# Marine Modelling
## Mullach Mor, Isle of Rum

**Mowi Scotland Limited**

**April 2026**


| | | | |
|---|---|---|---|
| Mowi Scotland | OFFICE<br>Mowi, Farms Office, Glen Nevis Business Park<br>PH33 6RX Fort William | PHONE | FAX<br>- |
| | | MAIL<br>environment @mowi.com | |
| | POSTAL<br>Mowi, Farms Office, Glen Nevis Business Park<br>PH33 6RX Fort William | WEB<br>http://mowiscotland.co.uk | |

## CONTENTS

## List of Figures

# List of Tables

## 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 the proposed Mullach Mor salmon farm and cumulative solids deposition will comply with pertinent environmental quality standards.

For bath medicines, a realistic treatment regime, with 1 pen treatment per day, was simulated to mimic a full site treatment using Azamethiphos. Each treatment required 1.23 kg of azamethiphos (the active ingredient in Salmosan, Salmosan Vet and Azure), resulting in a daily release of 1.23 kg (Table 1) and a total discharge over 8 days of 9.78 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 1.23 kg 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$^2$. The baseline simulation presented here was designed to be relatively conservative.

Simulations using the BathAuto spreadsheet for Deltamethrin resulted in a consentable quantity of 27 g.

The modelling presented goes beyond that required in pre-application screening guidance issued by SEPA (SEPA, 2025). At the request of the Local Planning Authority and NatureScot, cumulative marine modelling of solids was simulated including Mullach Mor and the neighbouring existing site of Rum. The model set-up mimicked, as far as possible, that of the NewDepomod screening model. Results showed that there was no interaction between the footprints of each of the sites. The solids footprints were also checked for interaction with a near-by Burrowed Mud PMF.

*Table 1. Summary of Results*

| | |
|---|---|
| **Site details** | |
| Site Name: | Mullach Mor |
| Site Location: | Isle of Rum |
| Peak Biomass (T): | 2,650 |
| **Pen details** | |
| Number of Pens: | 8 |
| Pen Circumference (m): | 160 |
| Pen Depth (m): | 16 |
| Pen Group Configuration: | 2 x 4 |
| **Azamethiphos consent to be applied for** | |
| Recommended 3-hour (kg): | 1.23 |
| Recommended 24-hour (kg): | 1.23 |
| **Deltamethrin consent to be applied for** | |
| Recommended 6-hour (kg): | 0.027 |

# 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 proposed marine salmon farm Mullach Mor, Isle of Rum (Figure 1). 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 (SEPA, 2023).

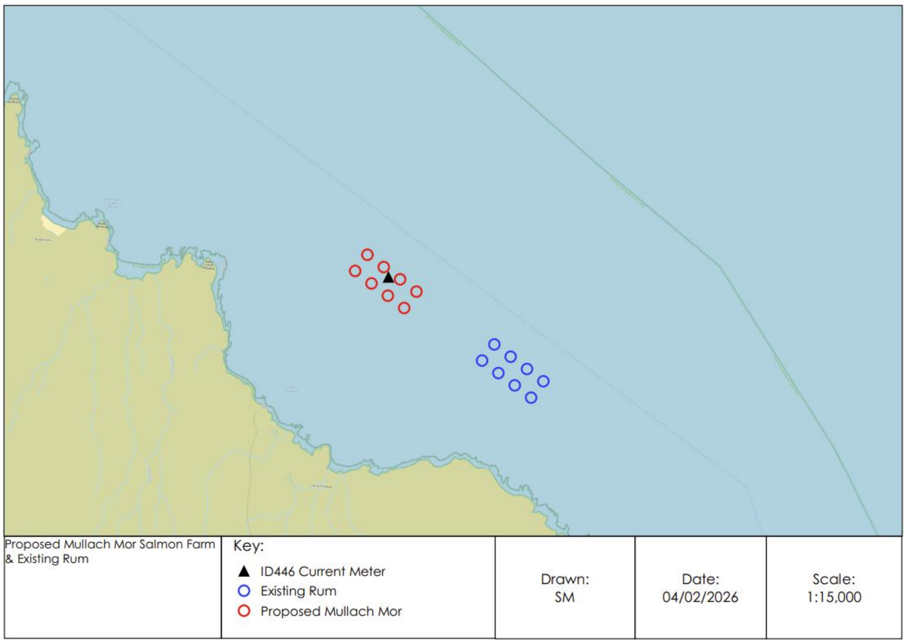


*Figure 1. Location of the proposed salmon farm, Mullach Mor (o), and neighbouring existing site Rum (o), off the Isle of Rum, including the location of the ADCP deployment ID446 (▲) relative to the pen positions.*

## 1.1 Site Details

The proposed site is situated in the Small Isles region, off the Isle of Rum (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 | ID446 |
|---|---|
| Site: | Mullach Mor |
| Current Meter Position: | 140569, 803399 |
| Depth of Deployment Position (m): | 34 |
| Duration of Record (days): | 72 |
| Start of Record: | 14/02/2025 |
| End of Record: | 27/04/2025 |
| Current Meter Averaging Interval (min): | 20 |
| Magnetic Correction to Grid North: | 1.13 |

# 2. MODEL DETAILS

## 2.1 Model Domain and Boundary Conditions

The hydrodynamic modelling was performed using RiCOM (River and Coastal Ocean Model; Walters and Casulli, 1998). 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 Small Isles region particularly around the proposed and existing Mowi sites of Mullach Mor and Rum (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 88,329 nodes and 168,561 triangular elements. Model bathymetry (Figure 4) was also taken from the ECLH sub-model (SSM, MS 2016).

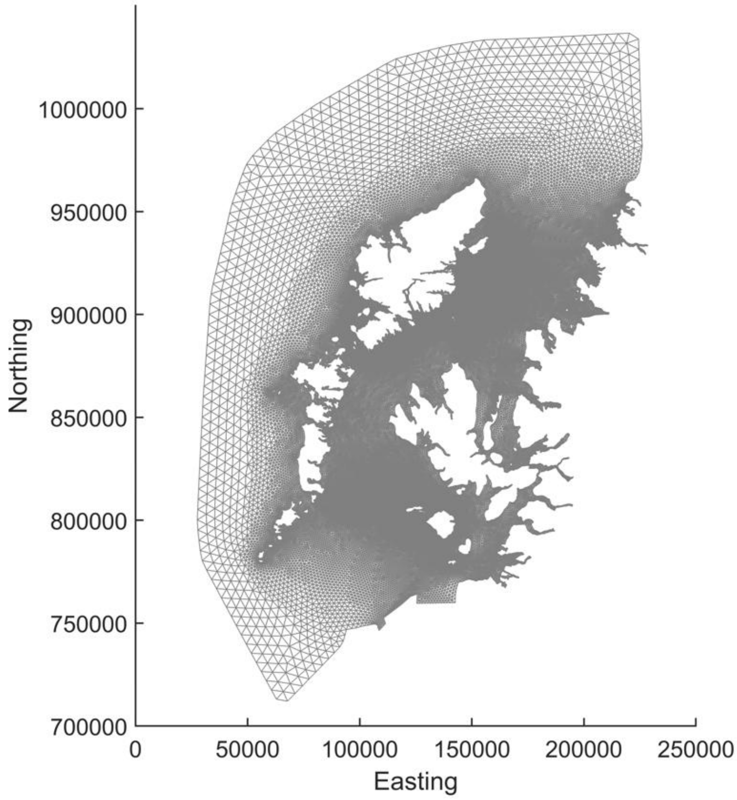


*Figure 2. The mesh and domain of the modelling study, adapted from the ECLH sub-model.*

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 (2026).

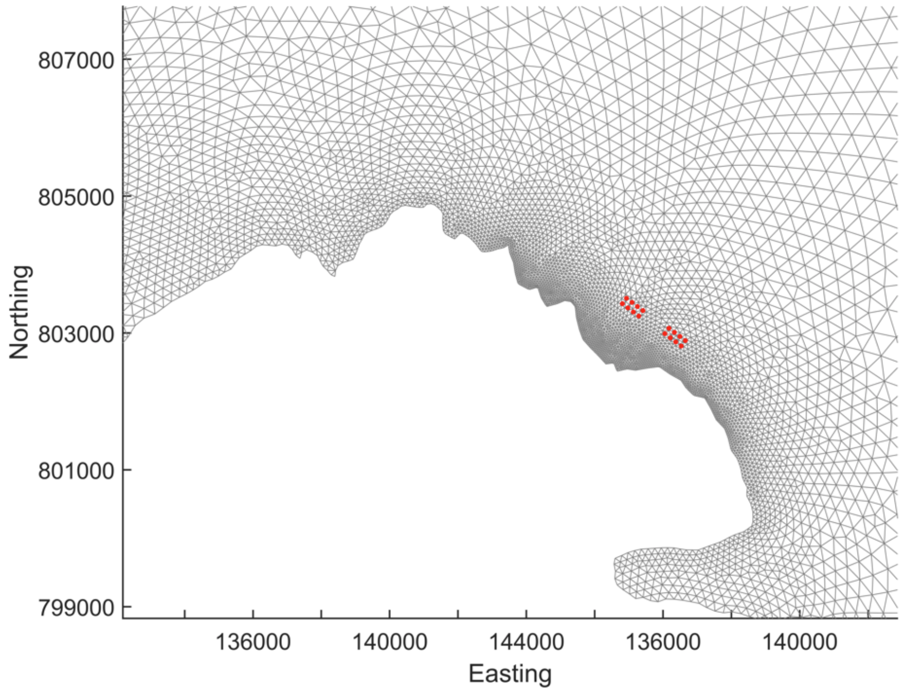


*Figure 3. The unstructured mesh around the proposed Mullach Mor (west) and existing Rum sites in the modified model grid, with the pen locations indicated (●).*

