SEPA's duties under the Nature Conservation (Scotland) Act 2004 (section 15) and the Conservation Regulations 1994, (Regulations 48 and 49) during regulation

Record of the assessment of the conservation implications of fin fish farm activity, in the Firth of Lorn Special Area of Conservation

Licence application number: CAR/L/1099909

Coordinating Officer: Naveed Bhatti, Marine Ecologist

Date of completion: 27/04/2012

Project and site description	
1	**Brief description of the project**
	Within or near (less than 3km) to the Firth of Lorn SAC there are seven licensed marine fin fish farms producing salmon at Port nan Seannag (Lunga) (CAR/L/1000811), Ardmaddy (CAR/L1010472), Bagh Lachlainn (CAR/L/1025495), Port na Cro (CAR/L/1000810), South West Shuna (CAR/L/1025496), Bagh Dail nan Ceann North & South (CAR/L/1004226), and Ardifuir (CAR/L/1021927). These sites are authorised by SEPA under the Controlled Activity Regulations (CAR) and allowed to use certain listed chemicals for such activities as fish health, net anti-fouling and bio security. For example, the farms are licensed to treat outbreaks of sea lice using a selection of chemical treatments, and licensed to use specific amounts depending on many factors such as the size and location of the farm, and number of fish stocked at time of treatment. Lakeland Marine Farm Ltd. propose to relocate the cages at their Ardmaddy fish farm (CAR/L/1010472) to a new site at Ardmaddy South (CAR/L/1099909), increase the licensed biomass and sea lice treatment chemicals. The level of authorisation for marine fish farms under the CAR regime is classed as 'complex' and the materials have the potential to have a significant effect upon the SAC, therefore a Habitats Regulations appraisal and appropriate assessment must be made. The potential hazards which can be controlled through the CAR licensing process, either individually or in combination, are (a) smothering, (b) chemical treatments and (c) cumulative nutrient enhancement. These only will be addressed below.

	This appropriate assessment updates previous versions of the Firth of Lorn SAC appropriate assessment (including v1 Dec 2005, and v2 Sep 2011) with regard to the Ardmaddy/Ardmaddy South fish farm sites and any cumulative effects. This appropriate assessment considers the development in relation to the qualifying features and conservation objectives, using information gathered from the site and the most applicable modelling techniques. This information has been collated from SEPA's own data, as well as that submitted by the applicant.
2	**Special Areas of Conservation or Special Protection Areas within the screening distance of the project**
	Firth of Lorn, Argyll and Bute
3	**Qualifying interests for the SAC/SPA (habitats and/or species) and conservation objectives for each of these interests**
	The general site character of the Firth of Lorn SAC is: • Marine areas. Sea inlets (100%) **Qualifying interests** (see http://jncc.defra.gov.uk/ProtectedSites/SACselection/sac.asp?EUCode=UK0030041) The natural heritage interests of the Firth of Lorn SAC for which the site is designated are: Annex I habitats that are a primary reason for selection of this site: • *1170 Reefs* This well-defined, discrete area encompasses a complex group of islands, sounds and inlets characterised by some of the strongest tidal streams in the UK. The area is moderately exposed to wave action with very sheltered pockets enclosed by islands and skerries. Reefs extend from the shallow depths between the islands and mainland into depths of over 200m, in many places close inshore. The varied physical environment is reflected in the variety of reef types and associated communities and species, which are amongst the most diverse in both the UK and Europe. These range from those characteristic of conditions sheltered from waves and currents, to those influenced by extreme tidal streams. A rapid transition in communities occurs with the deceleration of the tidal streams. Species present include some which are normally characteristic of deeper water (the sponges *Mycale lingua* and *Clathria barleii*, and the featherstar *Leptometra celtica*), and others which are considered scarce (including the brown alga *Desmarestia dresnayi*). Many species occurring here have either a northern or southern-influenced distribution and reach their geographic limits in this area, for example, the southern cup-coral *Caryophyllia inornata*, the nationally scarce brittlestar *Ophiopsila annulosa*, and the northern bryozoans *Bugula purpurotincta* and *Caberea ellisii*. Annex I habitats present as a qualifying feature, but not a primary reason for the selection of this site: • Not applicable.

	Annex II species that are a primary reason for the selection of this site: • Not applicable. Annex II species present as a qualifying feature, but not a primary reason for site selection: • Not applicable. **Conservation Objectives** (see http://gateway.snh.gov.uk/sitelink/documentview.jsp?p_pa_code=8256&p_Doc_Type_ID=29) To avoid deterioration of the Annex I habitats (listed above) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the habitats; and To ensure for the Annex I habitats (listed above) that the following are maintained in the long term: • extent of the habitat on site • distribution of the habitat within site • structure and function of the habitat • processes supporting the habitat • distribution of typical species of the habitat • viability of typical species as components of the habitat • no significant disturbance of typical species of the habitat.
4	**Is the proposal directly connected with, or necessary to, conservation management of the SAC/SPA?**
	No
Assessment of likely significant effect	
5	**Identify the individual elements or phases of the overall project that would give rise to a likely significant effect. Clearly identify any element**

of the project where the scale or magnitude of effect is not known or cannot be determined at this stage.

Proposal Details

Lakeland Marine Farm Ltd proposes to

- relocate their site in Seil Sound from Ardmaddy, approximately 900m south, to Ardmaddy South
- change the type of cages from 18 x 24m x 24m x 10m deep cages to 12 x 100m circumference x 15m deep circular cages
- change the amounts of in-feed sea lice treatments for emamectin benzoate
- change the amounts of azamethiphos, cypermethrin and deltamethrin bath treatments
- change the cage surface area from 10,368m^2 to 9549m^2
- increase the biomass from 1300t to 2500t
- the proposed extent of moorings at the new site is 179,800m^2
- no change to the species farmed salmon.

