

# Project memo

## EIF calculation for treated sea water discharge for Johan Castberg.

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**DATE**  
2017-02-22

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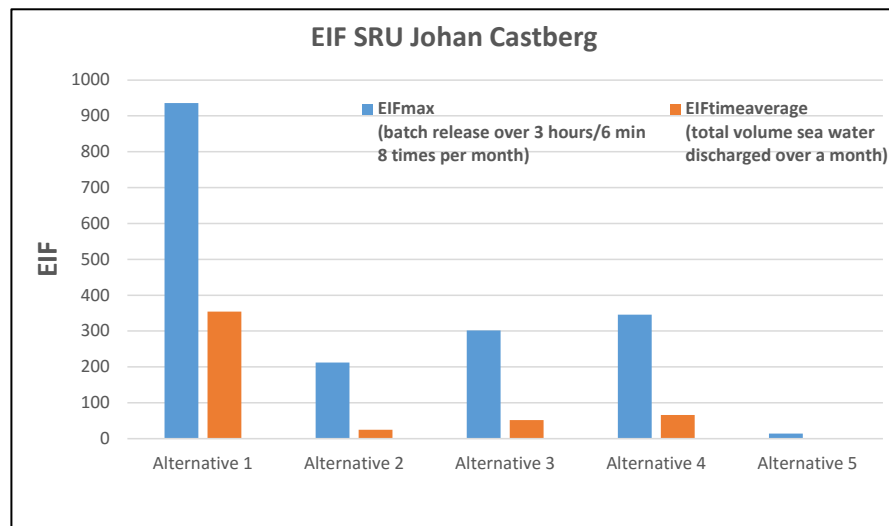
**CLIENTS REF.**  
Rune Weltzien

**PROJECT NO.**  
302002238

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**ABSTRACT**

EIF calculations for biocid treatment of SRU with different discharge alternatives has been calculated for Johan Castberg.



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Restricted

# Document history

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VERSION	DATE	VERSION DESCRIPTION
1.0	2017-02-22	Draft report

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## 1 Input data

### 1.1 Field data

Johan Castberg is located in the Barents Sea. EIF simulations for a single discharge point for treated sea water at the following position has been calculated:

72° 30' 15.122'' N and 20° 15' 46.789'' E.

The discharge depth is set to 20 m below sea surface.

### 1.2 Cases for EIF calculations

For this study EIF has been calculated for the different alternative scenarios that are listed below:

- Alternative 1: Online treatment - SRU full capacity;
- Alternative 2: Online treatment - Average capacity years 2032-2052 P50 JC, 95% PWRI;
- Alternative 3: Online treatment - Average capacity years 2032-2052 P50 JC+P50 Real option, 95% PWRI;
- Alternative 4: Online treatment - Average capacity years 2032-2052 P50 JC, 80% PWRI;
- Alternative 5: Offline treatment

Alternative 1 represents the maximum discharge of treated seawater at an early production phase when PWRI is low.

Alternative 5 represents the minimum potential discharge of treated seawater from an offline biocide treatment scenario.

Alternative 2 – 4 represents discharge of treated seawater at PWRI plateau for various produced water profiles.

### 1.3 Input data for the alternatives

The input data for all treated sea water discharge alternatives for Johan Castberg is presented in Table 1.1.

EIF simulations for online biocide treatment of SRU 8 times per month with a duration of 3 hours per treatment has been calculated. For calculation of EIF max the total volume of sea water discharged per treatment has been used over a period of 3 hours.

For Alternative 5, offline biocide treatment of SRU 8 times per month with a duration of only 6 min per treatment has been calculated.

The alternatives representing EIF max is based on batch release with duration 3 hours/6 min per treatment 8 times per month and the total volume of sea water discharged per treatment has been used.

For the alternatives representing EIF time average the total volume of sea water discharged over a month has been used. All alternatives has been simulated over 30 days.

Table 1.1 Input data for all treated sea water discharge alternatives for Johan Castberg.

	Total seawater per treatment to sea (Sm <sup>3</sup> )	Duration (h)	Number of treatments per month	Total seawater per month to sea (Sm <sup>3</sup> )
<b>Alternative 1</b>	1425	3	8	11368
<b>Alternative 2</b>	297	3	8	2376
<b>Alternative 3</b>	437	3	8	3492
<b>Alternative 4</b>	500	3	8	3996
<b>Alternative 5 (Offline)</b>	20	6 min	8	160

## 1.4 Water composition

With reference to similar EIF simulations in June 2015 for biocide treatment of SRU at Heidrun, the contribution from the active component in the biocide to EIF is expected to be 99-100%. Therefore this component will be the only considered in the EIF simulations for biocid treated seawater from the SRU at Johan Castberg.

It is planned to use following types of chemicals in the SRU at Johan Castberg:

- Scale inhibitor
- Chlorine scavanger
- Biocide

Input to the EIF simulations is only given for the active biocide component. The input can be seen in Table 1.2 below:

Table 1.2 Chemicals and their eco-toxicological properties used for EIF simulations.

Chemical code	Concentration (mg/L)	Bioaccum. LogPow	Biodegradation % 28 day	K-factor	PNEC ppb, norm EC50/1000	Weighting
Bio 10 KI	20	0.78	55	0.0285	0.106	1

## 2 Results of EIF max for Johan Castberg chemical release

The total volum of sea water per treatment has been used for the calculations.

Table 2.1 Table showing maximum EIF for the water column Alternative 1.

Computed max. EIF:	936							
Time averaged EIF:	229							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		11799						
Bio 10 KI			20	0.106	100	935.7688	1	229

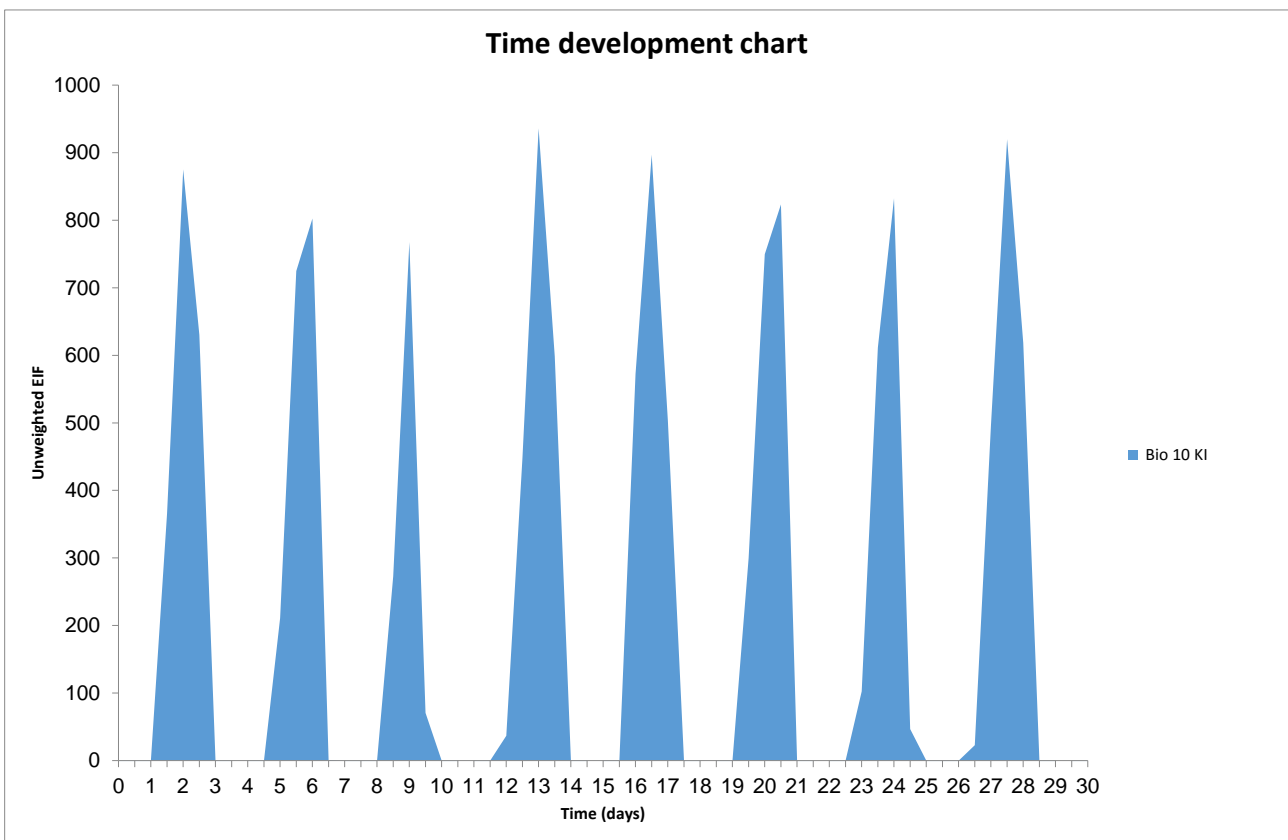


Figure 2.1 Time development of the 3 hours treatment 8 times per month.

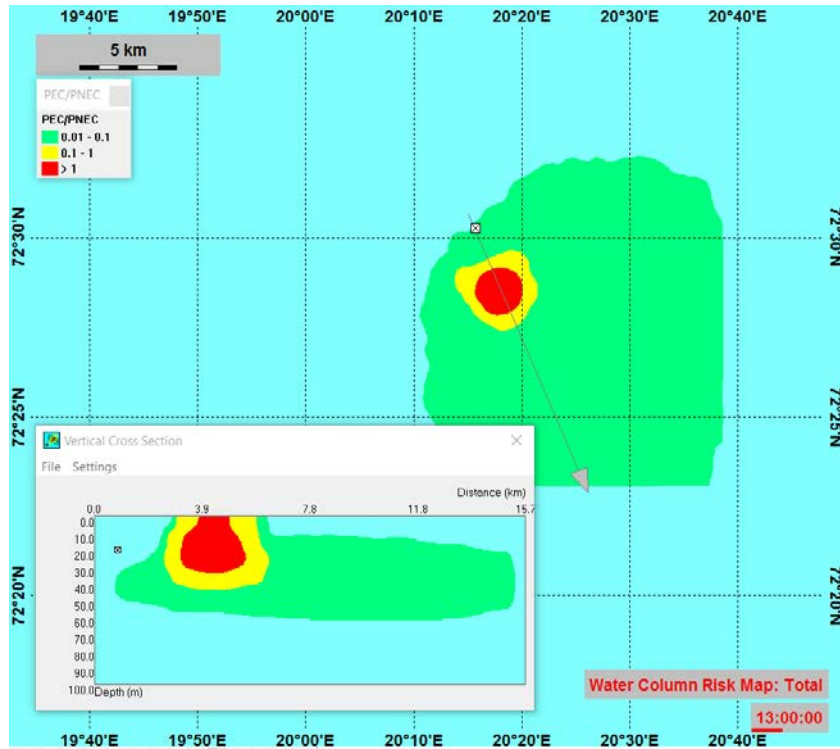


Figure 2.2 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-1.