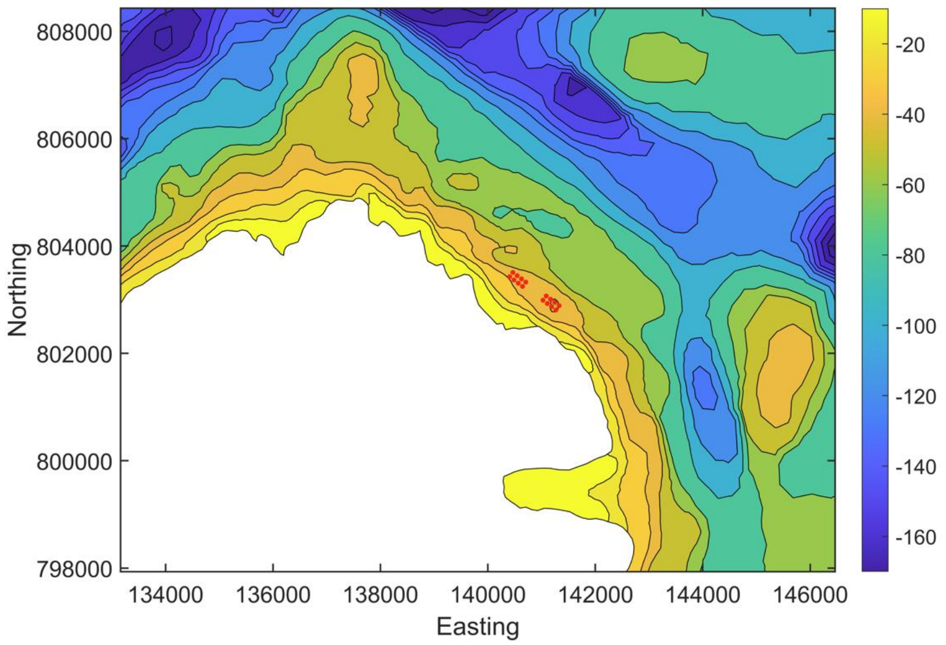


*Figure 4. Model water depths (m) around the proposed Mullach Mor (west) and existing Rum (east) salmon farms from the modified model. The pen locations indicated (●).*

# 3. MEDICINE DISPERSION MOLDELLING

## 3.1 Azamethiphos 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 11 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 5 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 ~120 µg $L^{-1}$, with a total mass of 9.78 kg of azamethiphos released during treatment (8 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 ~*977,480* numerical particles in total, each particle representing 10 mg of azamethiphos.

Each simulation ran for a total of 265 hours (11.04 days). This covered the treatment period (168 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 (µg/L) anywhere on the regular grid; and
(ii) The area ($km^2$) 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 horizonal diffusion coefficient, $K_{H.}$ The lower horizontal diffusion coefficient sensitivity value of 0.03 $m^2s^{-1}$ was taken from the results of a dye study, undertaken at the near-by Mowi site Muck, by Anderson Marine Ltd. in 2017.

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

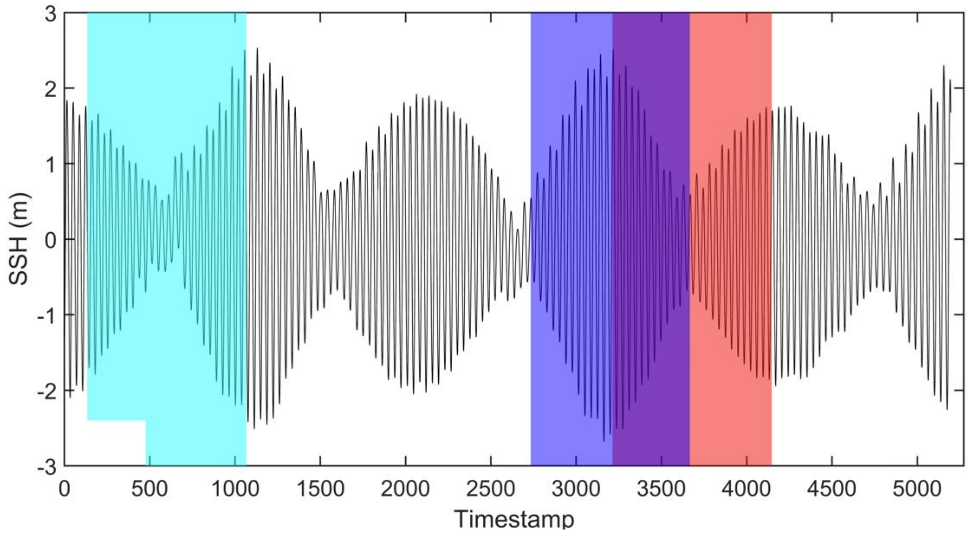


*Figure 5. Sea surface height (SSH) at Mullach Mor from 14th February to 27th April 2025 (ID446). Dispersion simulations were performed over neap tides (red, start day 31st March 2025, cyan, start day 1st March 2025) and spring tides (dark blue, start day 24th March 2025)*

## 3.2 Azamethiphos 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. 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.*

| Pen | Easting | Northing | Net Depth (m) | Treatment Mass (kg) | Release Time (hours) |
|---|---|---|---|---|---|
| 1 | 140466 | 803507 | 5 | 1.23 | 0 |
| 2 | 140546 | 803447 | 5 | 1.23 | 24 |
| 3 | 140626 | 803387 | 5 | 1.23 | 48 |
| 4 | 140706 | 803327 | 5 | 1.23 | 72 |
| 5 | 140406 | 803428 | 5 | 1.23 | 96 |
| 6 | 140486 | 803367 | 5 | 1.23 | 120 |
| 7 | 140566 | 803307 | 5 | 1.23 | 144 |
| 8 | 140646 | 803247 | 5 | 1.23 | 168 |

*Table 4. Dispersion model simulation details for the treatment of the 8 pens at Mullach Mor.*

| | Run No. | T 1/2 (h) | Kh | Kv |
|---|---|---|---|---|
| Neap Tides, Start day = 45 (31st March 2025, Rum West ID446) | | | | |
| Baseline | 1 | 134.4 | 0.1 | 0.001 |
| Sensitivity | 2* | 134.4 | 0.03 | 0.001 |
| Sensitivity | 3* | 134.4 | 0.2 | 0.001 |
| Spring Tides, Start day = 37 (24th March 2025, Rum West ID446) | | | | |
| Baseline | 4 | 134.4 | 0.1 | 0.001 |
| Sensitivity | 5* | 134.4 | 0.03 | 0.001 |
| Sensitivity | 6* | 134.4 | 0.1 | 0.001 |
| Neap Tides, Start day = 15 (1st March 2025, Rum West ID446) | | | | |
| Baseline | 7 | 134.4 | 0.1 | 0.001 |

*results to the sensitivity simulations can be found in the appendix

## 3.3 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 $L^{-1}$ 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 10.04 cm $s^{-1}$ was used from ID446 (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 $L^{-}1$ 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 ($ms^{-1}$) | 0.1004 |
| Area of 160 m pen ($km^2$) | 0.00203718 |
| Distance from shore (km) | 0.814 |
| Mean water depth (m) | 34 |
| Treatment Depth (m) | 5 |
| **Mixing zone ellipse area ($km^2$)** | **0.15831943** |

## 3.4 Cumulative Azamethiphos Modelling

Cumulative bath modelling was undertaken due to the close proximity of the proposed Mullach Mor and existing Rum sites. The simulations will follow two different treatment scenarios (Table 6); the first with 1 pen treatment per day, starting with the Rum pens and following with the Mullach Mor pens. The length of the simulation will follow suit with the standard runs, 16 days to cover the treatment of each pen, a dispersion period of 72 hours after the final treatment and an extra 25 hours to check for chance concentration peaks. The second treatment scenario undertaken was to check that the 72-hour EQS and MAC are comfortably met if, in the unlikely event, the adjacent pens are treated simultaneously. This simulation will mirror the set-up of the first scenario except a pen from each site will be treated each day. This will decrease the modelling run time to 8 days to cover the treatment time, a dispersion period to the EQS assessment of 72 hours after the final treatment and an extra 25 hours. A 72-hour MAC of 1 km is used in these plots to account for the fact that there are two sites being assessed.

