oyster beds have been omitted from the plots but concentrations have been checked and do not exceed either the 3-hour or 72-hour EQS at their locations.

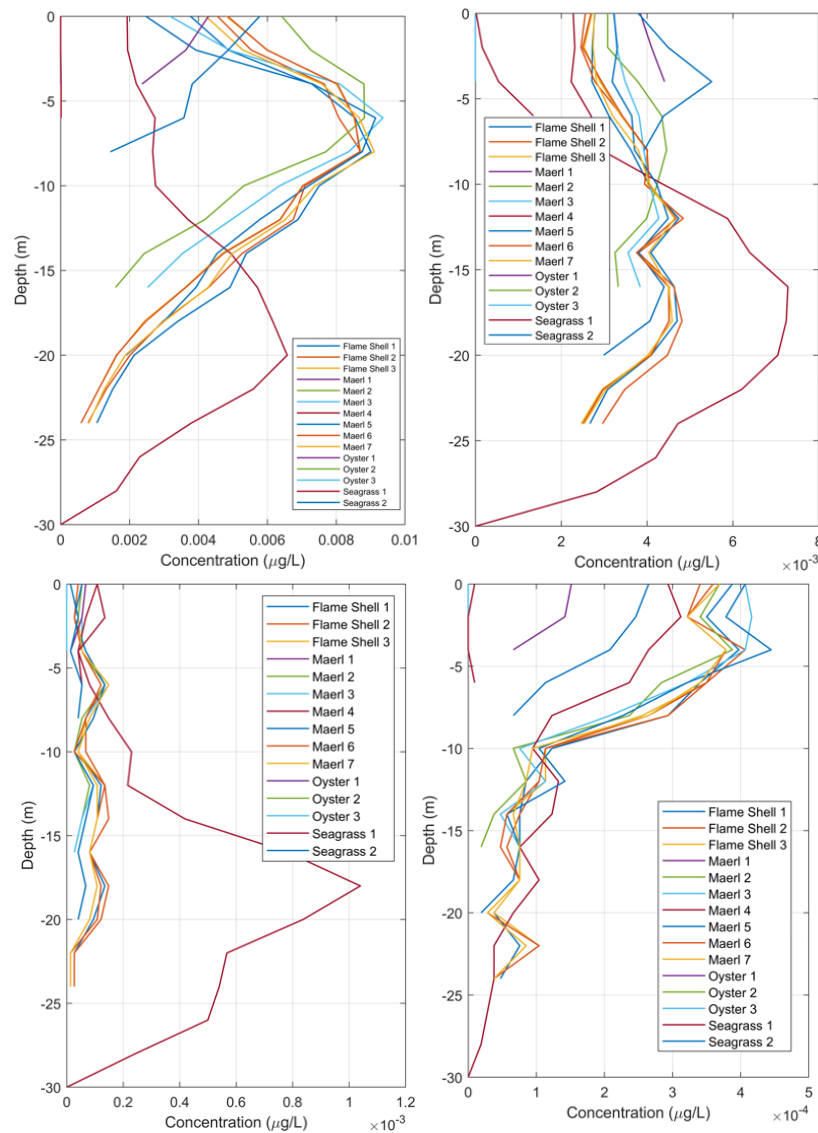


Figure 16. Concentration depth profiles for the fifteen special features at 3 (left) and 72 (right) hours after final treatment over neap tides (top) and spring tides (bottom).

Figure 16 shows concentration depth profiles, calculated using a 250 m radius area around each of the specified special features, at 3 and 72 hours after the final treatment release at both spring and neap tides. Concentrations at all special features are well below both the 3-hour and 72-hour EQS (MACs of 0.25 and 0.1  $\mu\text{g/L}$ ) throughout the water column. The higher concentrations are seen nearer the surface in most cases, and decrease towards the seabed, where the special features are located. This is followed by a significant decline in concentration, shown in the 192 hours depth profile. It is clear that the concentrations decrease at depth, highlighting that all of the benthic habitats are less exposed to the medicine releases. These results indicate that the medicine releases from Maol Ban fish farm will not have a detrimental effect on the near-by special features and that medicine levels are well below environmental quality standards.

## 4 SUMMARY AND CONCLUSIONS

A total of 6 dispersion simulations have been performed to assess whether bath treatments at Maol Ban salmon farm will comply with pertinent environmental quality standards. A realistic treatment regime, with 1 treatment a day, was simulated. Each pen required 897 g of Azamethiphos for treatment, resulting in a total discharge over 6 days of 5.38 kg. Simulations were performed separately for modelled neap and spring tides, and the sensitivity of the results to key model parameters was tested. Results are summarised in Table 8.

The model results confirmed that the treatment scenario proposed, with a daily release of no more than 897 g, should consistently comply with the EQS. The peak concentration during the baseline simulation after 192 hours (72 hours after the final treatment) was less than 0.1 µg/L, the maximum allowable concentration, and the area where concentrations exceeded the EQS of 0.04 µg/L was substantially less than the allowable 0.5 km<sup>2</sup>. In all simulations performed, including sensitivity testing, the EQS and MAC criteria were met. Further simulations over a second and third neap tide demonstrated that the modelled treatment regime consistently complied with the relevant EQS and MAC. For the simulation during spring tides, greater dispersion meant that the MAC and EQS were met very comfortably. Peak concentrations near the seabed at the identified special features (SEPA, 2023) were found to be consistently less than both the 3-hour and 72-hour MAC over the full treatment simulation. Therefore, it is believed that the requested daily quantity of 897 g of azamethiphos can be safely discharged at Maol Ban without breaching the MAC or EQS.

Simulations using the BathAuto spreadsheet for Deltamethrin resulted in a consentable quantity of 16 g.

*Table 8. Summary of Results*

|                                               |          |
|-----------------------------------------------|----------|
| <b>Site details</b>                           |          |
| Site Name:                                    | Maol Ban |
| Site Location:                                | Caol Mor |
| Peak Biomass (T):                             | 2,250    |
| <b>Pen details</b>                            |          |
| Number of Pens:                               | 6        |
| Pen Circumference (m):                        | 160      |
| Pen Depth (m):                                | 15       |
| Pen Group Configuration:                      | 2 x 3    |
| <b>Azamethiphos consent to be applied for</b> |          |
| Recommended 3-hour (kg):                      | 0.897    |
| Recommended 24-hour (kg):                     | 0.897    |
| <b>Deltamethrin consent to be applied for</b> |          |
| Recommended 6-hour (kg):                      | 0.016    |

## 5 REFERENCES

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