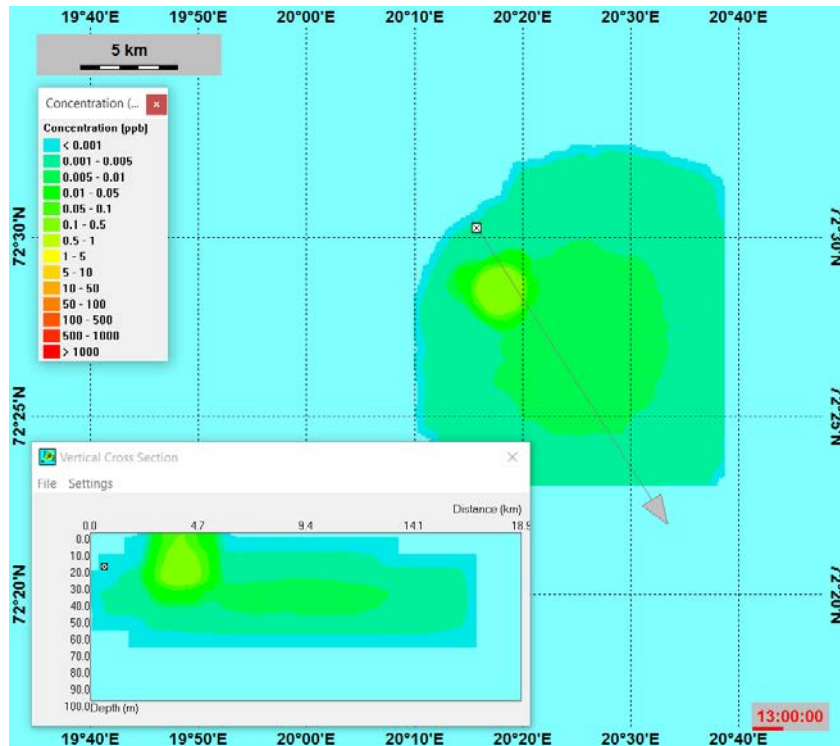


Figure 2.3 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-1.

Table 2.2 Table showing maximum EIF for the water column Alternative 2.

Computed max. EIF:	212							
Time averaged EIF:	30							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		2459						
Bio 10 KI			20	0.106	100	212.0412	1	30

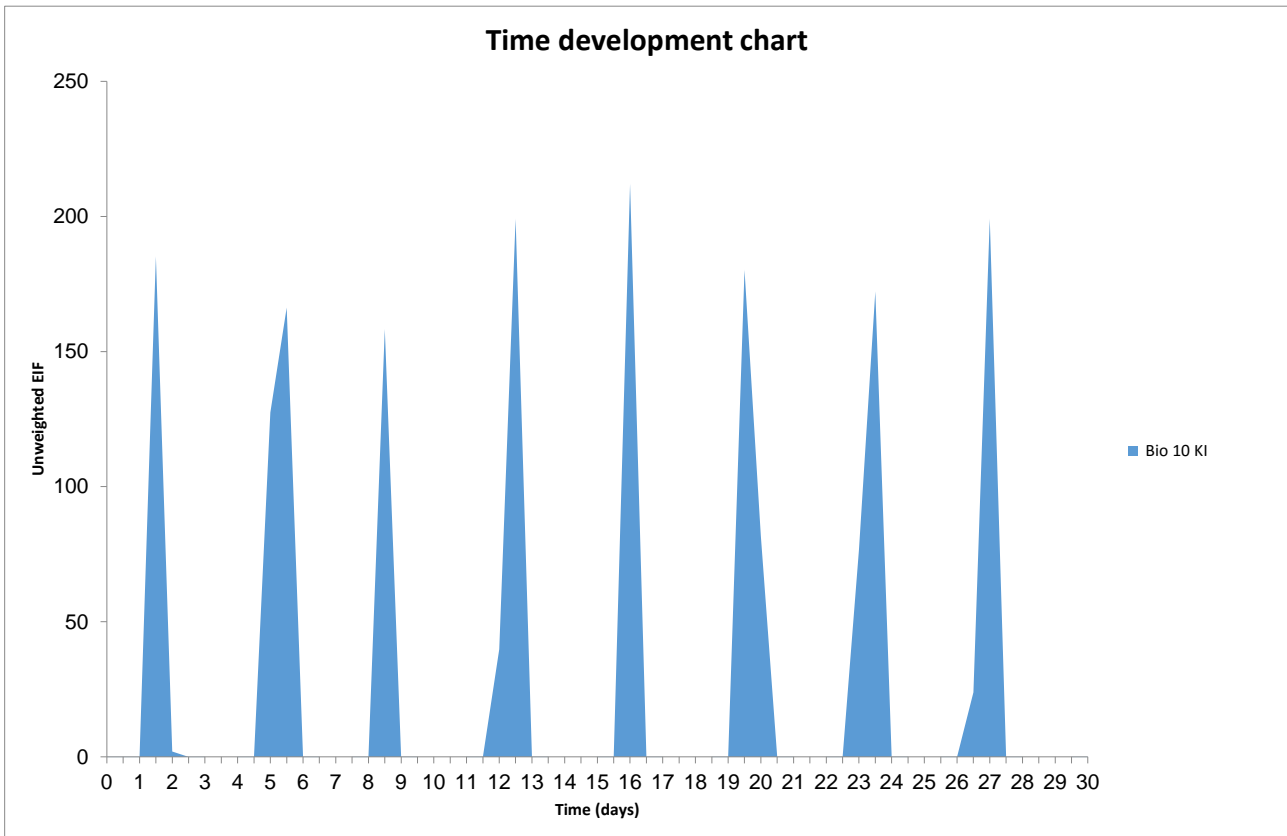


Figure 2.4 Time development of the 3 hours treatment 8 times per month.

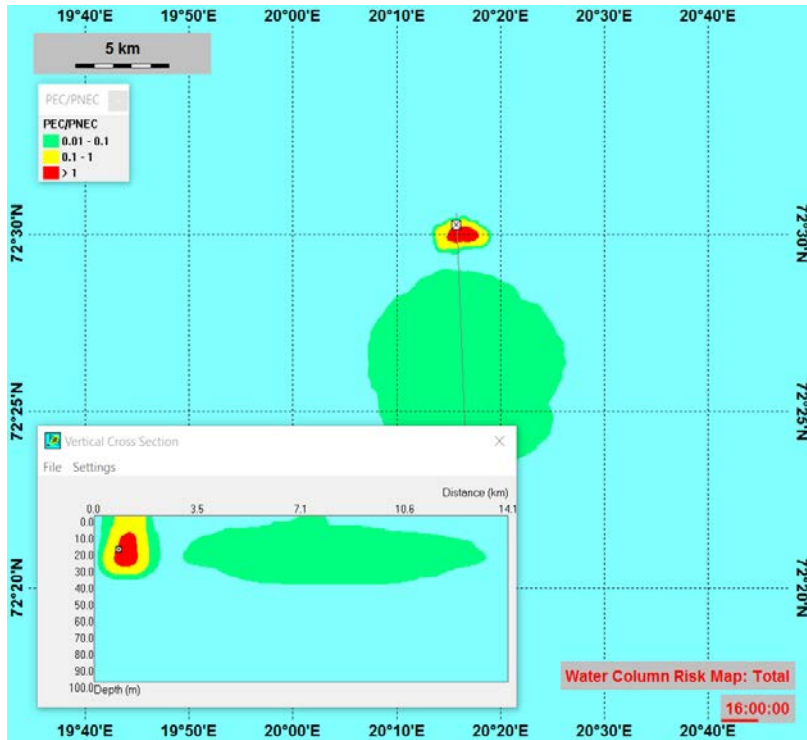


Figure 2.5 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-2.

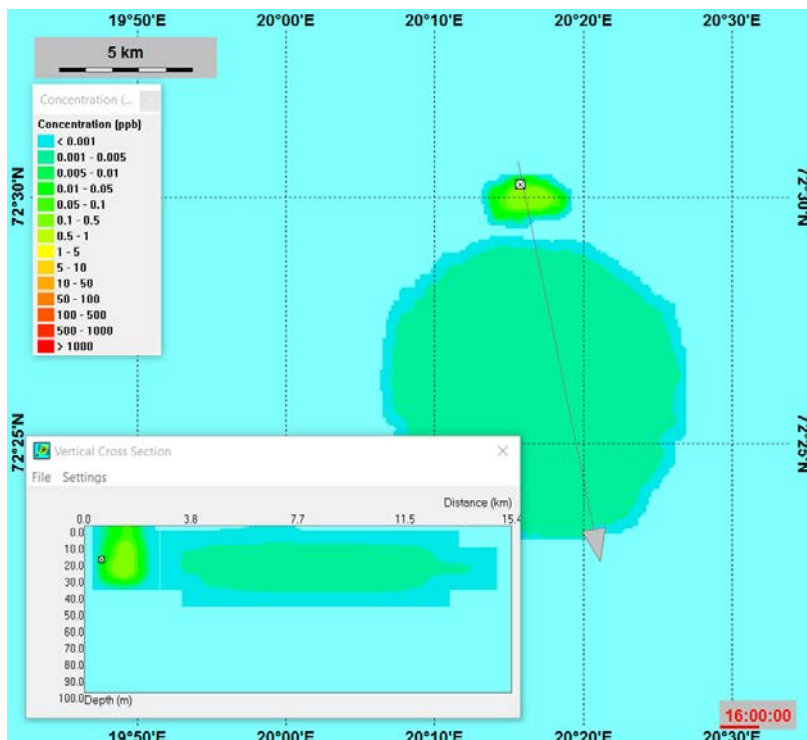


Figure 2.6 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-2.

Table 2.3 Table showing maximum EIF for the water column Alternative 3.

<b>Computed max. EIF:</b>	<b>302</b>							
Time averaged EIF:	51							
<b>Components</b>	<b>Product</b>	<b>Rel.Tons/day</b>	<b>Concentration ppm</b>	<b>PNEC ppb</b>	<b>Contribution to risk</b>	<b>Contribution max EIF</b>	<b>Weight</b>	<b>Contribution time averaged EIF</b>
Total		3618						
Bio 10 KI			20	0.106	100	301.6361	1	51

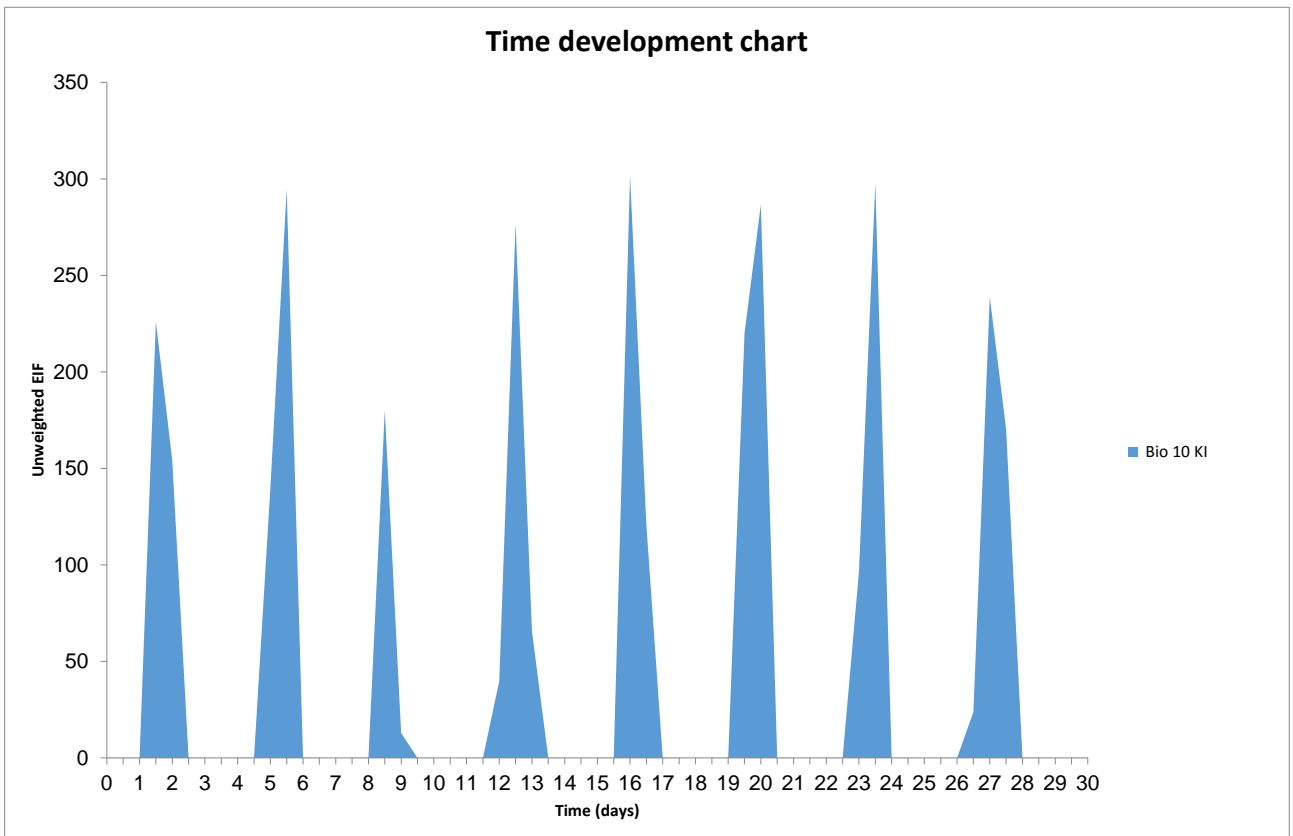


Figure 2.7 Time development of the 3 hours treatment 8 times per month.