For each scenario, they were run over both spring and neap tides and individual pen treatments released 1.23 kg of Azamethiphos (Table 6), which is the current 3-hour consent at Rum and the sought for 3-hour consent at Mullach Mor.

*Table 6. Cumulative modelling treatment scenarios, time (h) with respect to the beginning of the simulation*

| Site | Pen Number | Release time (h) Scenario 1 | Release time (h) Scenario 2 | Treatment Amount (kg) |
|---|---|---|---|---|
| Rum | 1 | 0 | 0 | 1.23 |
| Rum | 2 | 24 | 24 | 1.23 |
| Rum | 3 | 48 | 48 | 1.23 |
| Rum | 4 | 72 | 72 | 1.23 |
| Rum | 5 | 96 | 96 | 1.23 |
| Rum | 6 | 120 | 120 | 1.23 |
| Rum | 7 | 144 | 144 | 1.23 |
| Rum | 8 | 168 | 168 | 1.23 |
| Mullach Mor | 1 | 192 | 0 | 1.23 |
| Mullach Mor | 2 | 216 | 24 | 1.23 |
| Mullach Mor | 3 | 240 | 48 | 1.23 |
| Mullach Mor | 4 | 264 | 72 | 1.23 |
| Mullach Mor | 5 | 288 | 96 | 1.23 |
| Mullach Mor | 6 | 312 | 120 | 1.23 |
| Mullach Mor | 7 | 336 | 144 | 1.23 |
| Mullach Mor | 8 | 360 | 168 | 1.23 |

## 3.5 Deltamethrin 6-hour EQS

Deltamethrin dispersion was modelled using the BathAuto Excel spreadsheet. The same current data from Mullach Mor, ID446, was used as input to the spreadsheet, and the same treatment depth of 5 m. The completed spreadsheet is included with the application files.

## 3.6 Interactions with Special Features

Two near-by habitat and species PMF's of interest have been identified (SEPA, 2025a) which are thought to be at potential risk from medicine influence and hence must be considered when modelling the treatment and solids releases from Mullach Mor. Table 7 shows details of the features of interest, and the locations are indicated in Figure 6.

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 the Northern Seafan & Sponge Communities are benthic habitats. Solids deposition footprints were overlain the Burrowed mud PMF area, which was determined via a baseline survey of the area surrounding the proposed site location.

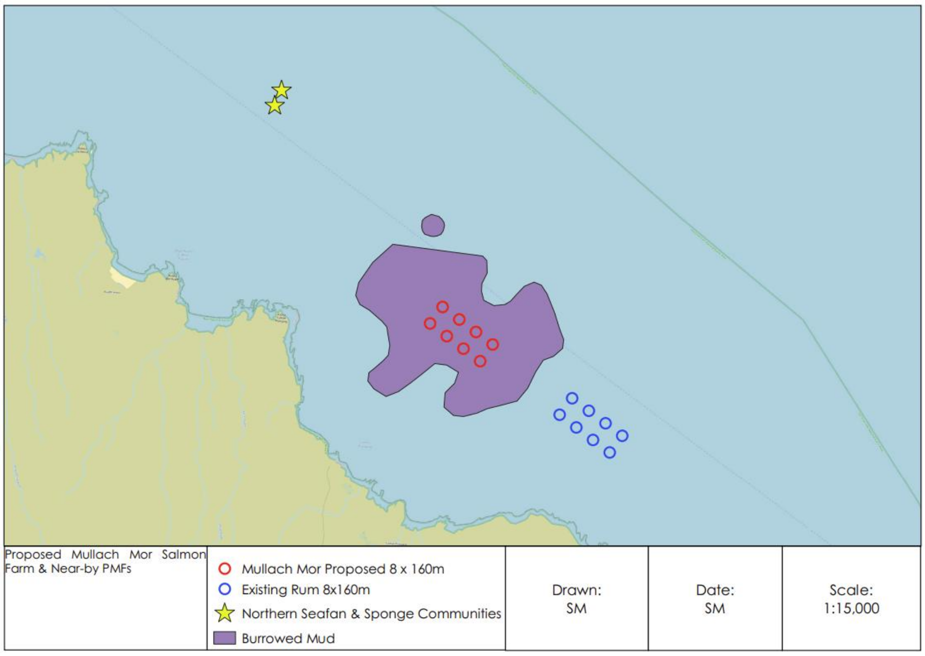


*Figure 6. Identified special features near the proposed Mullach Mor and existing Rum salmon farms.*

*Table 7. Details of identified special features.*

| Feature Name | Feature Type | Location | Reason for Identification |
|---|---|---|---|
| Northern Seafan and Sponge Communities | PMF/MPA protected feature | 139694 E, 804546 N | At risk from bath medicine |
| Northern Seafan and Sponge Communities | PMF/MPA protected feature | 139661 E, 804473 N | At risk from bath medicine |
| Burrowed Mud | PMF/MPA protected feature | Area shown in figure 6 | At risk from solids deposition |

# 4. MEDICINE DISPERSION RESULTS

## 4.1 Baseline Dispersion During Neap & Spring Tides (ID446)

A standard treatment of eight 160 m pens, with a reduced net depth of 5 m and assuming 1 pen can be treated per day at a treatment concentration of ~120 µg/L, resulted in a treatment mass per pen of azamethiphos of 1.23 kg and a total treatment release of 9.84 kg over 168 hours. The time series of maximum concentration from run001 (Table 4) is shown in Figure 7. The 8 peaks in concentration of ~120 µg/L following each treatment event over the first 7 days are evident. Following the final treatment after 168 hours, the maximum concentration fell steadily away (Figure). A default half-life of 134.4 hours (5.6 days) was used. The maximum concentration 72 hours after the final treatment (time = 240 hours) was well below 0.1 µg/L, the maximum allowable concentration (MAC).

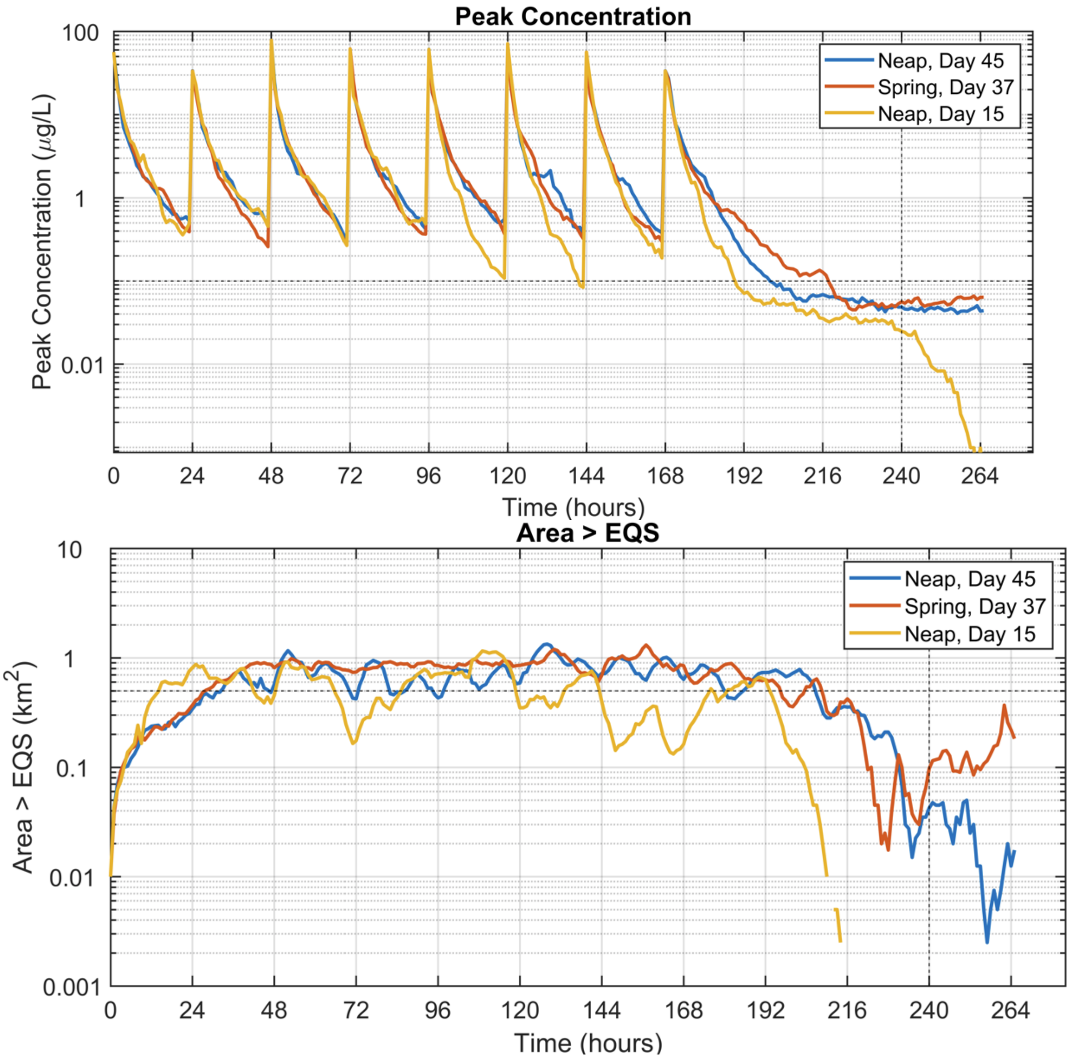


*Figure 7. Time series of maximum concentration (top) and the area where concentrations exceeded the EQS (bottom). The model was run at spring tides for the fourth, fifth and sixth set of model runs and over a second neap tide in the seventh (Table 4), with varying horizontal diffusion coefficient $K_H$ ($m^2$ $s^{-1}$). The MAC and area limit 72 hours after the final treatment (Time = 240 h) of 0.1 µg/L and 0.5 $km^2$ are indicated by the horizontal dashed lines.*

The area where the EQS of 0.04 µg/L was exceeded peaked at about 1.3 $km^2$ following the final treatment, but had fallen well below the 0.5 $km^2$ threshold immediately after; by 72 hours after the final treatment, the exceeded area was close to zero (Figure 7).