The potential hazards of the development upon the Annex I habitats are likely to be individually or in combination: (a) smothering, (b) chemical treatments, and (c) cumulative nutrient enhancement and benthic impacts. These will be controlled through the CAR licensing process and each is addressed separately below:

SAC features in the vicinity of the proposal

Both the proposed and existing sites are outwith the SAC boundary, however, the proposed site is approximately 300m closer to the nearest part of the SAC boundary at Cuan Sound. The existing site is 2.1km away and the proposed site 1.8km away from the SAC. The existing and proposed cage locations and SAC boundary can be seen in Figure 1 below.

Figure 1. Proposed cage locations (red circles) and SAC boundary for the proposed Ardmaddy South and existing Ardmaddy fish farm sites

Effects on reef species

Few studies have been undertaken to evaluate the effects of different levels of solids flux on reef organisms. The solids flux:ITI relationship has been empirically determined specifically for benthic infauna, and therefore is not applicable to reef fauna; however, it likely that some reef fauna will be more sensitive to solids flux. This is indicated by those relevant reef organisms to which are assigned AMBI (AZTI Marine Biotic Index) scores:

AMBI scores are assigned as follows [see Borja, A., J. Franco & V. Pérez (2000) A Marine Biotic Index to Establish the Ecological Quality of Soft-Bottom Benthos Within European Estuarine and Coastal Environments. *Marine Pollution Bulletin* **40** (12) 1100 – 1114]:

- Group I – Species very sensitive to organic enrichment and present under unpolluted conditions. They include the specialist carnivores and some deposit feeding tubiculous polychaetes.
- Group II – Species indifferent to enrichment, always present in low densities with insignificant variations with time. These included suspension feeders, less selective carnivores and scavengers.
- Group III – Species tolerant to excess organic matter enrichment. These species may occur under normal conditions, but their populations are stimulated by organic enrichment. They are surface deposit-feeding species, as tubiculous spionids [polychaetes].
- Group IV – Second-order opportunistic species. Mainly small sized polychaetes: subsurface deposit-feeders, such as cirratulids.
- Group V – First-order opportunistic species. These are deposit feeders, which proliferate in reduced sediments.

The taxa noted from the SAC (see §3 above) with AMBI scores assigned, e.g. *Dendrodoa grossularia*, *Corynactis viridis*, *Caryophylla inornata*, *Ophiopsila annulosa*, all fall into group I.

The MarLIN website www.marlin.ac.uk has assessed available information on the sensitivity of different species and habitats to various factors, including smothering, increase in suspended sediment, synthetic compound contamination, hydrocarbon contamination and changes in nutrient levels. For those species listed in the qualifying interests, no information is available or they are not listed. Information is available for four types of reef habitats which are likely to be found in the SAC, namely,

- Antedon spp., solitary ascidians and fine hydroids on sheltered circalittoral rock CR.LCR.BrAs.AntAsH http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=313&code=2004
- Neocrania anomala and Protanthea simplex on very sheltered circalittoral rock CR.LCR.BrAs.NeoPro http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=5&code=2004
- Ophiothrix fragilis and/or Ophiocomina nigra beds on slightly tide-swept circalittoral rock or mixed substrata CR.MCR.EcCr.CarSp.Bri http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=278&code=2004
- Faunal and algal crusts, Echinus esculentus, sparse Alcyonium digitatum and grazing-tolerant fauna on moderately exposed circalittoral rock CR.MCR.EcCr.FaAlCr.Pom http://www.marlin.ac.uk/habitatsensitivity.php?habitatid=337&code=2004.

The habitats have been assessed against smothering by 5cm of sediment for one month. MarLIN indicates that the habitats CR.LCR.BrAs.AntAsH, CR.LCR.BrAs.NeoPro and CR.MCR.EcCr.CarSp.Bri will have a moderate sensitivity to smothering, due to their high intolerance but moderate recoverability. The habitat CR.MCR.EcCr.FaAlCr.Pom has an intermediate intolerance to smothering, but a low sensitivity due to its high recoverability.

For suspended sediment, the habitats were assessed against 100mg/l for one month. MarLIN indicates that the above habitats are not sensitive or have a very low sensitivity to an increase in suspended sediment. This is due to their low intolerance and either immediate or very high recoverability.

For synthetic compounds and hydrocarbon contamination, the habitats and species were assessed against mass mortality (both short- and long-term),

a reduction in abundances, and sub-lethal effects such as a reduced reproductive potential.

MarLIN indicates that the habitats CR.LCR.BrAs.AntAsH and CR.MCR.EcCr.FaAlCr.Pom have a moderate sensitivity to synthetic compound contamination, due to a high intolerance but high recoverability. There is insufficient information for the habitats CR.LCR.BrAs.NeoPro and CR.MCR.EcCr.CarSp.Bri, however they are also expected to show a moderate sensitivity, high intolerance and high recoverability.

For hydrocarbon contamination, MarLIN indicates the habitat CR.LCR.BrAs.AntAsH will have a moderate sensitivity, due to a high intolerance but high recoverability. There is insufficient information for the habitat is CR.LCR.BrAs.NeoPro, but this is expected to show a similar response to CR.LCR.BrAs.AntAsH. The habitats CR.MCR.EcCr.CarSp.Bri and CR.MCR.EcCr.FaAlCr.Pom are both listed as having a low sensitivity, due to their low or intermediate intolerance and high recoverability.