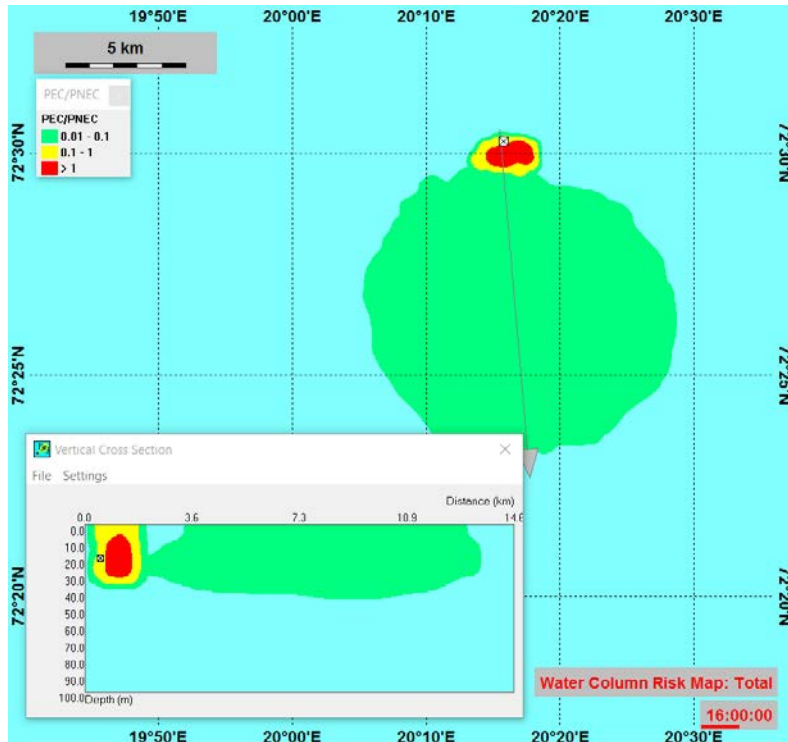


Figure 2.8 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-3.

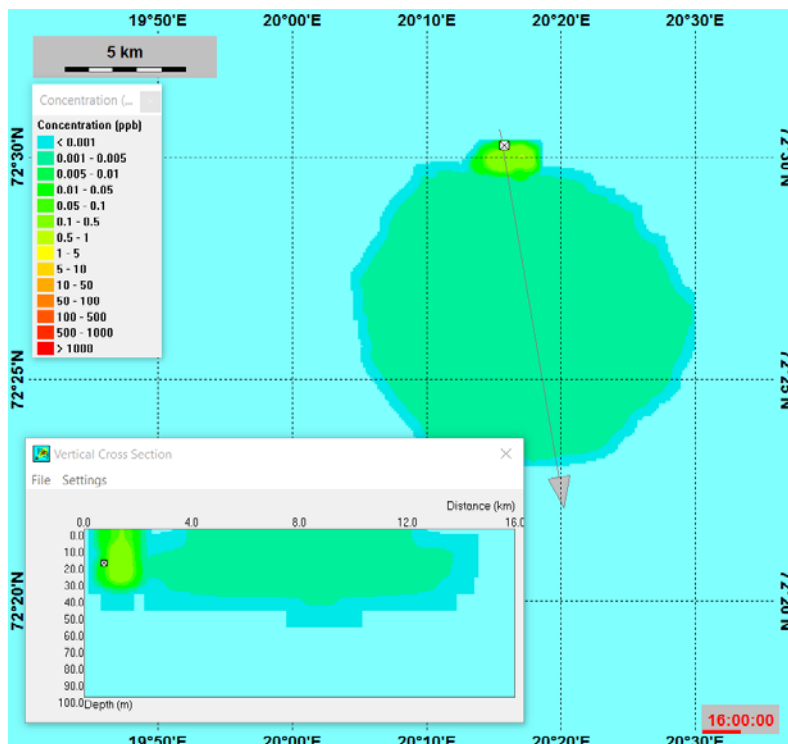


Figure 2.9 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-3.

Table 2.4 Table showing maximum EIF for the water column Alternative 4.

<b>Computed max. EIF:</b>	<b>346</b>							
Time averaged EIF:	58							
<b>Components</b>	<b>Product</b>	<b>Rel.Tons/day</b>	<b>Concentration ppm</b>	<b>PNEC ppb</b>	<b>Contribution to risk</b>	<b>Contribution max EIF</b>	<b>Weight</b>	<b>Contribution time averaged EIF</b>
Total		4140						
Bio 10 KI			20	0.106	100	346.4336	1	58

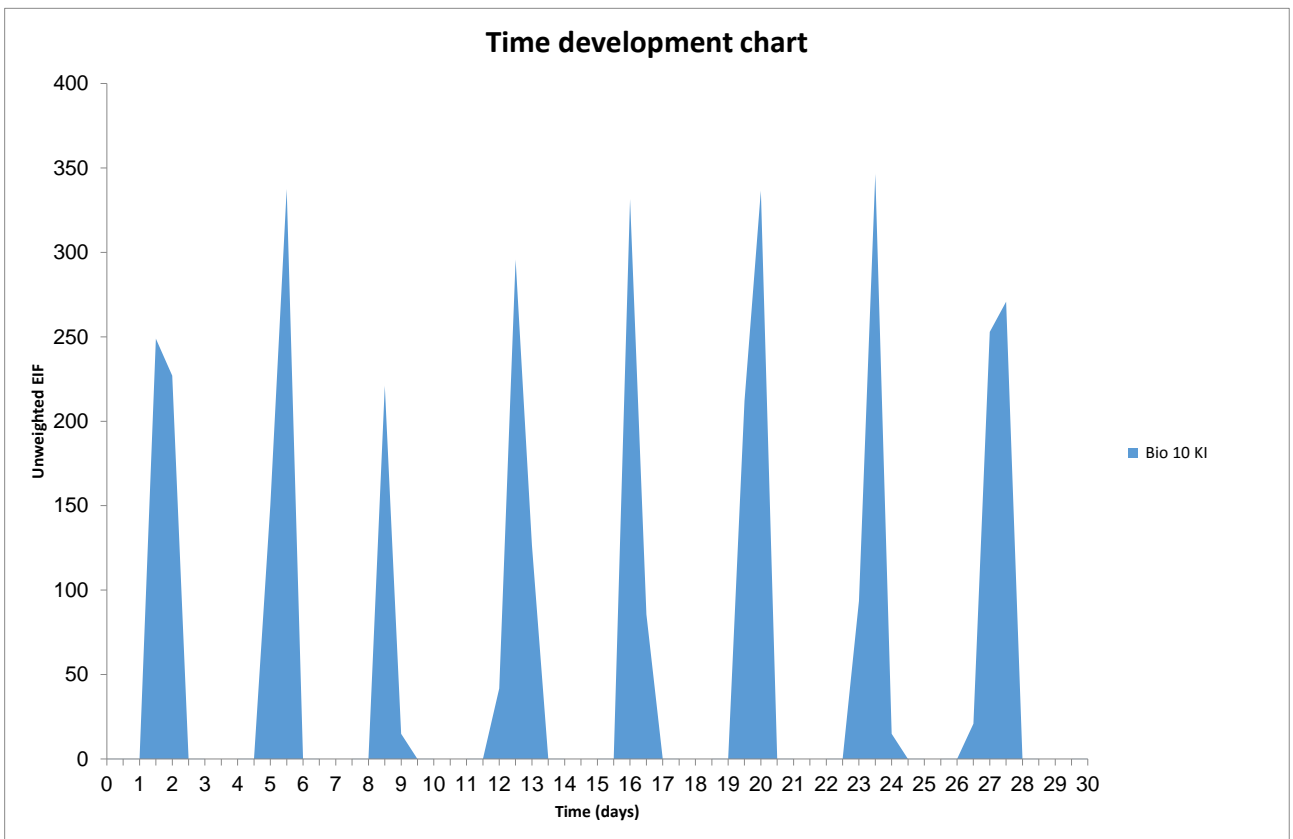


Figure 2.10 Time development of the 3 hours treatment 8 times per month.

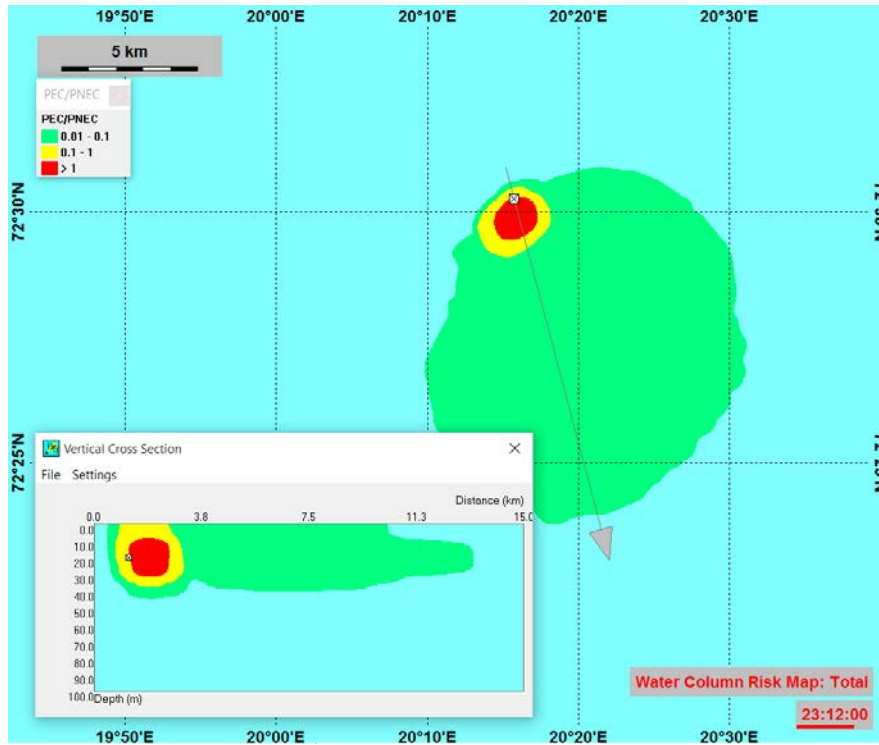


Figure 2.11 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-4.