These results indicate that, with a horizontal diffusion coefficient of 0.1 $m^2$ $s^{-1}$, and a medicine half-life of 134.4 hours, the environmental quality standards are achieved.

Dispersion simulations were carried out during modelled spring tides in March 2025 repeating the main set carried out for neap tides (Table 4), as well as repeating the baseline over a second neap tide from March 2025 (Table 4). The same treatment scenario of 1 treatment per day was simulated, with each treatment using 1.23 kg of Azamethiphos.

All baseline simulations showed passes for both the MAC and EQS (Figure 7). Other sensitivity testing is shown in the appendix.

## 4.2 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 10.04 cm $s^{-1}$ was used from ID446 (Table 1) which was thought to be a representative value for the surface 0 – 5 m layer at Mullach Mor. 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 µg/L is exceeded for a single selected pen treatment at neap tide (first release on 31$^{st}$ March 2025) are shown in Figure 8. The single pen treatment selected was the 4$^{th}$ 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 (158,319 $km^2$) after 3 hours.

For spring tide releases (first release on 24$^{th}$ March 2025), the area where concentrations exceeded the 3-hour EQS also complied with the allowable area (Figure 8). This demonstrates that the discharge quantity of 1.23 kg of Azamethiphos from each of the 8 proposed 160 m pens at Mullach Mor should not breach the 3-hour Environmental Quality Standard.

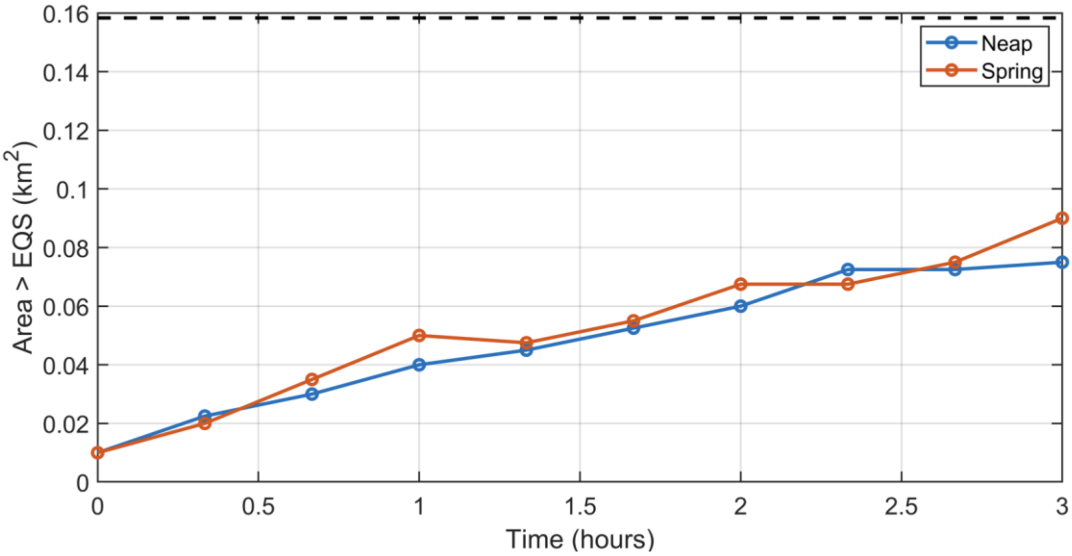


*Figure 8. Time series of the area exceeding the 3-hour EQS for the fourth (middle) pen treatment during the 3 hours following release at neap and spring tide. The 3-hour mixing zone area is indicated (---).*

## 4.3 Cumulative Bath Modelling

Cumulative modelling was undertaken for the proposed Mullach Mor and the existing, neighbouring Rum site. The first scenario had the Mullach Mor pens treated following all of the Rum pens (Table 6) over both neap and spring tides. The second scenario saw both the Mullach Mor and Rum pens treated simultaneously, again over both neap and spring tides.

Figure 9 shows the time series for peak concentration and area where concentrations exceed the EQS for Scenario 1, over both neap and spring tides. Sixteen concentration peaks are seen which depicts each pen treatment release. The first 8 concentration peaks are the release times of treatments at Rum and the following 8 peaks are the times of treatment at Mullach Mor. The plots show that both the EQS and the MAC are comfortably met for both simulations. Figure 10 shows similar for Scenario 2 over both neap and spring tides. The results show that for peak concentration there is a very minor increase which breeches the MAC after 72-hour after the final treatment. The area where concentrations exceed the EQS also breeches the threshold after the 72-hours post-final treatment. It is worth noting that Scenario 2, where the sites are treated simultaneously, is very unlikely to happen in practice due to boat availability, among other reasons.

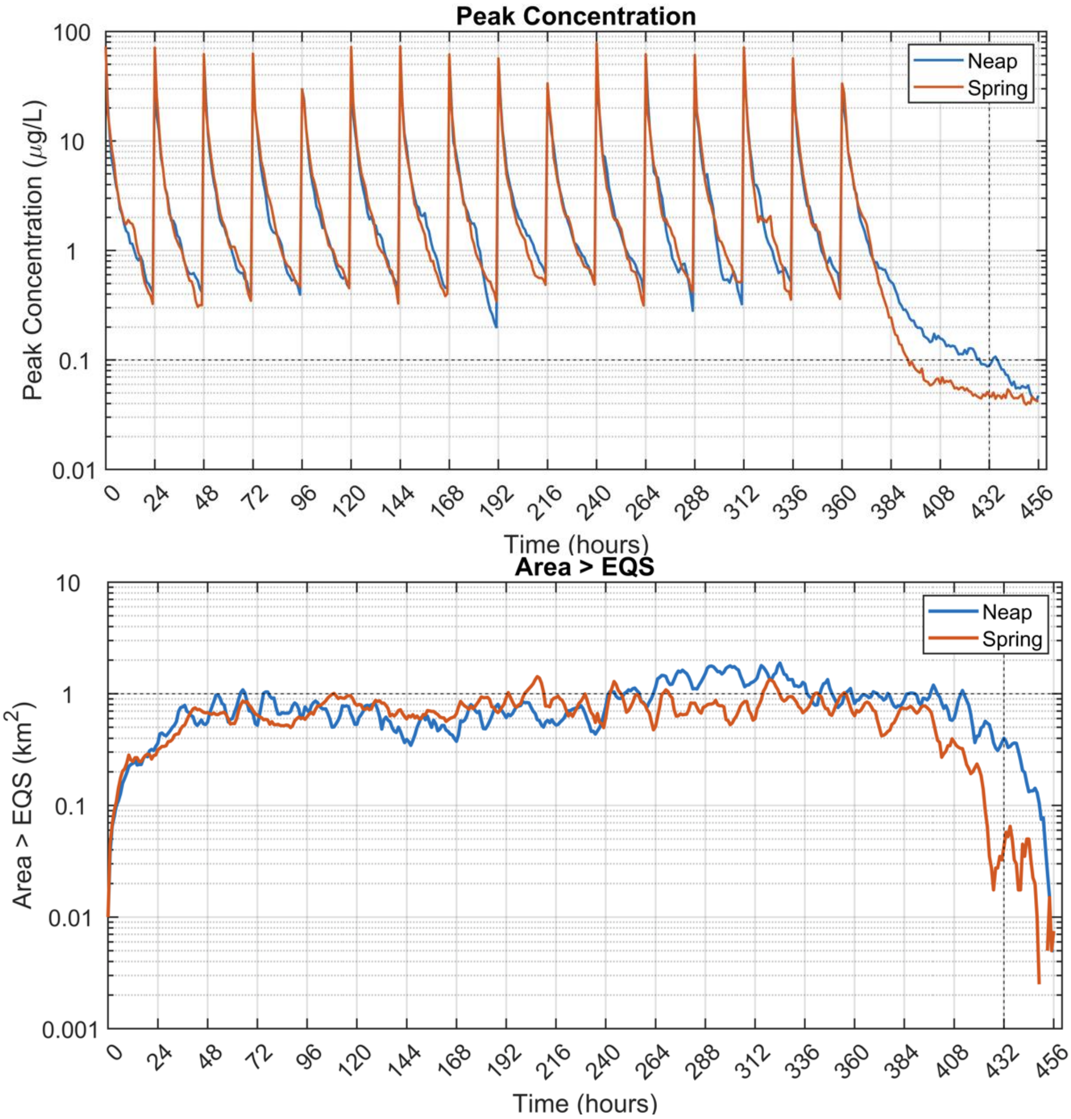


*Figure 9. Time series of maximum concentration (top) and the area where concentrations exceeded the EQS (bottom) for Scenario 1 (Table 6) at both spring and neap tides. The MAC and area limit 72 hours after the final treatment (Time = 240 h) of 0.1 µg/L and 1 km² are indicated by the horizontal dashed lines.*