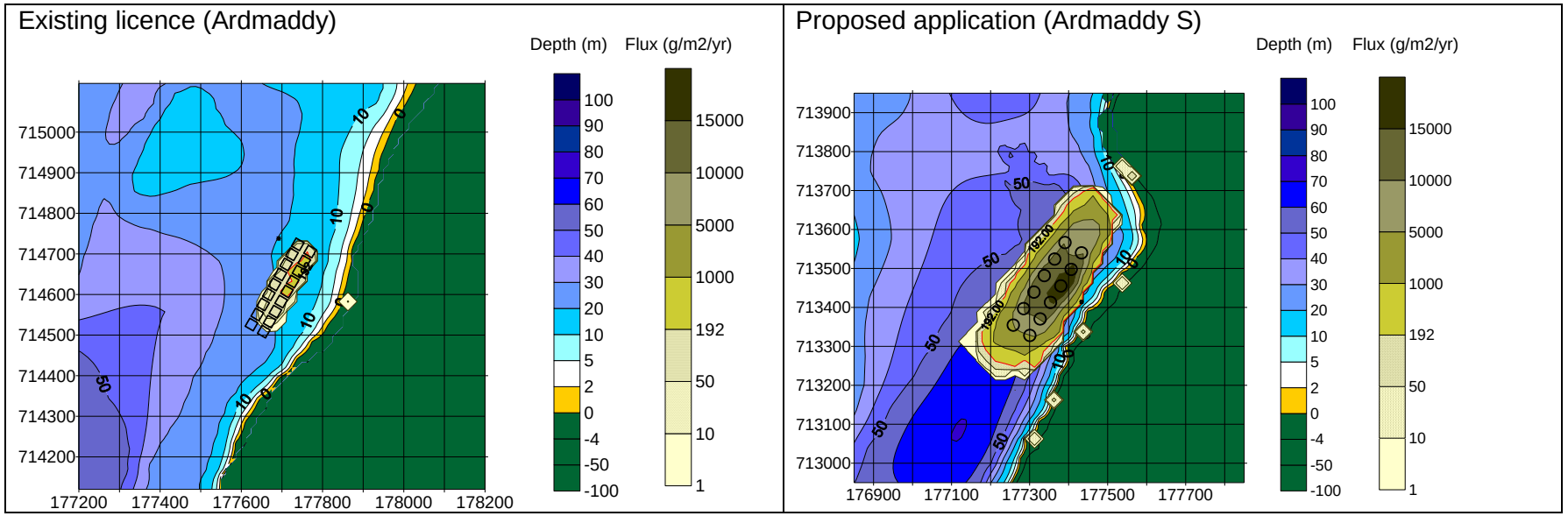
For changes in nutrient levels, MarLIN indicates the habitats CR.LCR.BrAs.AntAsH, CR.LCR.BrAs.NeoPro and CR.MCR.EcCr.CarSp.Bri will have a low sensitivity or are not sensitive, due to a high recoverability and low intolerance. The habitat CR.MCR.EcCr.FaAlCr.Pom will have a moderate sensitivity, due to a high intolerance but high recoverability.

a) Receptor: solids flux smothering

The deposition of waste feed and faecal particles has the potential to smother reef habitat and associated species. SEPA uses the bespoke particle-tracking model AutoDepomod to determine the sea bed deposition footprint of particles leaving the cages and also any re-suspension of deposited material to the wider area.

The modelled output of solids flux around the fish farm cage groups are shown in Figure 2 below. The edge of the Allowable Zone of Effect (AZE) is modelled at 192$gm^{-2}yr^{-1}$, which is equivalent to the 30ITI boundary. This modelling has been produced by the applicant, and subsequently validated, checked and approved by SEPA. More information on the modelling methodology may be found in SEPA's Fish Farm Manual at http://www.sepa.org.uk/water/water_regulation/regimes/aquaculture/marine_aquaculture/fish_farm_manual.aspx

Figure 2. Modelled benthic footprint for solids flux around the Ardmaddy & Ardmaddy S cage groups



The proposed site-specific AZE footprint is larger than existing footprint. This is because the proposed site is located in deeper water with relatively more quiescent conditions. AutoDepomod predicts that approximately 60% of the solids will be exported from the model domain for the proposed site, *cf.* nearly 100% for the existing site. The proposal will result in a 13% increase of solids exported from the modelled domain (see Table 1 below).

Table 1. AutoDepomod predictions of solids exported from the fish farm sites

	Existing site	Proposed site	% increase
Maximum biomass	1300t	2500t	92
Release of solids	530,824kg	1,020,838kg	92
Export	528,859kg	598,930kg	13
% export	100	59	

It is reasonable to assume that the solids which are not exported, will be subject to natural degradation processes within the model domain, and so will not affect the SAC or its features. The amount of solids exported is modelled to increase by 70,071kg/yr, the fate of which will be examined in more detail. This increase represents less than 3% of the total solids exported from all the fish farms within, or near to the SAC boundary, and within Seil

Sound and the Sound of Shuna (i.e. for fish farms at Ardifuir (CAR/L/1021927), Port nan Seannag (Lunga) (CAR/L/1000811), Ardmaddy (CAR/L1010472), Bagh Lachlainn (CAR/L/1025495), Port na Cro (CAR/L/1000810), South West Shuna (CAR/L/1025496), Bagh Dail nan Ceann North & South (CAR/L/1004226), and Shuna Castle Bay (CAR/L/1000801). Note that the two sites in neighbouring Loch Melfort, Eilean Coltair (CAR/L/1000197) and Kames Bay (CAR/L/1000237), have been excluded from the evaluation, due to (i) their distance from the nearest point of the SAC boundary (Kames Bay is 8.1km away, and Eilean Coltair 6.1km), and (ii) their low prospect of increasing the amounts of solids in the wider area as they are in relatively quiescent situations. For example only 0.005% of solids released at Eilean Coltair is expected to be exported from the site.

Natural rates of deposition in the Firth of Lorn SAC have been investigated by Perry (see Perry (2010) Sedimentation in the Firth of Lorn, Marine Special Area of Conservation (Marine Scotland Science report) see http://www.scotland.gov.uk/Resource/Doc/295194/0107877.pdf [accessed 20/3/12]). The results found that natural sedimentation rates ranged from 1–60µl/l, but were more typically 2–13µl/l. The sedimentation rates underneath the fish farm cages (using a flux rate of 10000$gm^{-2}yr^{-1}$)would equate to less than 1% of the lowest rates observed naturally, and that outside the modelled grid (using a flux rate of 1$gm^{-2}yr^{-1}$) would be less than 0.001%. These natural sedimentation rates were measured near the Garvellachs Island groups (Eileach an Naoimh), which is a relatively exposed location, however it does indicate that there are large amounts of suspended sediment being transported naturally within the SAC, and that the hydrographically dynamic environment of the SAC will spread the solids exported from the fish farm widely.