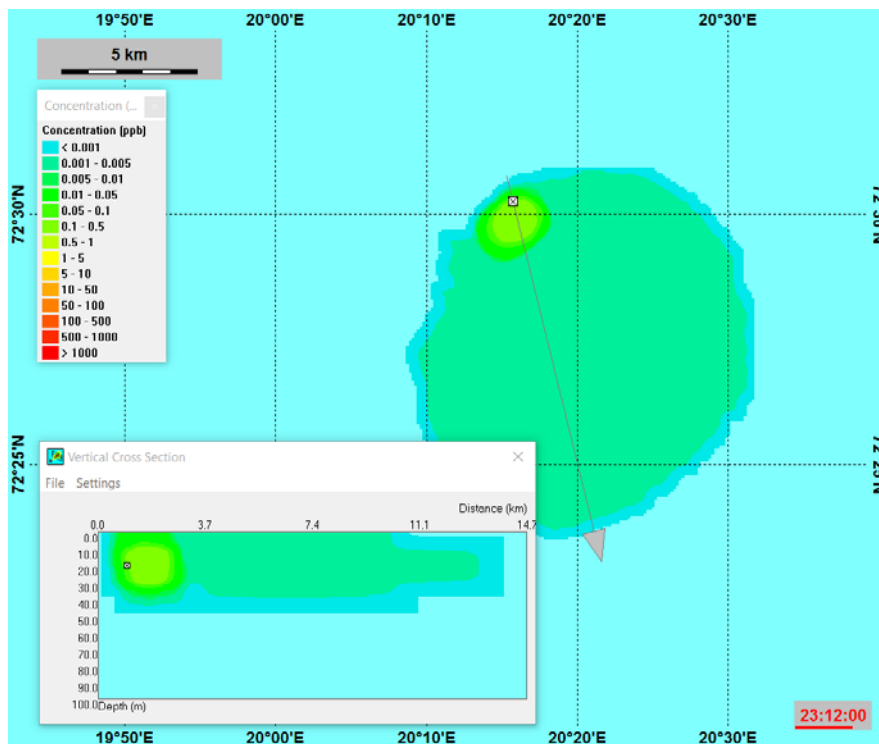


Figure 2.12 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-4.

Table 2.5 Table showing maximum EIF for the water column Alternative 5.

Computed max. EIF:	14							
Time averaged EIF:	0.5							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		4968						
Bio 10 KI			20	0.106	100	13.937	1	0.5

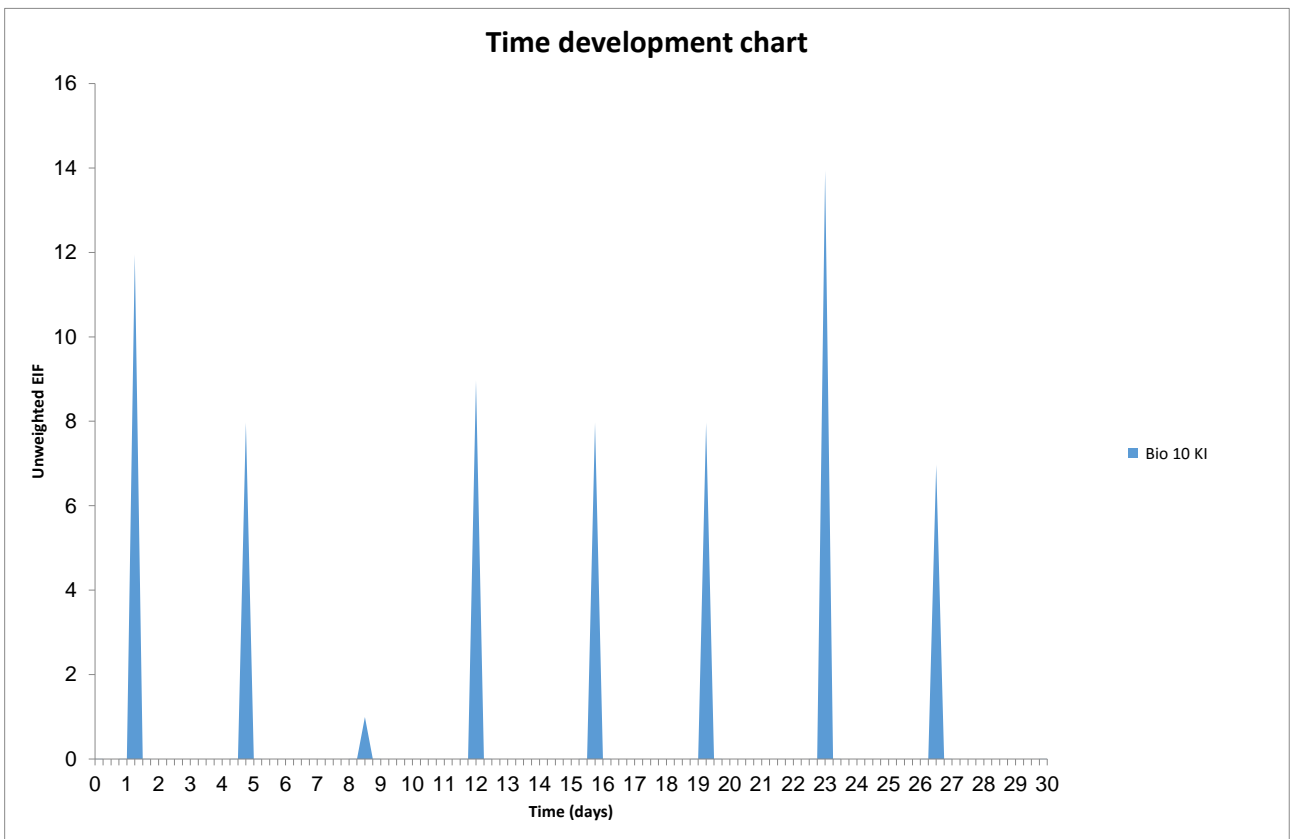


Figure 2.13 Time development of the 6 minutes treatment 8 times per month.

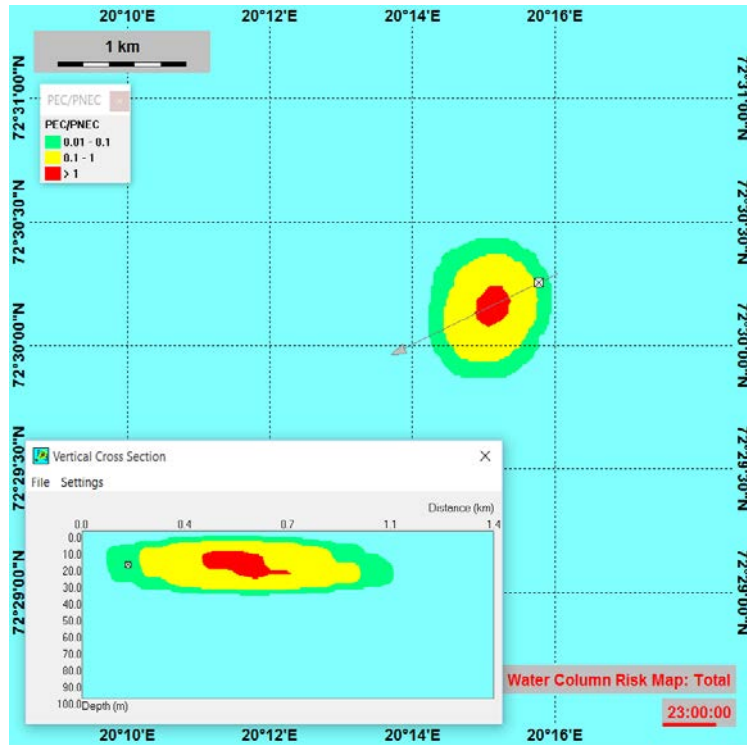


Figure 2.14 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-5.

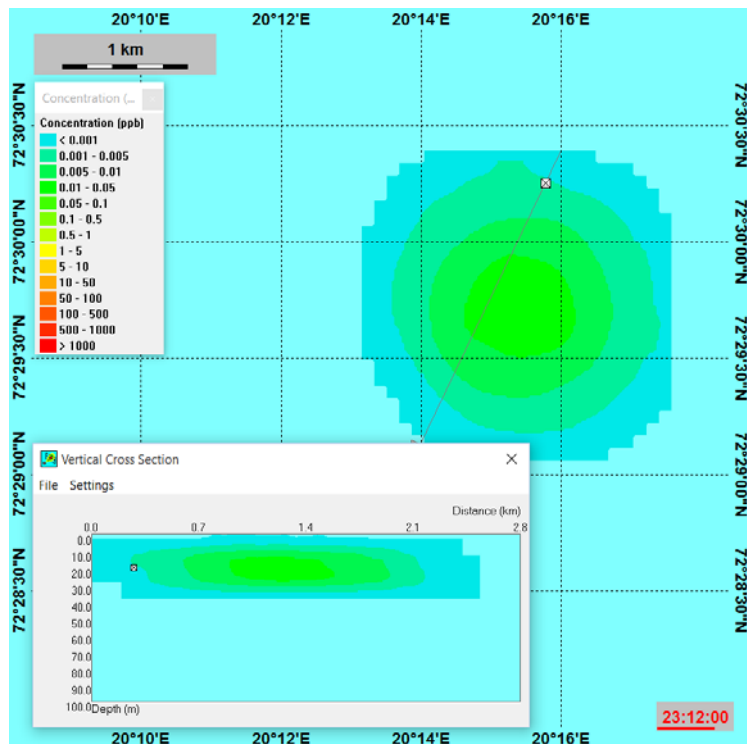
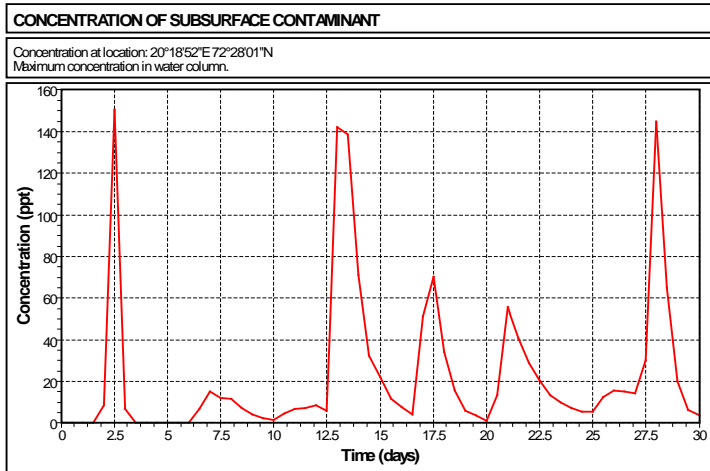


Figure 2.15 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-5.

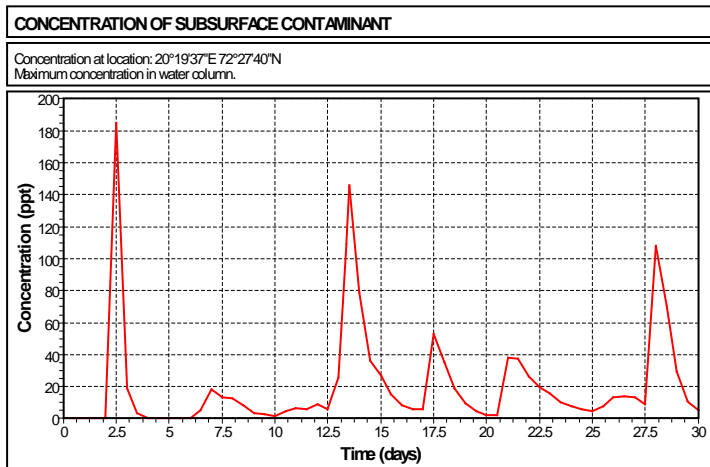
## 2.1 Concentration profiles for EIF max alternatives (batch release with duration 3 hours/6 min per treatment 8 times per month)

The concentration profiles of biocide is taken from the outer edge for each PEC/PNEC interval at the time step with maximum risk, point 1 = PEC/PNEC > 1, point 2 = PEC/PNEC 0.1-1, point 3 = PEC/PNEC 0.01-0.1, and gives the concentration at that point during 30 days simulation.