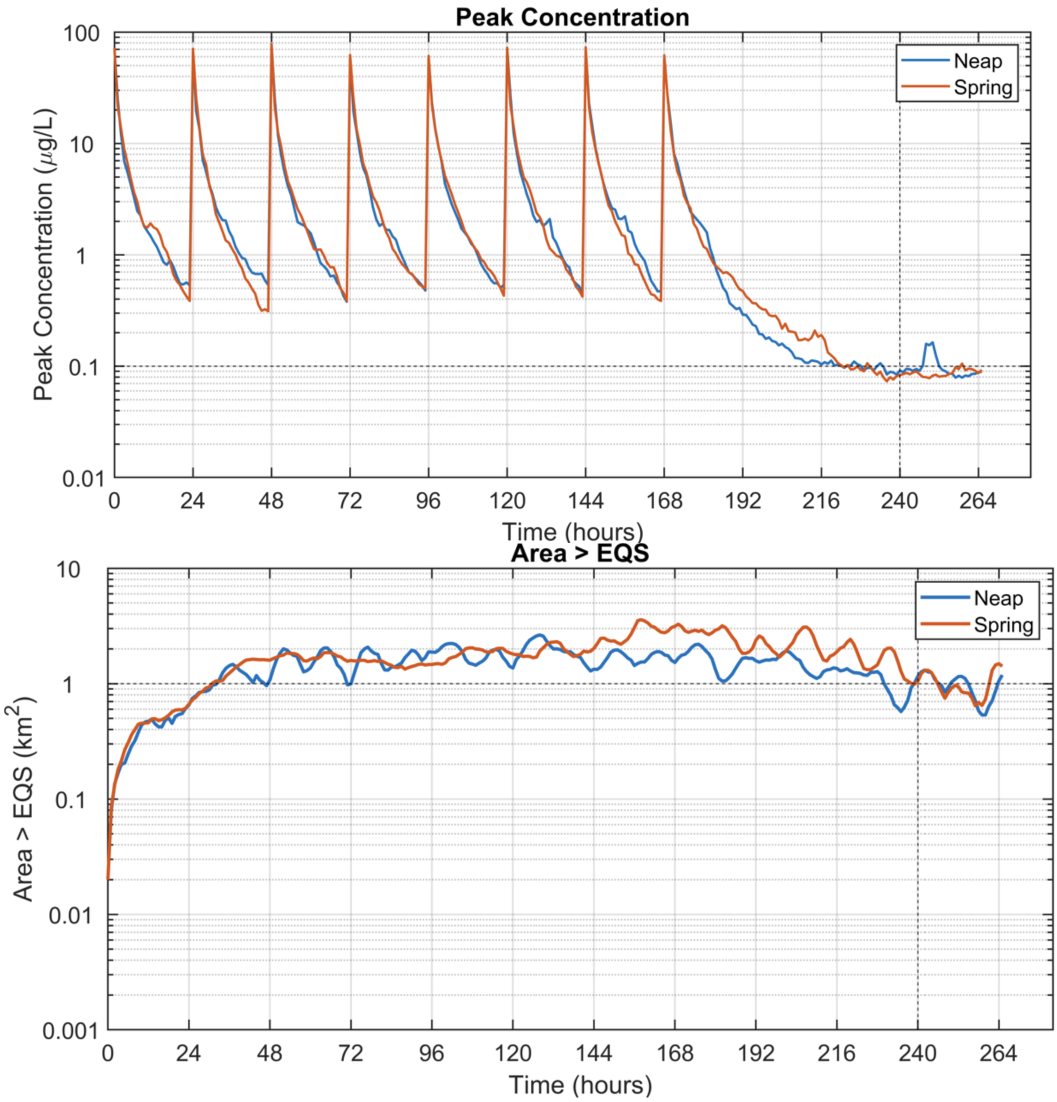


*Figure 10. Time series of maximum concentration (top) and the area where concentrations exceeded the EQS (bottom) for Scenario 2 (Table 6) at both spring and neap tides. The MAC and area limit 72 hours after the final treatment (Time = 240 h) of 0.1 µg/L and 1 km² are indicated by the horizontal dashed lines.*

## 4.4 Deltamethrin 6-hour EQS

The conservative BathAuto excel spreadsheet, using input data from the ID446 deployment at Mullach Mor, was utilised to calculate a maximum consentable quantity of Deltamethrin. The results gave a permitted Deltamethrin mass of 27 g, which allows for 1 pen to be treated in 6 hours.

## 4.5 Bath Medicine Interactions with Special Features

Figure 11 to Figure 13 show the hourly peak concentrations at each of the identified special feature, Northern Seafan and Sponge Communities, locations (SEPA, 2024) for a 5 m thick layer above the seabed. The concentrations are zero for the full time series over neap tides and minimal throughout at spring tide, with some minor spikes, staying well below the EQS level for the whole simulation.

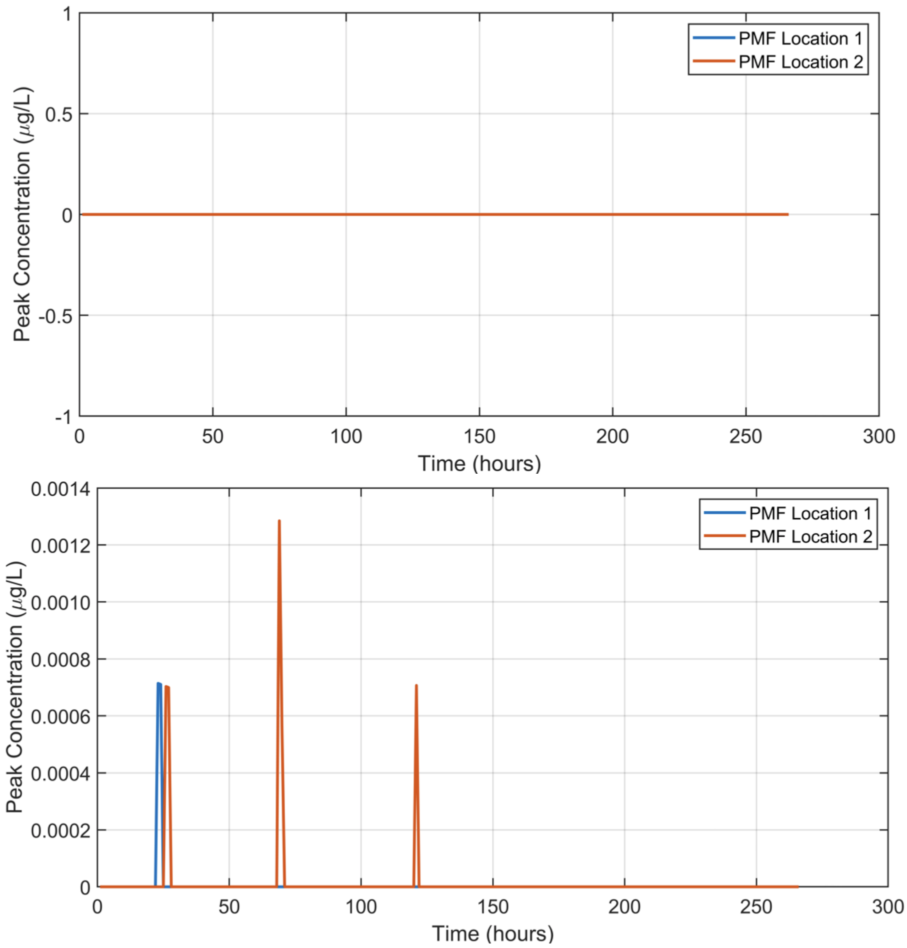


*Figure 11. Peak concentrations at both identified PMF locations over neap (top) and spring (bottom) tides*

Figure 12 shows the concentrations around the site and specified special features for the 5 meter layer above the seabed. For neap tides, concentrations 3 hours after the final treatment (171 hours) do not exceed 0.04 ug/L and are well below the 3-hour MAC. Concentrations 72-hours after the final treatment have dispersed to very low levels. For spring tides, concentrations for the 5 meters above the seabed are zero at both 171 and 240 hours. The modelled medicine plumes do not interact with the PMF locations.