Background concentrations are reported to be 5–10gm^{-3} [Perry 2010 *ibid., see also* Dale, A. C. & T. J. Sherwin (2011) Scallop dredging in the Firth of Lorn Marine SAC: modelling of indirect environmental impacts *Scottish Natural Heritage Commissioned Report* **414**], which compare to the maximum concentrations underneath the cages of 0.01gm^{-3} and outside the modelled grid of 0.000001gm^{-3}. It is interesting to note that a recent investigation into the effects of dredging in the Firth of Lorn SAC, found typical maximum concentrations of 0.1gm^{-3} after one tidal cycle, when the levels of suspended silt in the water column after a simulated dredging event were examined the (Dale & Sherwin 2011).

A report for SARF investigated the exported solids from the fish farms in the Seil Sound and Shuna Sound area (The Fate of Particulate Wastes Arising From Fish Farm Sites (SARF Project 37) see http://www.sarf.org.uk/cms-assets/documents/28813-936945.sarf035---fina1report---nov07.pdf [accessed 20/3/12]). Modelling results from this predicted that 67% of the solids from the Ardmaddy site would enter the SAC via Cuan Sound and 2% via the southern boundary. If the locations of all the fish farms in the SARF study are compared, it can be reasonably assumed that the Ardmaddy and Ardmaddy South sites will be similar to each other in terms of the proportions of solids exported into the SAC. The high current speeds and dynamic environment in the Cuan Sound and Sound of Luing mean that these solids are not likely to settle within the Cuan Sound or its vicinity, but will be transported more widely within the SAC and beyond. This means that, if for instance all the material exported into the SAC is evenly distributed only within the SAC (and not transported further in the Firth of Lorn), the increase in the sedimentation rate would be 0.2$gm^{-2}yr^{-1}$ (using 210km^2 for the area of the SAC). Such an increase in sedimentation in the SAC would represent approximately 0.00001% of the observed background levels.

The SARF study also found that AutoDepomod overestimates the amount of solids exported from the model domain, as it does not account for material which was previously exported but which later returns to the model domain. This provides conservatism to the modelled outcomes, and in

reality, the amounts of solids from the fish farms in the SAC should be less.

Therefore, it can be reasonably concluded that

- the increase in solids exported from the proposed Ardmaddy South site is negligible when compared to the amounts already exported from neighbouring fish farms in the Seil Sound and Sound of Shuna area
- any solids exported into the SAC will be widely distributed, both within the SAC and beyond
- the amounts of solids resulting from fish farms in the SAC are many orders of magnitude below the natural sedimentation rates, and can thus be considered insignificant.

Summary of solids flux impacts

The proposed changes in solids flux may give rise to a likely significant effect. This likely significant effect is due to the predicted export of solids emanating from the proposed fish farm being transported into the Firth of Lorn SAC, through both the Cuan Sound (67%) and the southern boundary (2%).

However, the above assessment leads to the conclusion that the proposal will result in a relatively small (<3%) increase of solids from fish farms in the general area of the SAC. The reported natural sedimentation rates in the SAC are relatively high, and the increase in sedimentation in the SAC, resulting from the proposal, represents 0.00001% of the natural background rates.

The levels of smothering and sedimentation are negligible compared with those used for the MarLIN sensitivity assessments for relevant reef habitats, and the increase in solids flux over the background levels would not be effectively measurable. This combined with the generally dispersive nature of the SAC and beyond, means it is reasonable to conclude that the proposed changes in solids flux will not give rise to a likely significant effect on the SAC designated features.

This means it is reasonable to conclude that any potential impacts due to changes in solids flux on the SAC designated features will be negligible and will not compromise the site's Conservation Objectives. This conclusion is based upon the most up-to-date scientific research, and best available rigorous modelling.

b) Receptor: toxic effects from sea lice treatments

Sea lice medicine residues, both in the water column and in the sediment, have the potential to be toxic to reef habitat and associated species. The principal materials that may affect sea bed fauna are the sea lice bath treatments azamethiphos (trade name Salmosan®), cypermethrin (trade name Excis®) and deltamethrin (trade name AMX®), and the in-feed treatments emamectin benzoate (the active ingredient of Slice®) and teflubenzuron (the active ingredient of Calicide®). These products are licensed by SEPA for use against sea lice infestations on salmon farms. Limits are imposed on the amounts of these products licensed to discharge, and these are calculated using the AutoDepomod model. The limits imposed ensure that the residues arising from amounts of the material used are within SEPA standards set to protect flora and fauna, standards known as Environmental Quality Standards (EQS). These standards are derived from toxicity studies on sensitive organisms, and then a safety factor of between 10 and 100 is then applied.

Hydrogen peroxide (Paramove®, Salartect®) is also licensed for used as a sea lice treatment, however, this quickly breaks down into water and oxygen, and is therefore not considered hazardous to marine organisms.

Cypermethrin concentrations in the water column are virtually non-detectable within an hour of treatment, having no measurable effect on zooplankton, and is thought to have a half life of 35 days in organic marine sediments (2005 SAMS Research Project: PAMP (2005) *The Ecological Effects of Sea Lice Medicines in Scottish Sea Lochs*).