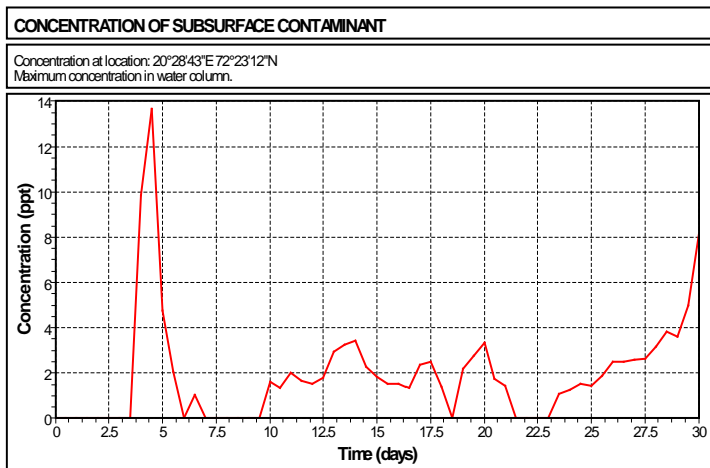
### Alternative 1, Point 1



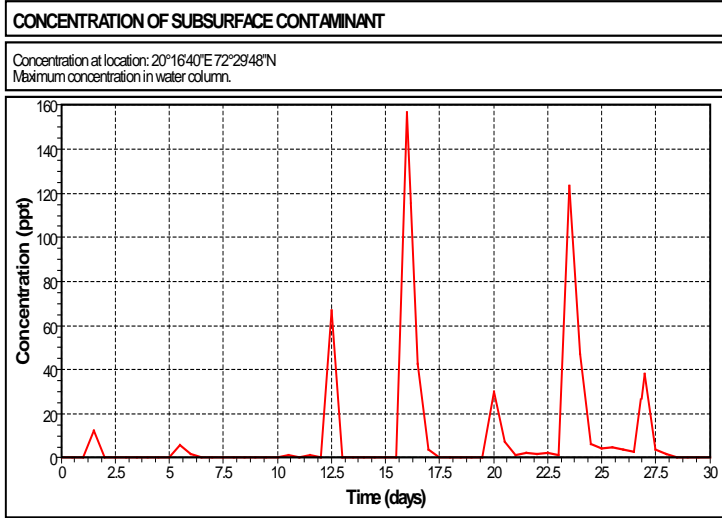
### Point 2



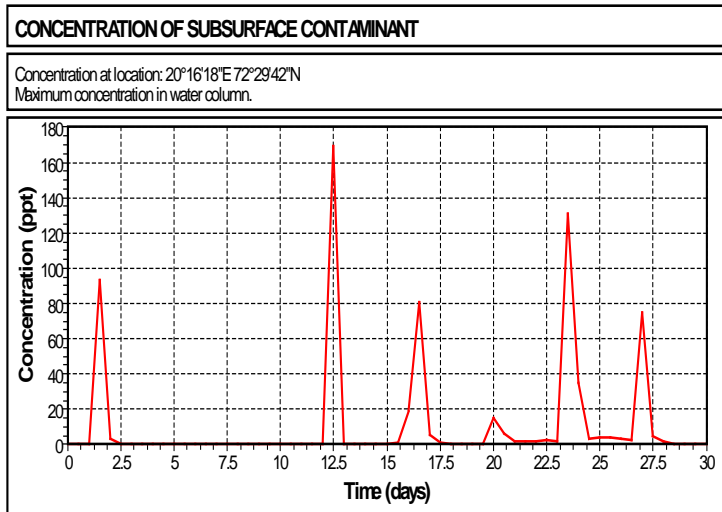
### Point 3



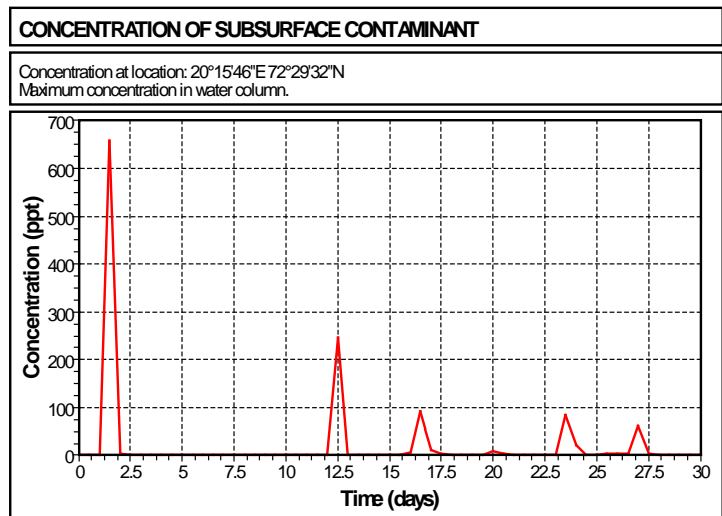
### Alternative 2, Point 1



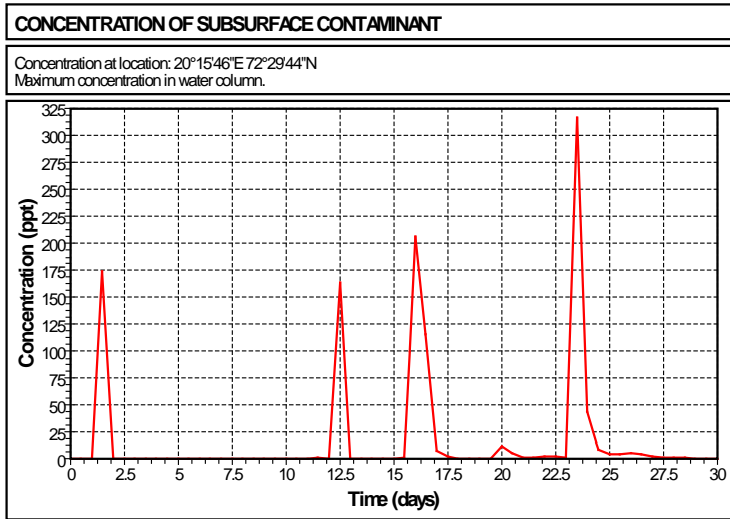
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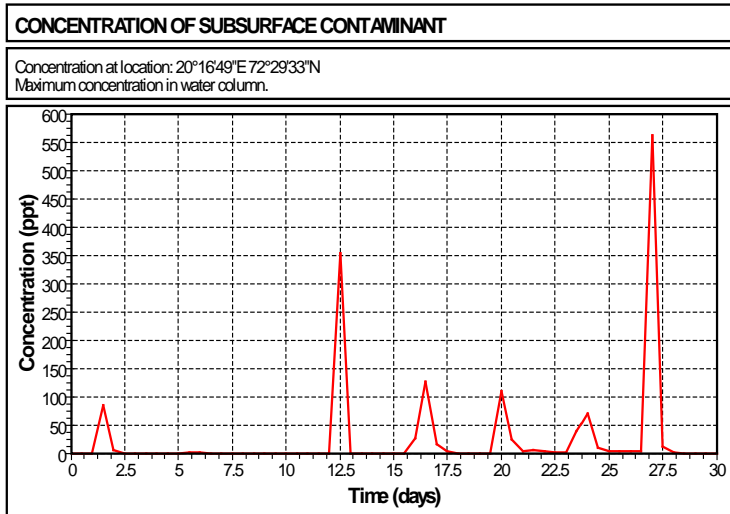
### Point 3



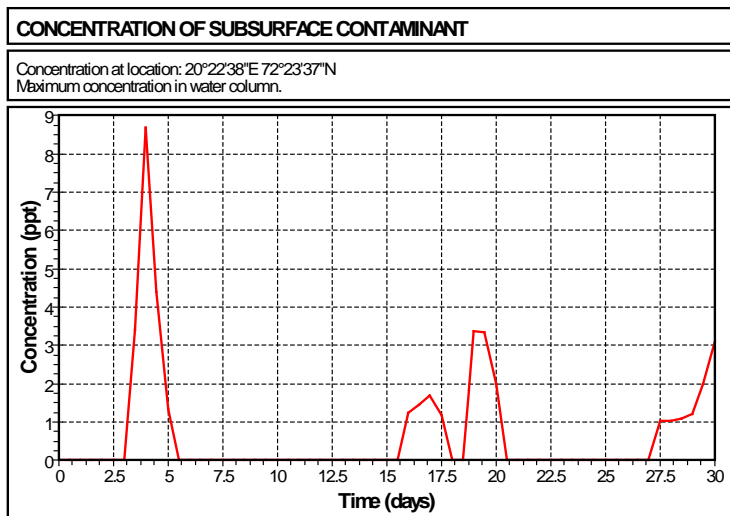
### Alternative 3, Point 1

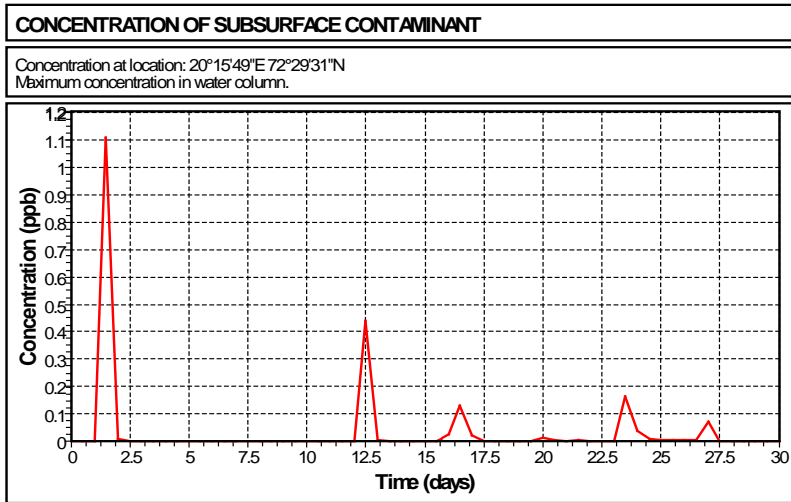
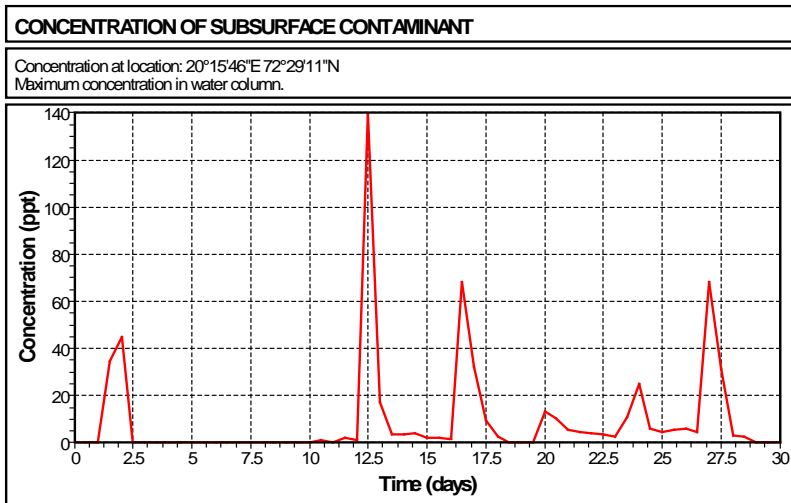
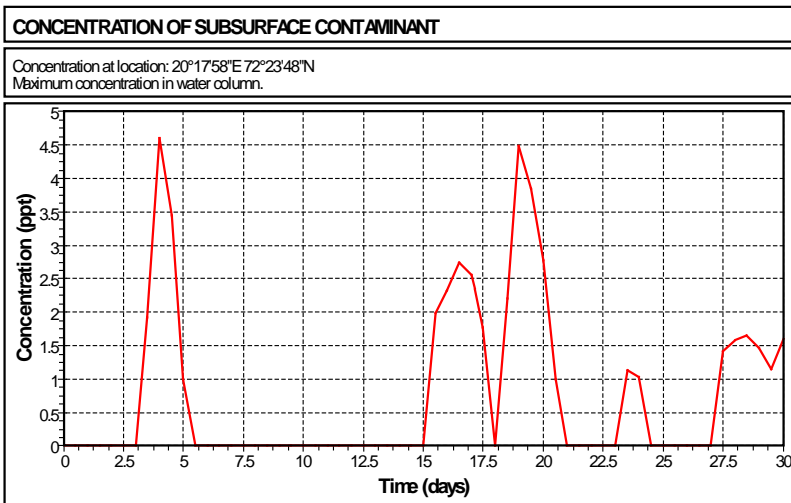