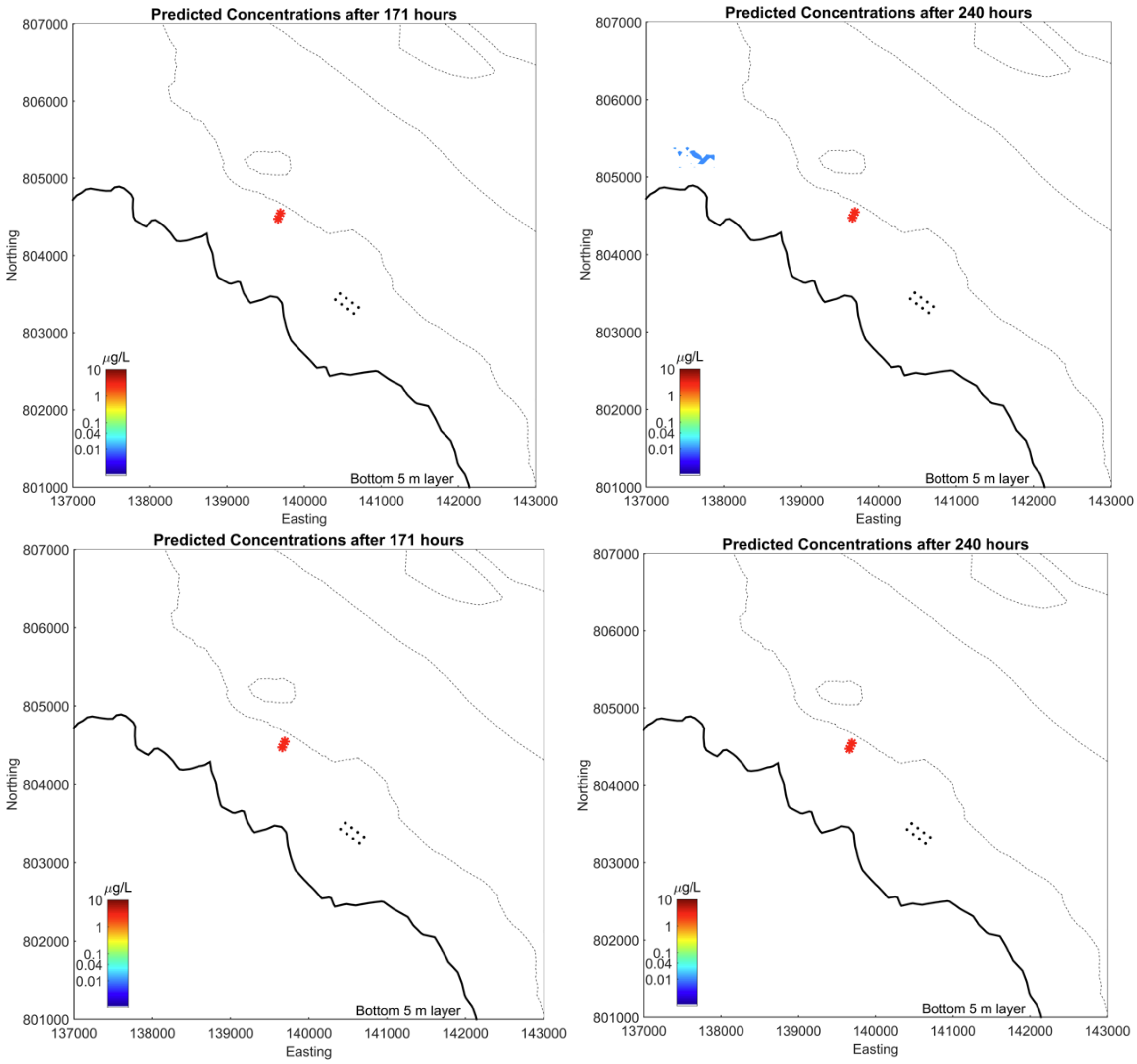


*Figure 12. Predicted concentration fields for a baseline neap (top) and spring (bottom) tide dispersion simulation at 3 (left) and 72 (right) hours after the final treatment at Mullach Mor. Specified special features are shown by the red stars.*

Figure 13 shows concentration depth profiles, calculated using a 250 m radius area around each of the two specified special features, at 3 and 72 hours after the final treatment release (171 and 240 hours elapsed) at both spring and neap tides. Concentrations at both special features are well below both the 3-hour and 72-hour EQS (MACs of 0.25 and 0.1 µg/L) throughout the water column. There are some spikes in concentration through the water column at 171 hours at both PMF locations, but these are several degrees of magnitude below either MACs. This is followed by zero concentrations, at all depths, by 240 hours. The pikes of concentrations that are observed, are all found further up the water column, highlighting that the benthic habitats are less exposed to the medicine releases. These results indicate that the medicine releases from the proposed Mullach Mor fish farm will not have a detrimental effect on the near-by special features and that medicine levels are well below environmental quality standards.

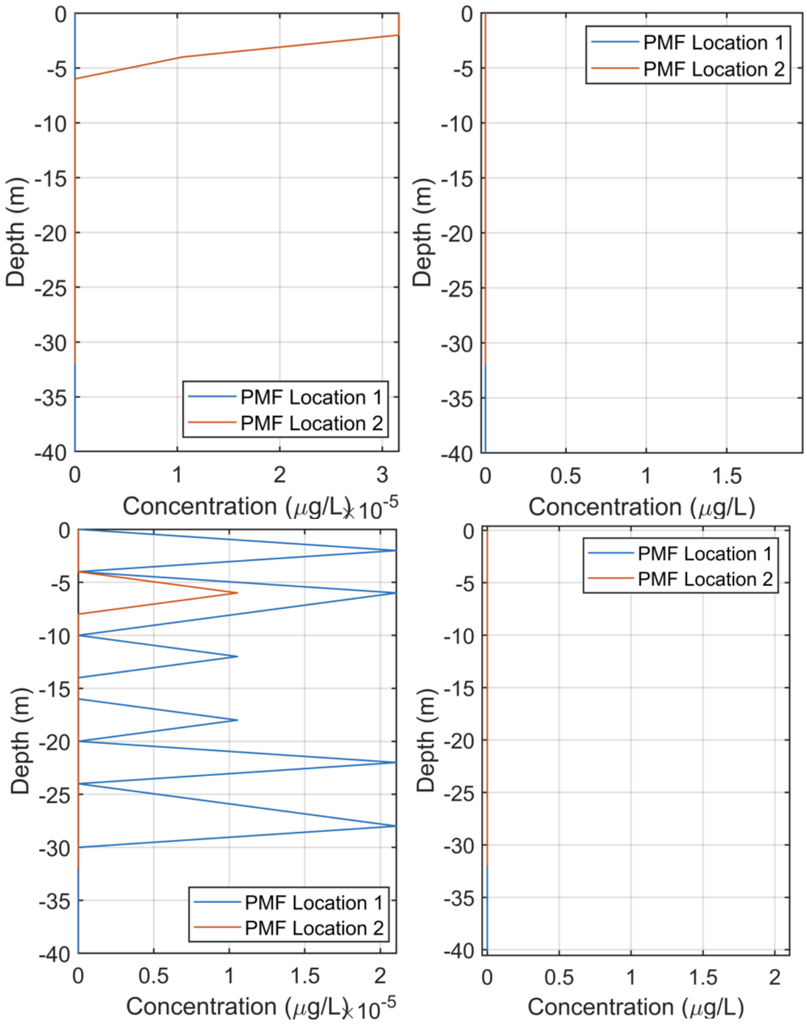


*Figure 13. Concentration depth profiles for the two special features at 3 (left) and 72 (right) hours after final treatment over neap tides (top) and spring tides (bottom).*

## 5. CUMULATIVE SOLIDS MARINE MODELLING

The cumulative solids particulate deposition modelling, performed using the UnPTRACK model (Gillibrand 2021), simulated the settling of waste solids (waste feed and faeces) discharged from the pens during a production cycle. The same pen positions were used in these simulations as the bath model runs (Table 3) but with a net depth of 16 m, together with pens at the existing Rum site (Table 8). Particles were discharged continuously, with each numerical particle representing 2.5 kg of particulate waste. Waste feed and faecal particles were assigned settling velocities within the ranges of 0.095 m $s^{-1}$ ±10% and 0.032 m $s^{-1}$ ± 10% respectively, the same as the values used by NewDepomod.

UnPTRACK contains a bed model, similar in formulation to that of NewDepomod, and likewise based on Sanford (2008). The modelled feed input was identical to NewDepomod, at 7 kg of feed per tonne of fish per day, and the calculated quantities of waste feed (3%) and faecal solids were calculated using the same algorithm. Waste particles were discharged continuously for one year in numbers proportionate to the site biomass (Table 9). Model output was the mean deposition rate over the final 90 days of the simulation (Days 275 – 365).