These chemicals are not naturally persistent and break down via hydrolysis and photolysis to non-toxic components, though this may vary under different conditions. For example the half-life of emamectin benzoate in anaerobic sediments is 164–175 days, whereas photolysis is known to accelerate its breakdown and may reduce the half-life to 0.7 days in seawater. The half-life used for AutoDepomod is 250 days, and so is conservative. [see e.g. McHenery, J.G. and C. M. Mackie (1999). Revised expert report on the potential environmental impacts of emamectin benzoate, formulated as Slice®, for salmonids. Cordah Report No.: SCH001R5, Schering-Plough Animal Health (2002) Potential environmental impacts of emamectin benzoate, formulated as Slice ®, for salmonids. Technical Report 36 pp., Bright D. A. and S. Dionne (2005) Use of emamectin benzoate in the Canadian finfish aquaculture industry: a review of environmental fate and effects. UMA Engineering Report for Environment Canada (accessed on 24/2/12) http://dsp-psd.pwgsc.gc.ca/Collection/En4-51-2005E.pdf, SEPA Fish Farm Advisory Group (1999) Emamectin Benzoate An Environmental Risk Assessment. 23 pp.]

Bath treatments

The proposed quantities and those for the existing licence, of bath chemical treatments (azamethiphos, cypermethrin and deltamethrin) are shown in Table 2 (below). The amounts of cypermethrin and deltamethrin are slightly higher than previous licensed (both representing ~50% increase). Note, however, that for azamethiphos, the 3hr discharge limit is not used as it would exceed the 24hr limit, thus there will be a 63% decrease for this particular chemical. The amounts licensed previously also used the Environmental Quality Standards (EQS) determined from modelling. The model takes into account the dispersing plumes and the EQS, and the mixing zone is defined as the lower of 0.5km^2 or 2% of the loch area (for more information on the modelling methodology see SEPA's Fish Farm Manual Annex G at

http://www.sepa.org.uk/water/water_regulation/regimes/aquaculture/marine_aquaculture/fish_farm_manual.aspx). The proposed amount of azamethiphos is significantly less than that for the existing licence, so this proposal will result in a lower risk of potential impact in the SAC. Cypermethrin and deltamethrin are readily bound to particles, and are rapidly removed from the water column. Furthermore, the data from the current meters deployed at the proposed site show that the mixing zone will not be taken directly toward the SAC boundary at Cuan Sound.

Therefore, it is concluded that any potential impacts due bath treatment use within the EQS will be negligible and will not compromise the site's conservation objectives.

Table 2. Quantities of sea lice bath treatments

	Azamethiphos (g)		Cypermethrin (g)	Deltamethrin (g)
	3hr discharge	24hr discharge	3hr discharge	3hr discharge
Proposed (Ardmaddy S—CAR/L/1099909)	324.3	87.5	65.0	24.4
Existing licence (Ardmaddy—CAR/L/1010472)	238.7	236.2	42.8	16.0

In-feed treatments

The proposed quantities and those for the existing licence, of in-feed chemical treatments (emamectin benzoate and teflubenzuron) are shown in Table 3 (below).

Table 3. Quantities of sea lice in-feed treatments

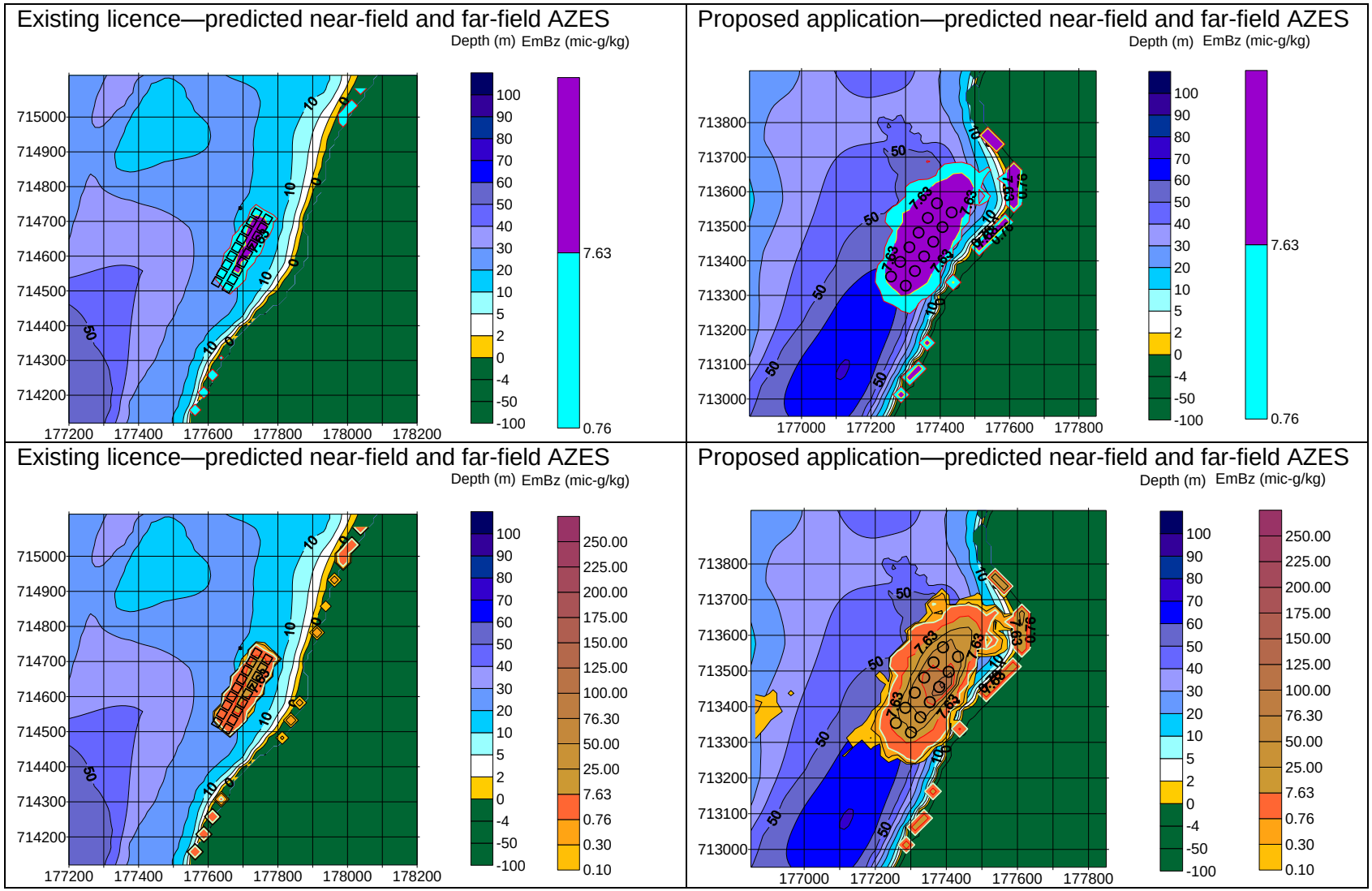
	Emamectin benzoate (g)		Teflubenzuron (g)
	Total Allowable Quantity (TAQ)	Maximum Treatment Quantity (MTQ)	
Proposed (Ardmaddy S—CAR/L/1099909)	1654.1	875.0	1358.0
Existing licence (Ardmaddy—CAR/L/1010472)	1245.5	455.0	1351.1