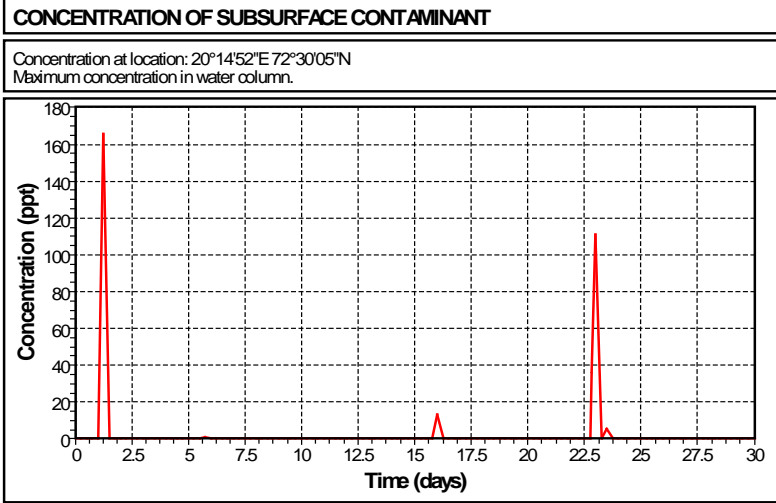
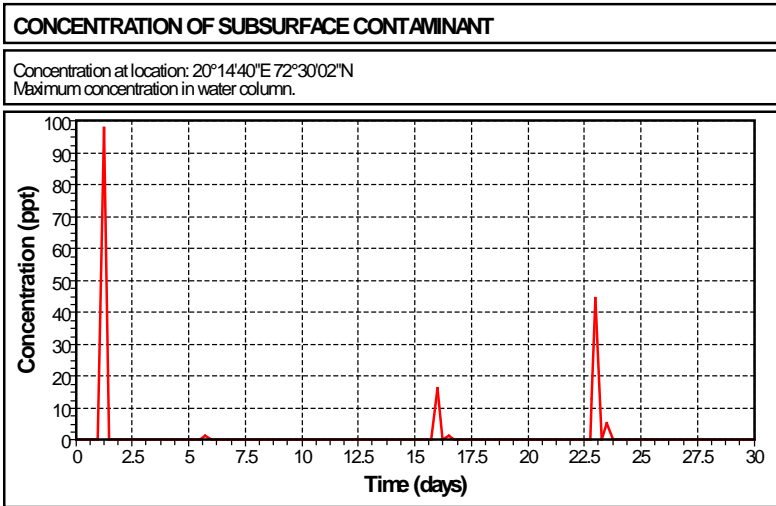
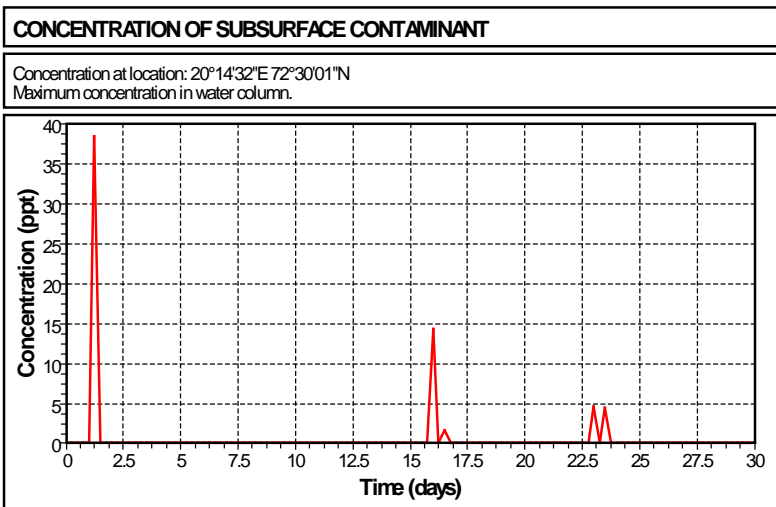
### Point 2



### Point 3



**Alternative 4, Point 1**

**Point 2**

**Point 3**


**Alternative 5, Point 1**

**Point 2**

**Point 3**




### 3 Results of EIF time average for Johan Castberg chemical release

The total volum of sea water per month has been used for the calculations.

Table 3.1 Table showing time averaged EIF for the water column Alternative 1.

Computed max. EIF:	354							
Time averaged EIF:	151							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		392						
Bio 10 KI			20	0.106	100	354.3976	1	151

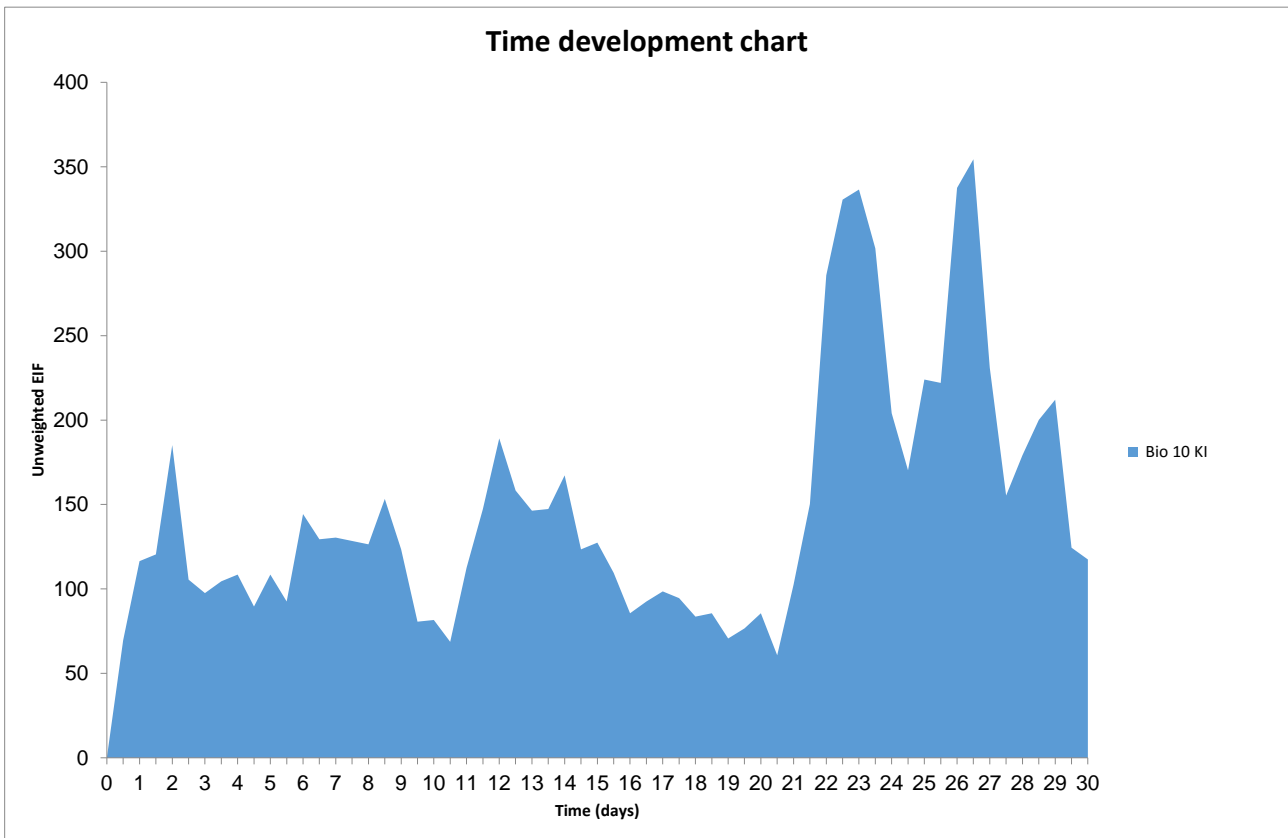


Figure 3.1 Time development of the 3 hours treatment 8 times per month.

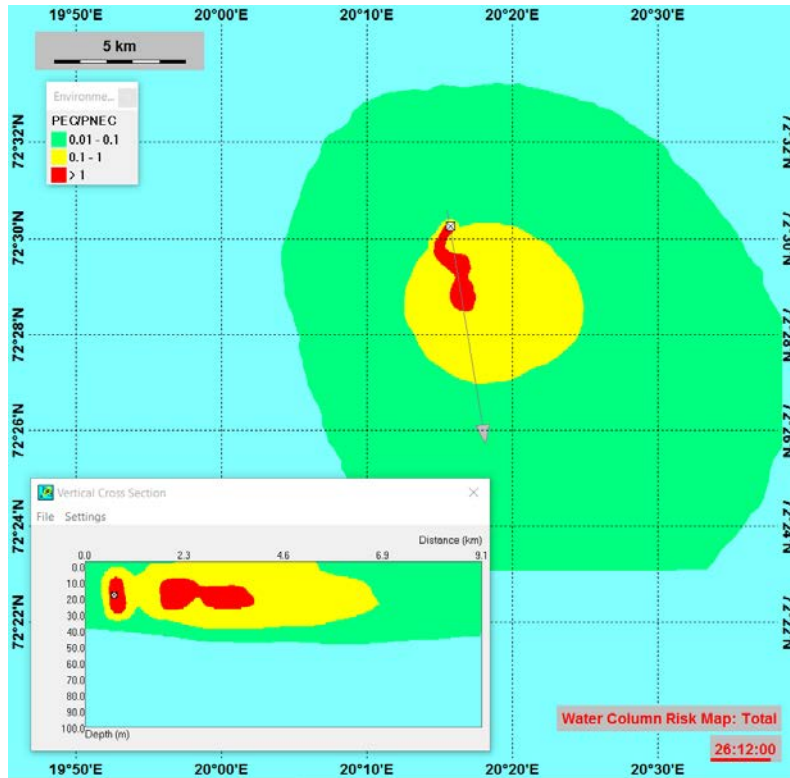


Figure 3.2 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-1.

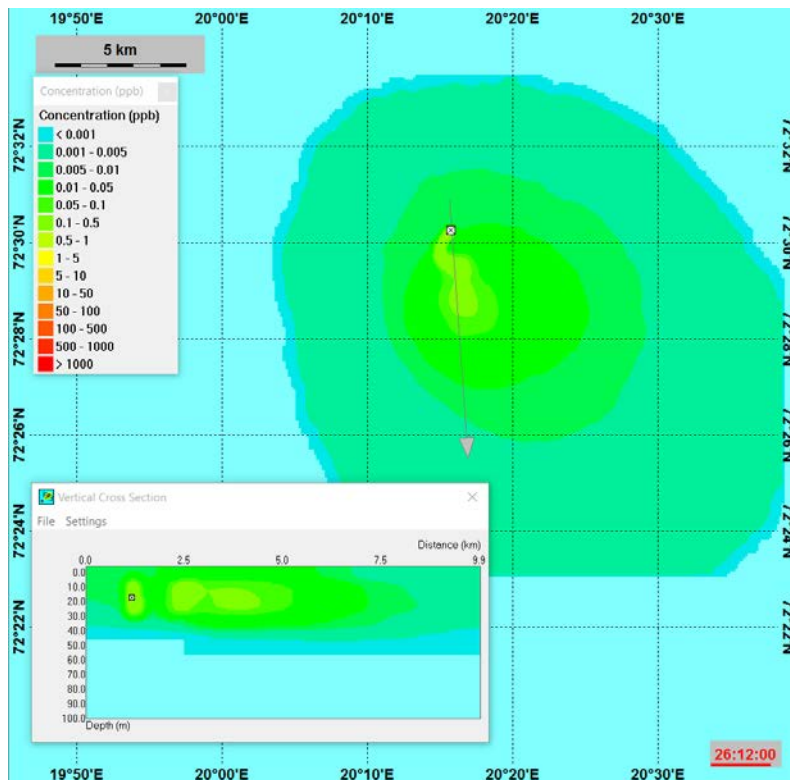


Figure 3.3 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-1.