*Table 8. Details of the 8 x 160 m pen centre locations and net depth used in the modelling for the neighbouring site at Rum.*

| Pen | Easting | Northing | Net Depth (m) |
|---|---|---|---|
| 1 | 141087 | 803069 | 16 |
| 2 | 141027 | 802990 | 16 |
| 3 | 141167 | 803009 | 16 |
| 4 | 141107 | 802929 | 16 |
| 5 | 141247 | 802949 | 16 |
| 6 | 141187 | 802869 | 16 |
| 7 | 141327 | 802889 | 16 |
| 8 | 141267 | 802809 | 16 |

*Table 9. Sites to be included in the cumulative depositional modelling.*

| Site Name | Location | Operator | Biomass (T) | Status |
|---|---|---|---|---|
| RUM1 | Rum | Mowi | 2,850 | Active |
| RUM2 | Mullach Mor | Mowi | 2,650 | Proposed |

## 5.1 Model Calibration

The model was first run for the existing Rum site (RUM1) only, and the predicted deposition rates compared to benthic IQI data collected at 26 stations during a seabed compliance survey in August 2025. The comparison between model and data was used to calibrate the model by varying key model parameters within acceptable ranges. The calibrated model was then used to predict regional deposition from the combined Mullach Mor and Rum sites for their respective consented/proposed biomasses (Table 9).

The parameter values that produced the best relationship (highest correlation coefficient, r, and lowest root-mean-square error, RMSE) are shown in Table 10. These are broadly similar to the values used in the SEPA standard default method for NewDepomod, but there are small differences introduced to achieve a better model fit (Table 10).

The relationship between predicted deposition and observed Infaunal Quality Index (IQI) at the 26 stations sampled in August 2025 is shown in Figure 14. The relationship is shown for both modelled solids and modelled carbon. The carbon content of feed is 49% and the carbon content of faeces is 30%; since both are incorporated in different proportions in the deposited waste, the carbon content of the settled material varies over space and time, but is typically in the range 35% – 45% of the total solids.

*Table 10. Parameter values used in the UnPTRACK bed model for cumulative waste solids modelling. The values used in the SEPA standard default method for NewDepomod are also shown for comparison.*

| Parameter | UnPTRACK Value | Units | NewDepomod value |
|---|---|---|---|
| Horizontal diffusion coefficient | 0.1 | $m^2 s^{-1}$ | 0.1 |
| Vertical diffusion coefficient | 0.001 | $m^2 s^{-1}$ | 0.0017 |
| Bed roughness length scale | 0.01 | m | 0.001273 |
| Critical erosion threshold | 0.02 | Pa | 0.02 |
| Release height of resuspended particles | 0.35 | m | 0.0 |
| Bed layer contraction time scale | 3600 | s | 0.0 |
| Bed layer expansion time scale | 345600 | s | 0.0 |
| Erosion mass equation coefficient | 0.031 | - | 0.031 |
| Erosion mass equation exponent | 1.0 | - | 1.0 |
| Sediment (mud) settling velocity | 0.0057 ±10% | $m s^{-1}$ | 0.0057 ±10% |

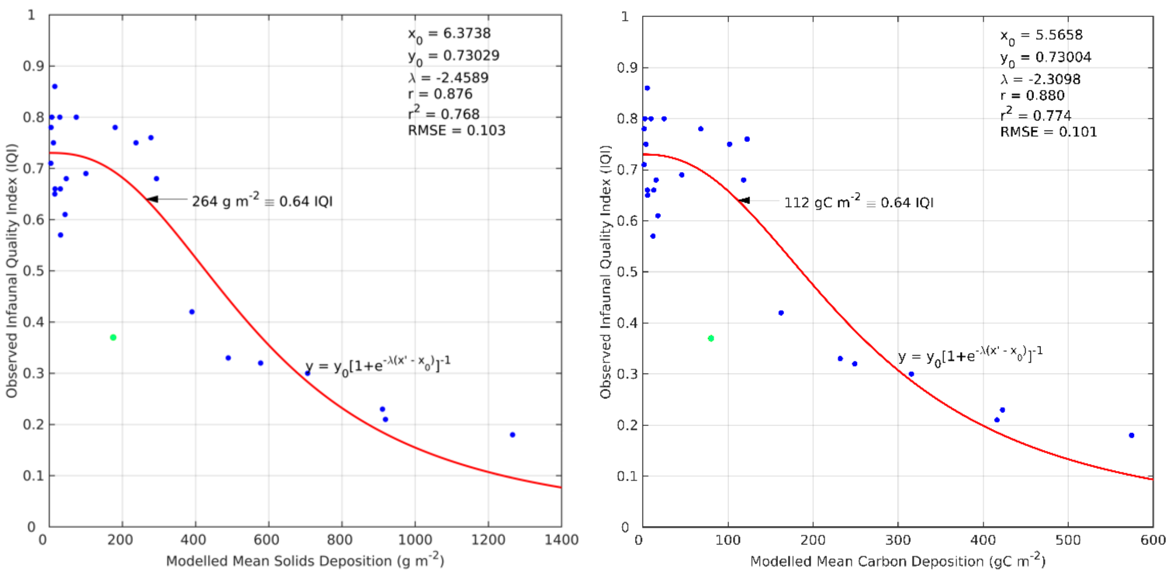


*Figure 14. Regression plots for the calibration of modelled solids (left) and modelled carbon (right) deposition against IQI from 26 stations sampled at Rum in August 2025.*

The comparisons between both modelled solids deposition and modelled carbon deposition with the observed IQI are reasonably good, with correlation coefficients r > 0.87 and RMS errors about 0.1. The regression shows that with this model configuration, a predicted carbon deposition rate of 112 g $m^2$ $yr^{-1}$ corresponds to an IQI of 0.64. The value used for plotting the combined footprint (100 gC $m^2$ $yr^{-1}$) is therefore slightly more conservative, corresponding to an IQI of 0.66. Note that the solids regression predicts a deposition rate of 264 g $m^2$ $yr^{-1}$ corresponds to and IQI of 0.64, similar to the critical solids deposition threshold (250 g $m^2$ $yr^{-1}$) of the SEPA standard default screening model approach.

As noted above, the Zone of Influence (ZoI) is generated from using a threshold of 100 gC $m^{-2}$ $yr^{-1}$, which is derived from the interrogation of the FeAST Tool (Marine Directorate 2026) and

EIA scoping guidance issued by NatureScot (NatureScot 2026). Marine modelling was hence used to calculate the ZoI of Mullach Mor and the neighbouring Rum site using the 100 gC $m^{-2}$ $yr^{-1}$ contour, to check for potential interactions with the near-by Burrowed Mud PMF.

## 5.2 Cumulative Deposition and PMF Interactions

Marine modelling was used to estimate the depositional footprint from both the proposed Mullach Mor site and the existing Rum site. The results were then mapped using the 100 g C $m^{-2}$ (Figure 15).

The plot indicates some overlap between the footprint and Burrowed Mud, due to the presence of the special feature directly beneath the proposed pens. However, the impact is very localised, likely due to the dispersive characteristics of the surrounding environment. Burrowed Mud is widespread in the Scottish marine environment, particularly in the Small Isles MPA; therefore, these localised effects represent a minor proportion of the habitats overall distribution and are not expected to affect the integrity of the feature in this area.

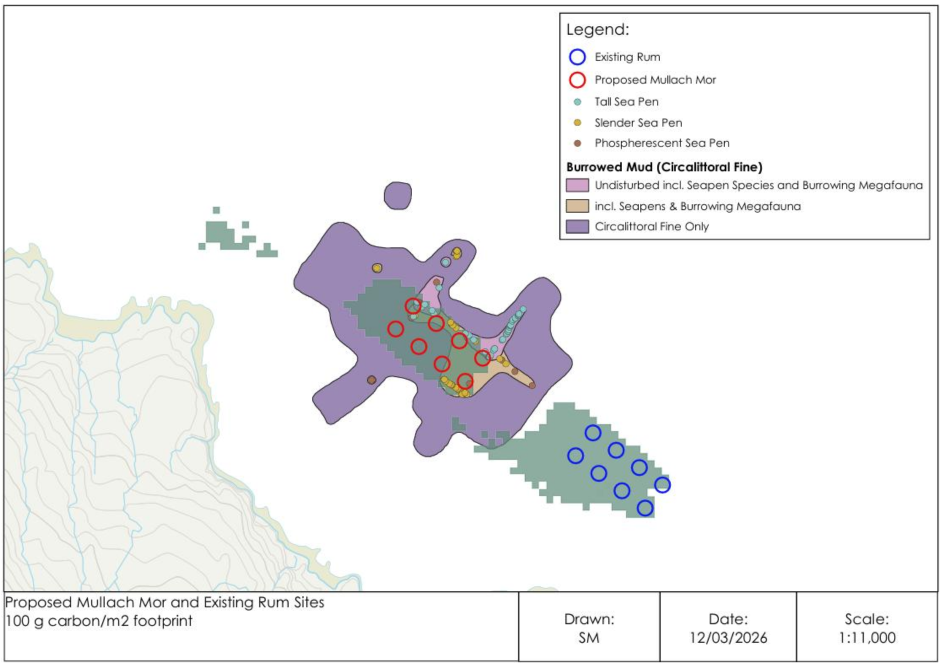


*Figure 15. Cumulative Solids Footprint for both Mullach Mor and Rum using the standard default contour of 100 gCm$^{-2}$, overlain with special features highlighted by SEPA and Nature Scot.*

# 6. SUMMARY AND CONCLUSIONS

A total of 7 dispersion simulations have been performed to assess whether bath treatments at the proposed Mullach Mor salmon farm will comply with pertinent environmental quality standards. A realistic treatment regime, with 1 treatment a day, was simulated. Each pen required 1.23 kg of Azamethiphos for treatment, resulting in a total discharge over 8 days of 9.84 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 11.