Emamectin benzoate

The applicant proposes an increase in the amounts of emamectin benzoate licensed (Table 3). The output plots from the model runs for emamectin benzoate in the sediments are included below (Fig. 3). The extent and area of the proposed emamectin benzoate footprint is similar to that of the proposed benthic 30ITI AZE (see Figs. 2, 3).

The far field Environmental Quality Standard (EQS) for emamectin benzoate is set at 100 times less than the toxicity tests thresholds, and the near field at 10 times less. Therefore, there is some considerable degree of safety built in to the modelled footprint at the near and far fields. These toxicity tests have been based on No Observable Effect Concentrations for studies carried out on the most sensitive species such as *Crangon crangon*, *Nephrops norvegicus*, *Corophium volutator*, *Arenicola marina* and planktonic copepods. The model predicts higher emamectin benzoate concentrations in the sediments at the cage edge than the standard of 7.63µg/kg (Fig. 3). This is because the near field area is calculated using 7.63µg/kg as the mean value within it.

Figure 3. Modelled benthic footprints for emamectin benzoate residues in sediments around the Ardmaddy & Ardmaddy S cage groups



For the existing Ardmaddy site, the operator returned actual sediment data for emamectin benzoate residues from samples taken in 2010. The sediments values were 0.4µg/kg and 0.6µg/kg at 100m from the cages and 0.6µg/kg at the cage. These results, and those from previous surveys, are all below the cage edge standard of 7.63µg/kg, and below the far field standard of 0.763µg/kg. The samples were collected at the time of maximum excretion from the fish.

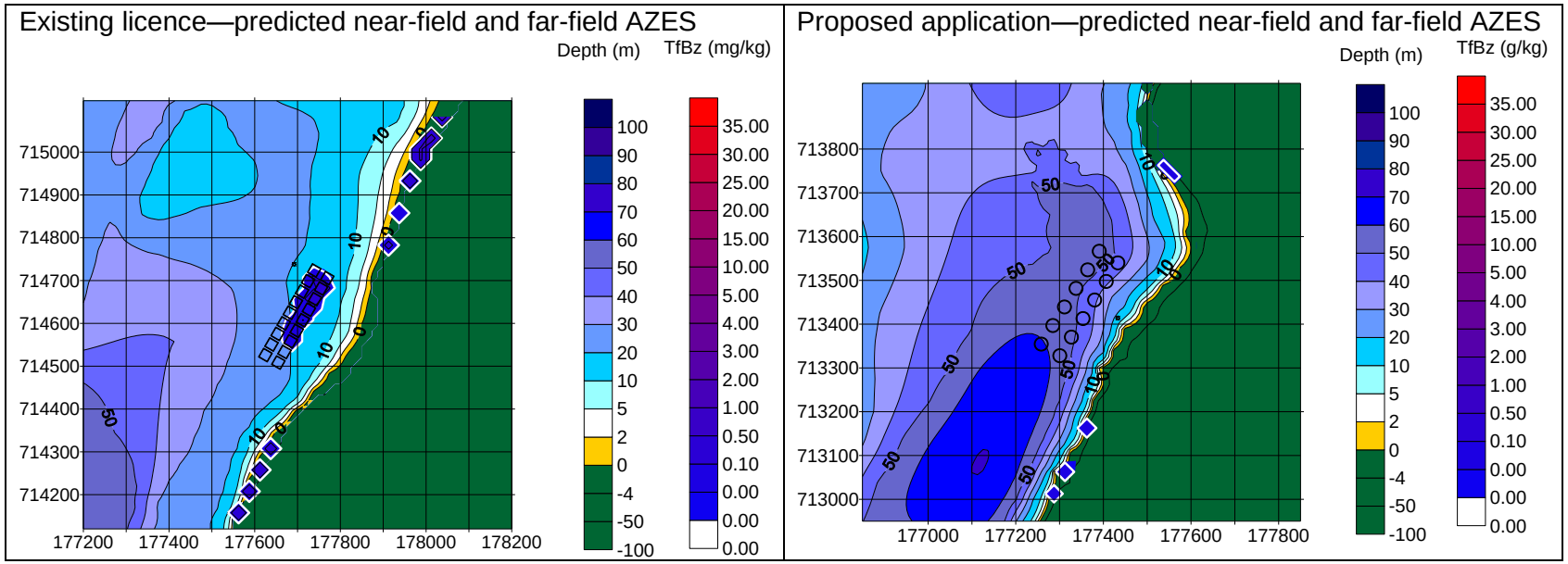
The model permits higher quantities of emamectin benzoate to be used at the proposed Ardmaddy South site due to more residues being retained within the model domain. The licence therefore also limits the amounts of in-feed chemicals according to the amounts exported from the site, and this is assessed for compliance against the far field Environmental Quality Standard (EQS) for 10km^2 (or for 50% of constrained areas) [for more information on the modelling methodology see SEPA's Fish Farm Manual Annex H at http://www.sepa.org.uk/water/water_regulation/regimes/aquaculture/marine_aquaculture/fish_farm_manual.aspx]. A proportion of emamectin benzoate residues will therefore be exported from the model grid, in a similar manner to the solids wastes. An estimated 67% of these residues will be exported into the SAC via the Cuan Sound and 2% via the southern boundary (SARF 37 *ibid*.) and the impact of these residues in the wider SAC will be evaluated in more detail below.