Table 3.2 Table showing maximum EIF for the water column Alternative 2.

<b>Computed max. EIF:</b>	<b>25</b>							
Time averaged EIF:	12							
<b>Components</b>	<b>Product</b>	<b>Rel.Tons/day</b>	<b>Concentration ppm</b>	<b>PNEC ppb</b>	<b>Contribution to risk</b>	<b>Contribution max EIF</b>	<b>Weight</b>	<b>Contribution time averaged EIF</b>
Total		82						
Bio 10 KI			20	0.106	100	24.8875	1	12

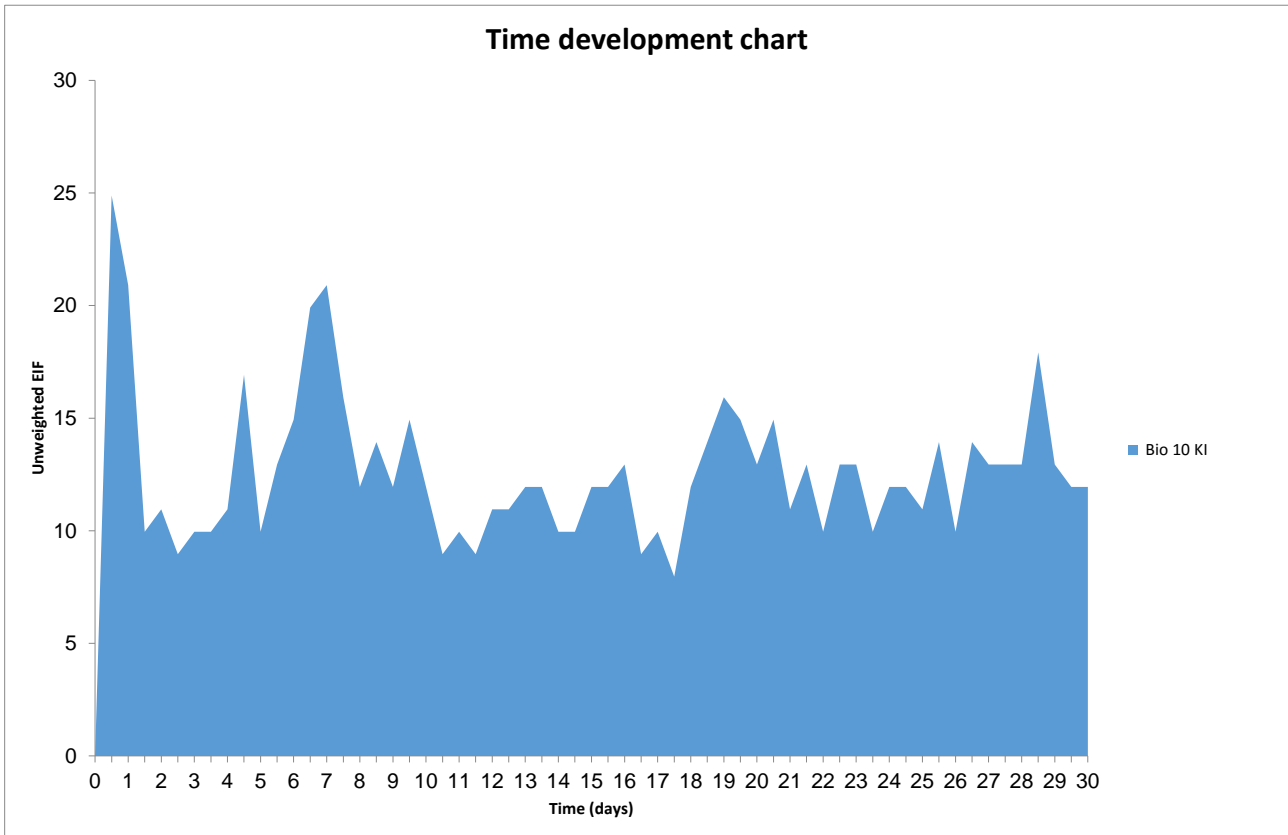


Figure 3.4 Time development of the 3 hours treatment 8 times per month.

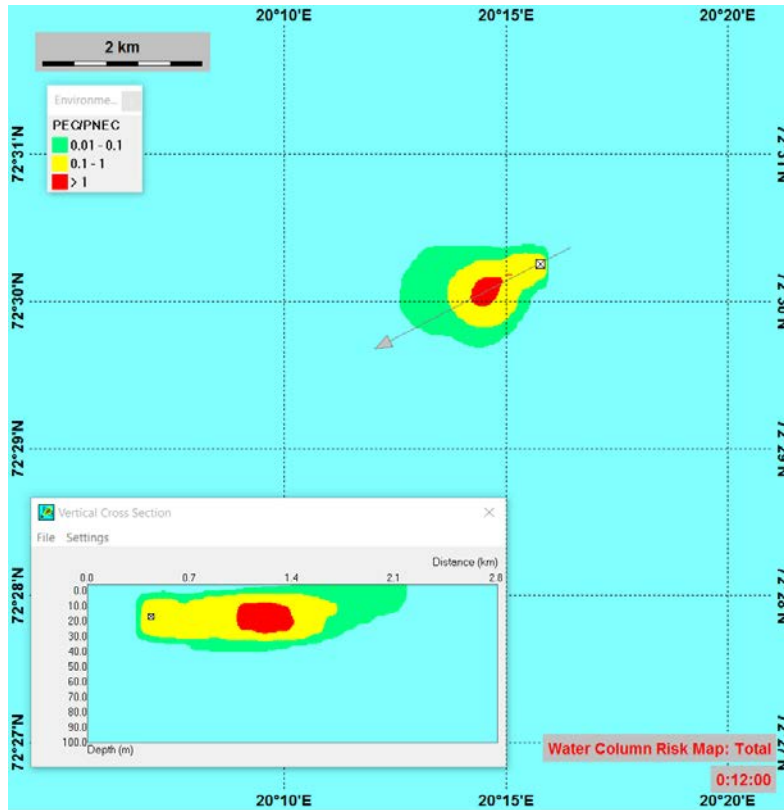


Figure 3.5 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-2.

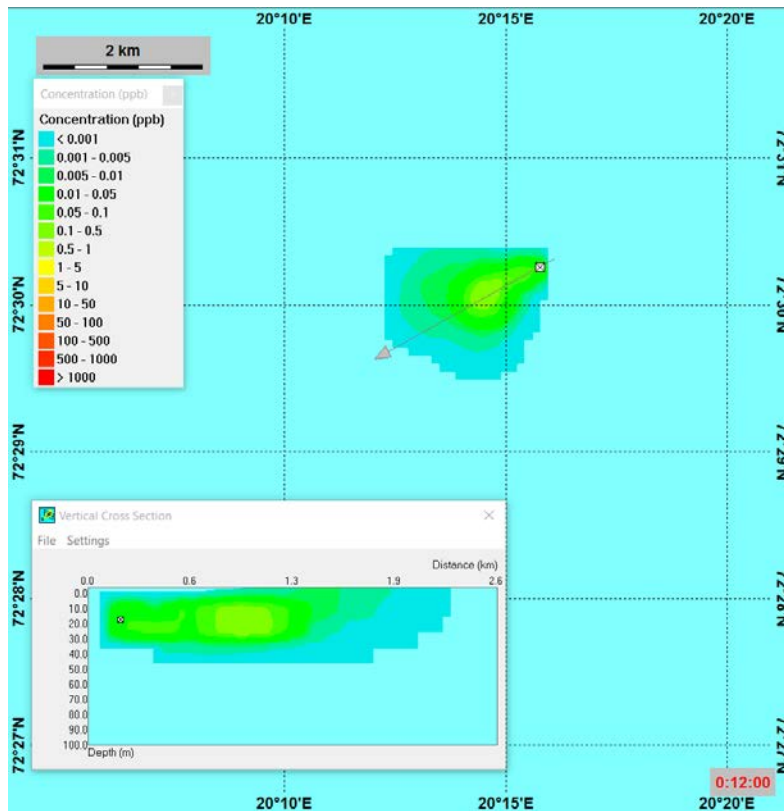


Figure 3.6 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-2.

Table 3.3 Table showing maximum EIF for the water column Alternative 3.

Computed max. EIF:	52							
Time averaged EIF:	20							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		120						
Bio 10 KI			20	0.106	100	51.7659	1	20

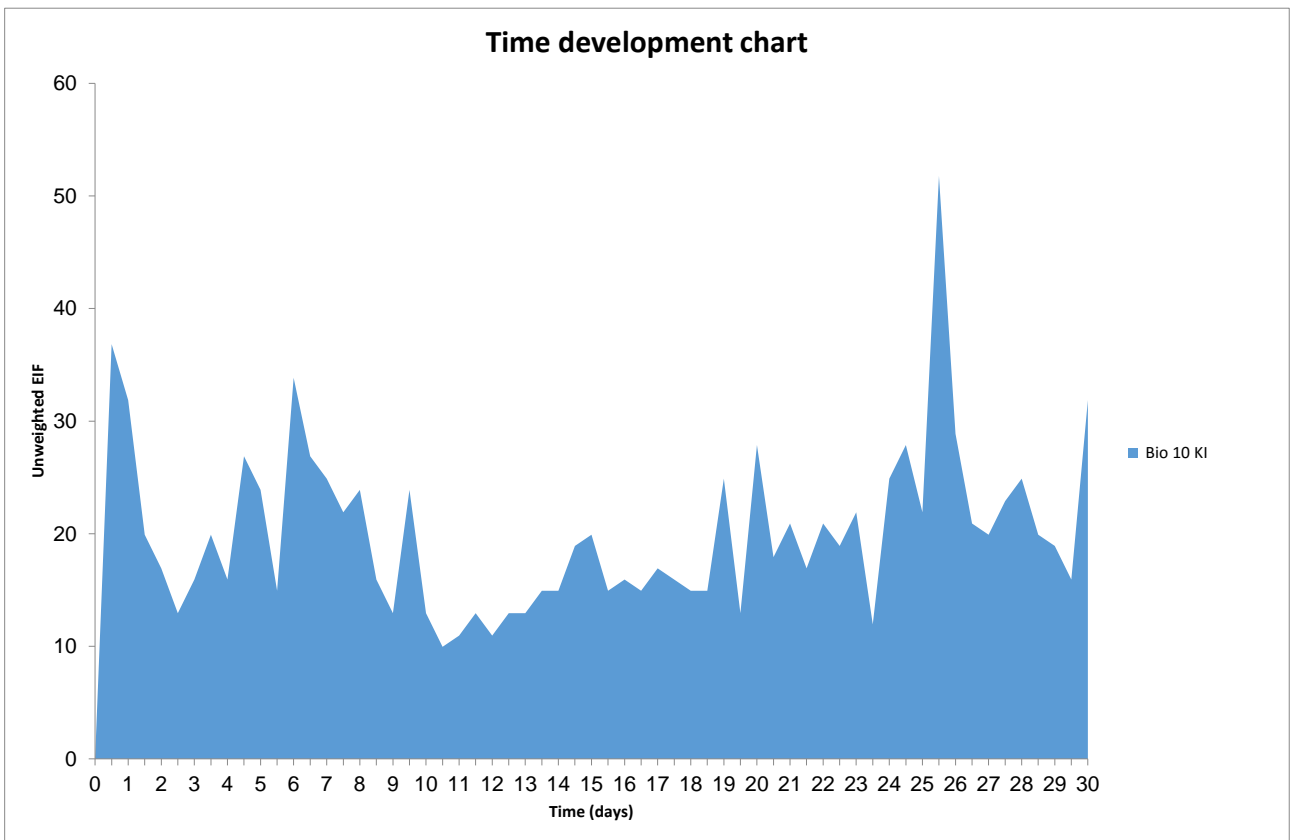


Figure 3.7 Time development of the 3 hours treatment 8 times per month.