The model results confirmed that the treatment scenario proposed, with a daily release of no more than 1.23 kg, 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 $km^2$. In all simulations performed, including sensitivity testing, the EQS and MAC criteria were met. Further simulations over a second 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 1.23 kg of azamethiphos can be safely discharged at Mullach Mor without breaching the MAC or EQS.

Simulations using the BathAuto spreadsheet for Deltamethrin resulted in a consentable quantity of 27 g.

Cumulative modelling results confirmed that sequential treatments at Mullach Mor and Rum will meet both the MAC and EQS comfortably. The MAC and EQS give minor failures for the simultaneous treatment scenario, but this is highly unlikely to be performed in practice.

Marine Modelling results showed that predicted solids deposition footprints will partly overlap with the Burrowed Mud but due to the abundance of this PMF, the impact is thought to be negligible.

*Table 11. Summary of Results*

| | |
|---|---|
| **Site details** | |
| Site Name: | Mullach Mor |
| Site Location: | Isle of Rum |
| Peak Biomass (T): | 2,650 |
| **Pen details** | |
| Number of Pens: | 8 |
| Pen Circumference (m): | 160 |
| Pen Depth (m): | 16 |
| Pen Group Configuration: | 2 x 4 |
| **Azamethiphos consent to be applied for** | |
| Recommended 3-hour (kg): | 1.23 |
| Recommended 24-hour (kg): | 1.23 |
| **Deltamethrin consent to be applied for** | |
| Recommended 6-hour (kg): | 0.027 |

## 7. REFERENCES


European Centre for Medium-Range Weather Forecasts (ECMWF) 2021, ERA5 Dataset https://www.ecmwf.int/en/forecasts/datasets/reanalysis-datasets/era5

Gillibrand, P.A., 2022. UnPTRACK User Guide. Mowi Scotland Ltd., June 2022, 33pp.

Mowi, 2026. Hydrodynamic Model Description: Mullach Mor, Isle of Rum. Mowi Scotland Ltd, March 2026.

Marine Directorate, 2026, (FEAST) Feature Activity Sensitivity Tool FEAST | marine.gov.scot

Marine Scotland, 2016. The Scottish Shelf Model. Marine Scotland. http://marine.gov.scot/themes/scottish-shelf-model

NatureScot, 2026. Statutory Consultee Response to EIA scoping request under the Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017, dated 13/02/2026. Highland Council Planning Portal, Ref. No. 25/04321/SCOP.

Pawlowicz, R.; Beardsley, B.; Lentz, S., 2002. Classical tidal harmonic analysis including error estimates in MATLAB using T_TIDE. Computers & Geosciences, 28, 929-937.

Sanford, L.P., 2008. Modeling a dynamically varying mixed sediment bed with erosion, deposition, bioturbation, consolidation, and armoring. Computers & Geosciences, 34, 1263–1283.

SEPA, 2023. Interim Marine Modelling Guidance for Aquaculture Applications. Scottish Environment Protection Agency, Air & Marine Modelling Unit, December 2023, 11 pp.

SEPA, 2025a, Aquaculture Modelling Screening & Risk Identification Report: Rum 2 (RUM2), June 2025

SEPA, 2025b, Rum Benthic Monitoring Survey Classification, December 2025.

## APPENDIX – SENSITIVITY TESTING

### Sensitivity to the Horizontal Diffusion Coefficient

The model results were tested for sensitivity to the horizontal diffusion coefficient used over spring and neap tides. The horizontal diffusion coefficient used for the standard runs was $K_H$ = 0.1 $m^2$ $s^{-1}$. Simulations were also performed with a lower value of $K_H$, specifically $K_H$ = 0.03 $m^2$ $s^{-1}$ which was calculated from the dye and drogue study results of the near-by site, Muck. And a higher value of $K_H$ = 0.2 $m^2$ $s^{-1}$ was undertaken as an extra sensitivity run. The time series of maximum concentration and area exceeding the EQS are shown in Figure A1. The legend corresponds to the run numbers described in Table 4. The MAC and EQS were both comfortably met for $K_H$ = 0.2 $m^2$ $s^{-1}$ (Run 3 & 6). There were minor breaches of both the MAC and EQS for $K_H$ = 0.03 $m^2$ $s^{-1}$ (Runs 2 & 5), but this value is known to be highly conservative for dispersion over a timeframe greater than a couple of hours.

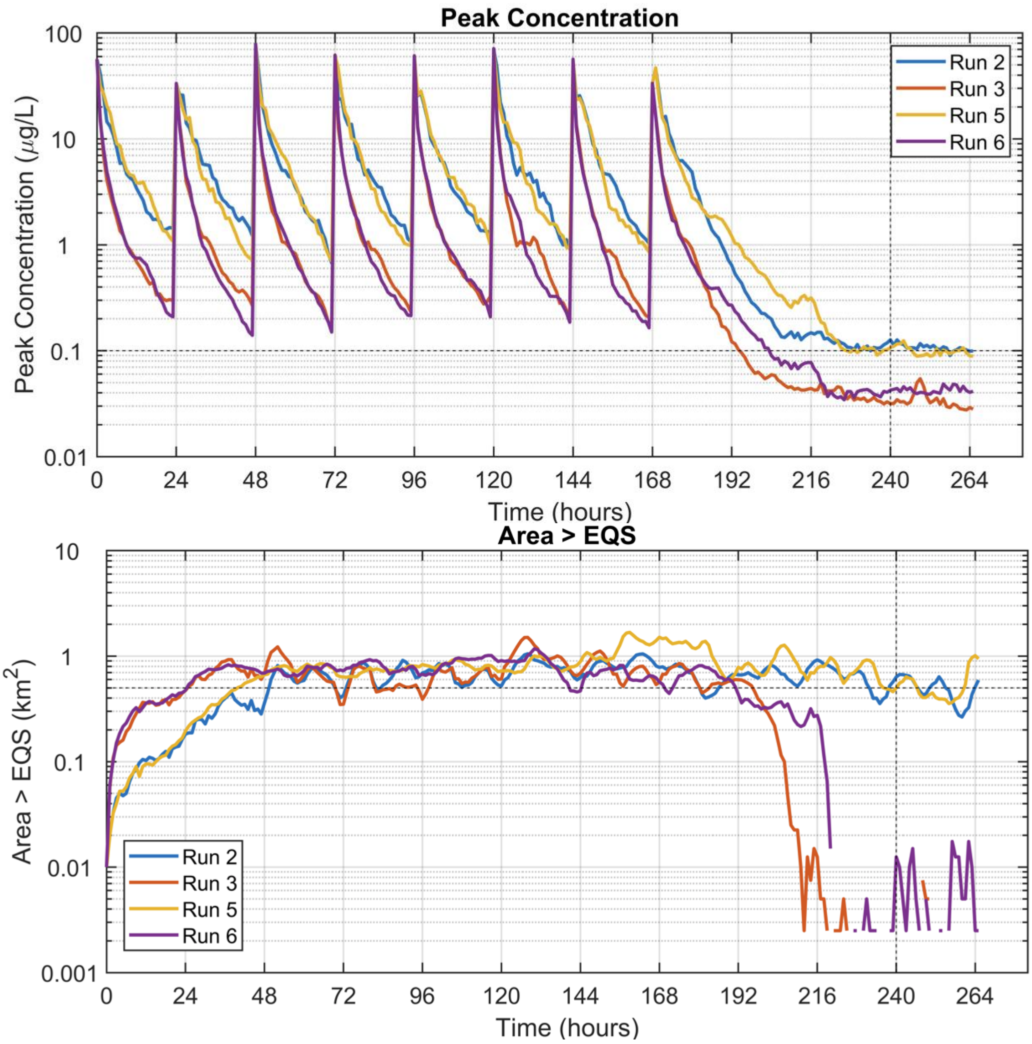


*Figure A1. Time series of maximum concentration (top) and area exceeding the EQS (bottom) from the first, second and third model runs (Table 4). The model was run during neap tide with varying horizontal diffusion coefficient $K_H$ ($m^2$ $s^{-1}$). The MAC and area limit 72 hours after the final treatment (Time = 240 h) of 0.1 μg/L and 0.5 $km^2$ are indicated by the horizontal dashed lines.*