Teflubenzuron

The applicant proposes a very small increase in the amount of teflubenzuron licensed. The output plots from the model runs for teflubenzuron in the sediments are included below (Fig. 4) (for more information on the modelling methodology see SEPA's Fish Farm Manual Annex H at http://www.sepa.org.uk/water/water_regulation/regimes/aquaculture/marine_aquaculture/fish_farm_manual.aspx).

The far field and near field Environmental Quality Standards (EQS) for teflubenzuron are set according to toxicity tests thresholds, in a similar manner to emamectin benzoate, and therefore there is some considerable degree of safety built in to the modelled footprint at the near and far fields. These toxicity tests have been based on No Observable Effect Concentrations for studies carried out on the most sensitive species such as *Crangon crangon*, *Nephrops norvegicus*, *Corophium volutator*, *Arenicola marina* and planktonic copepods. The cage edge standard is 10mg/kg, and the far field standard 2mg/kg.

Figure 4. Modelled benthic footprints for teflubenzuron residues in sediments around the Ardmaddy & Ardmaddy S cage groups



Due to the export of residues from the site, similarly to emamectin benzoate, the model limits the amount of teflubenzuron at both the proposed and existing sites. This means the equivalent treatable biomass is 19.3t for Ardmaddy and 19.4t for Ardmaddy South. The amount of teflubenzuron licensed is therefore not practical for treating the fish, and so it has not been used historically at the Ardmaddy site. No sediment data for teflubenzuron residues is therefore available. As only 19.4t of stock can be treated with teflubenzuron at the proposed Ardmaddy South site, its use here is not expected either.

It is therefore reasonable to conclude that there will be no significant impacts in the SAC due to the licensed amounts of teflubenzuron. However, teflubenzuron residues will be exported from the model grid, in a similar manner to the solids wastes and emamectin benzoate, and the impact of this in the wider SAC will be evaluated in more detail below.

Fate of sea lice in-feed residues in the SAC

The changes in the amounts of in-feed sea lice chemicals which will be exported from the modelled grid are shown in Table 4 (below).

Table 4. AutoDepomod predictions of in-feed residues exported from the fish farm sites

	Emamectin benzoate	Teflubenzuron
Export from Ardmaddy	921.7g	1216.0g
Export from Ardmaddy S	929.0g	1220.2g
Increase in export	7.3g	4.2g
Increase in export	0.8%	0.3%

It can be seen that the relative increase is very small, and below a statistical significance level of 1%. Such a minor change is within the margins of error e.g. for sampling, analysis, and the model.

These exported residues may be transported into the SAC, in a similar way to the solids residues. As the licensed quantities for teflubenzuron are too small to allow an effective treatment of the stocked fish, only the fate of the emamectin benzoate residues will be evaluated further. It can be seen that these amounts are very small, and if these increased amounts of emamectin benzoate were spread evenly in the SAC, this would represent 0.03% of the far field Environmental Quality Standard (EQS) (see Table 5).

Table 5. Fate of emamectin benzoate residues exported into the SAC

	Ardmaddy (existing licence)	Ardmaddy South (proposal)	Increase
Export to SAC[i]	636g	641g	5g
Distribution in SAC[ii]	3.03µg/m^2	3.05µg/m^2	0.02µg/m^2
Proportion of far field EQS[iii]	3.29%	3.31%	0.03%

[i] Proportion exported to the SAC is calculated as 69% as per SARF report (The Fate of Particulate Wastes Arising From Fish Farm Sites (SARF Project 37) see http://www.sarf.org.uk/cms-assets/documents/28813-936945.sarf035---fina1report---nov07.pdf [accessed 20/3/12]). Modelling results from this predicted that 67% of the solids from the Ardmaddy site would enter the SAC via Cuan Sound and 2% via the southern boundary.

[ii] This assumes all residues are retained in the SAC and not distributed further: due to the strong currents in the Sound of Cuan and Sound of Luing, combined with the low settling rates of the suspended particles reaching the SAC, mean the residues will be distributed widely and thus fairly evenly distributed in the SAC. (This is conservative as it is likely the residues will be distributed beyond the SAC).

[iii] The far field Environmental Quality Standard (EQS) is 0.763µg/kg

It is also important to consider the decay of emamectin benzoate residues and metabolites. The half-life in anaerobic sediments is 164–175 days, but may be as low as 0.7 days in seawater. A recent SEPA survey found a half-life of 58–93 days for emamectin benzoate, and no metabolites in the

	sediments—the metabolites appeared to break down even faster. The half-life used for AutoDepomod is 250 days, and so is conservative, therefore, in reality, the amounts in SAC will be significantly less than those calculated above. **Summary of sea lice treatment impacts** The proposed changes in the use of licensed sea lice treatments may give rise to a likely significant effect. The MarLIN sensitivity assessments do not examine the effects of specific sea lice treatments on reefs, but tests on the most sensitive taxa have been used to determine the Environmental Quality Standards (EQS). For bath treatments, the likely significant effect is due to the treatment plumes dispersing from the proposed fish farm and being transported into the Firth of Lorn SAC, mainly through the Cuan Sound. However, the modelling indicates that the dispersal plumes are not taken directly toward the SAC, and therefore the 0.5km^2 mixing zone will not extend into the SAC. This means that bath treatment levels within the SAC will all be below the Environmental Quality Standards (EQS). This combined with the generally dispersive nature of the SAC and beyond, allows the above assessment to lead to the conclusion that the proposed changes in licensed bath treatments will not give rise to a likely significant effect on the SAC designated features. For in-feed treatments, the likely significant effect is due to the predicted export of sea lice treatment residues emanating from the proposed fish farm, being exported into the Firth of Lorn SAC, through both the Cuan Sound (67%) and the southern boundary (2%). However, the above assessment leads to the conclusion that the proposal will result in a very small (<1%) increase of sea lice residues. This amount is not statistically significant (at the 1% or 5% levels), and is well within the margins of error for sampling, analysis and the model. Furthermore, the increase in the SAC is equivalent to 0.03% of the far field Environmental Quality Standard (EQS) of 0.763µg/kg. Such an increase is not effectively measurable, and this combined with the generally dispersive nature of the SAC and beyond, means it is reasonable to conclude that the proposed changes in sea lice treatments will not give rise to a likely significant effect on the SAC designated features. This means it is reasonable to conclude that any potential impacts due to the use of licensed sea lice treatments will be negligible and will not compromise the site's Conservation Objectives. This conclusion is based upon the most up-to-date scientific research, and best available rigorous modelling.
6	**Identify any likely direct, indirect or secondary impacts of the project, in combination with other plans or projects, on the SAC/SPA.**
	c) Receptor: cumulative effects Cumulative effects due to an increased biomass on the water quality and nutrient status may occur. Currently the sole means of determining carrying capacity for fish farms in a waterbody is by use of the Locational Guidelines. The existing Ardmaddy and proposed Ardmaddy South fish farm sites are not within a SEERAD Category area. This means the area has sufficient flushing to dilute and disperse the chemicals released from the fish farms such that, taken in combination, they do not breach Environmental Quality Standards (EQS). Any changes to cumulative effects due to the proposal

	are therefore considered negligible.
7	**Identify standard conditions within the authorisation, or other conditions agreed with the applicant, which will remove the risk of likely significant effects listed above.**
	The CAR licence for the fish farm contains site-specific numeric limits for the maximum biomass such that the solids flux will not be predicted to exceed the modelled Environmental Quality Standards (EQS). Environmental monitoring is built into the licence and enforcement action is taken if these are exceeded. The CAR licence also contains site-specific numeric limits for sea lice treatments such that their authorised use will not be predicted to exceed EQS. Environmental monitoring built into the licence will pick up residues of treatments and enforcement action is taken if these are exceeded.
8	**List any remaining likely significant effects, or identify those for which it is not possible to determine that there is no likely significant effect.**
Conclusion of assessment of likely significant effect	
9	**Is the plan/project likely to have a significant effect on the SAC/SPA, either alone or in combination, with other plans or projects?**
	No
Appropriate Assessment	
10	**Identify the relevant conservation objectives to consider for the SAC/SPA.**
	The Annex I habitat of the Firth of Lorn SAC which will be affected by marine fish farm operations is reefs. The relevant conservation objectives are: To avoid deterioration of the Annex I habitat (reefs) thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the habitats; and To ensure for the Annex I habitat (reefs) that the following are maintained in the long term: • distribution of the habitat within site • structure and function of the habitat

	• processes supporting the habitat • distribution of typical species of the habitat • viability of typical species as components of the habitat • no significant disturbance of typical species of the habitat.
11	**Identify any enforceable conditions agreed with the applicant, which will remove the risk of likely significant effect from the elements of the project listed above.**
	The numeric conditions placed within SEPA's CAR licences are robust and enforceable. SEPA will act upon evidence and data suggesting that numeric limits have been breached. These limits are not negotiable with the applicant as they are there to protect the environment, and their thresholds are set to protect the most sensitive fauna using a well-tried and tested process of Environmental Quality Standards (EQS) setting and additional inbuilt safety factors. SEPA believes that the above will provide appropriate mitigation to help avoid impacts on the site's integrity with respect to its conservation objectives.
12	**List any remaining likely significant effects, or identify those for which it is not possible to determine that there is no likely significant effect.**
Conclusion of Appropriate Assessment	
13	**Can it be ascertained beyond reasonable scientific doubt that the proposal will not adversely affect the integrity of the SAC/SPA?**
	The conclusion of the assessment of likely significant effect is that there will be no likely significant effect. However, SNH have advised that an appropriate assessment should be undertaken as part of this Habitats Regulations appraisal, and this should consider each of the relevant conservation objectives, justifying why each is maintained. • Distribution of the habitat within site: The proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective. The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective. The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field

	Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective. • Structure and function of the habitat: the proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective. The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective. The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective. • Processes supporting the habitat: the proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective. The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective. The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective. • Distribution of typical species of the habitat: the proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective. The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective. The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective. • Viability of typical species as components of the habitat: the proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling,

and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective.
The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective.
The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective.

- No significant disturbance of typical species of the habitat: the proposal will result in changes in solids flux in the SAC of 3% of the total due to fish farms, and 0.0001% of the natural background rates. These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of smothering are not expected to affect this conservation objective.
  The proposed use of sea lice bath treatments will not result in any exceedance of the Environmental Quality Standards (EQS) in the SAC. The modelling indicates that the dispersal plumes will not extend into the SAC, and thus the effects of bath treatments are not expected to affect this conservation objective.
  The proposal will result in changes in sea lice treatment residues in the SAC of amounts of <1%, which equates to 0.03% of the far field Environmental Quality Standard (EQS). These changes are within the margins of error for sampling, analysis and modelling, and are not effectively measurable. Thus the effects of sea lice medicines are not expected to affect this conservation objective.

Therefore the distance of the site to the SAC boundary, and any potential designated features, in combination with the proposed changes in solids flux, chemical treatments and cumulative nutrient enhancement (as evaluated above), lead to the conclusion:

there will be no adverse effect on the SAC site integrity.

As a competent authority, SEPA has undertaken a Habitats Regulations appraisal and appropriate assessment. This assessment has been based on high-quality and extensive scientific data, and uses the latest available information. A rigorous scientific conclusion may therefore be reached.

Therefore, in the view of SEPA, and in consultation with SNH, impacts from solids flux, sea lice treatments and nutrients are calculable and will not have an adverse effect on the SAC features or conservation interests of the site.