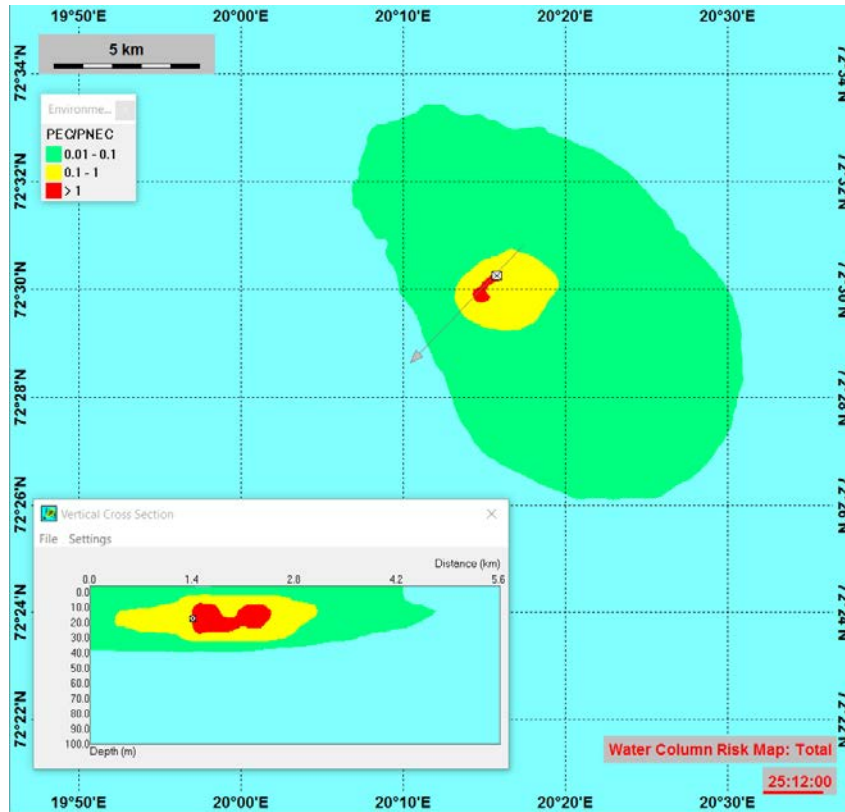


Figure 3.8 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-3.

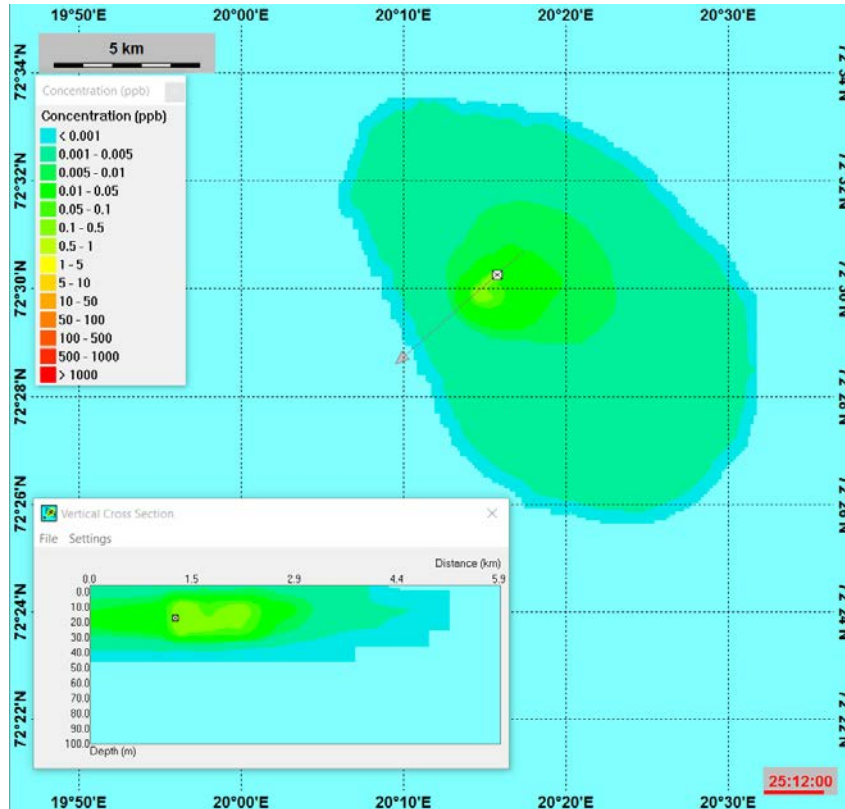


Figure 3.9 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-3.

Table 3.4 Table showing maximum EIF for the water column Alternative 4.

Computed max. EIF:	66							
Time averaged EIF:	25							
Components	Product	Rel.Tons/day	Concentration ppm	PNEC ppb	Contribution to risk	Contribution max EIF	Weight	Contribution time averaged EIF
Total		138						
Bio 10 KI			20	0.106	100	65.7029	1	25

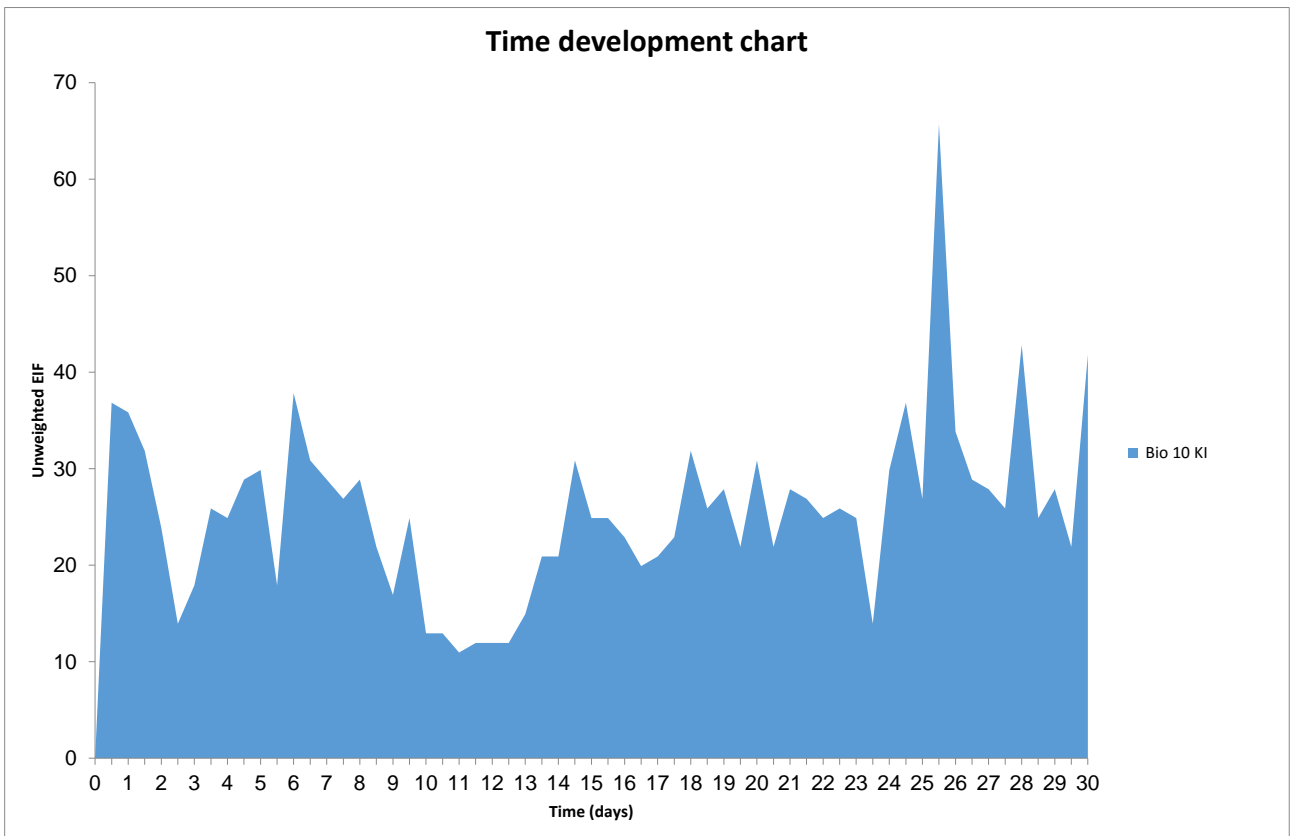


Figure 3.10 Time development of the 3 hours treatment 8 times per month.

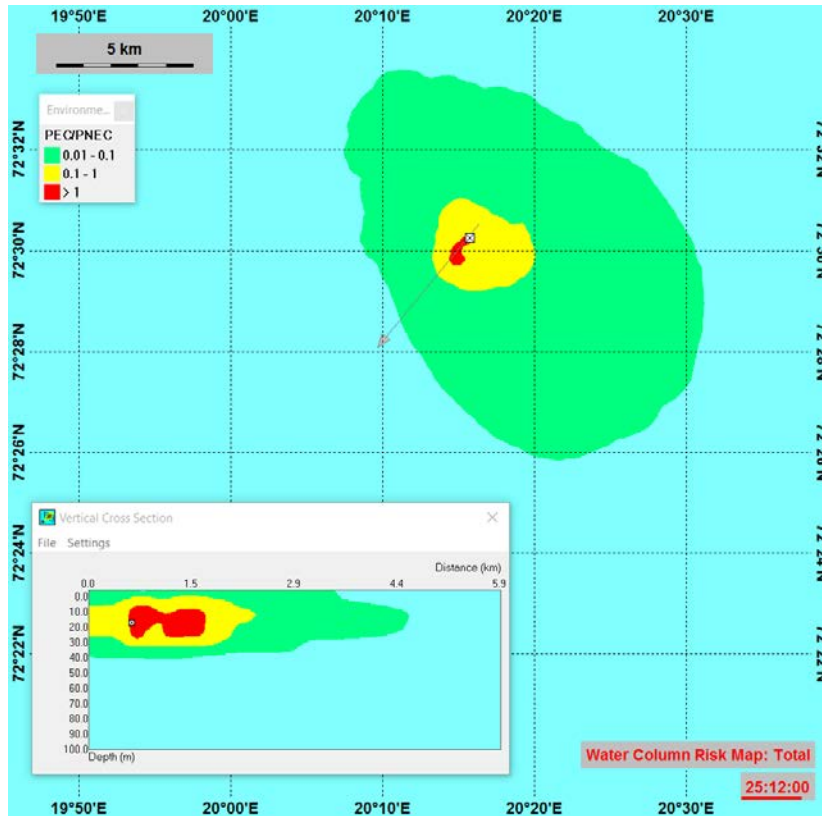


Figure 3.11 Snapshot showing time step for the maximum risk plume extent with vertical cross section for Alternative-4.

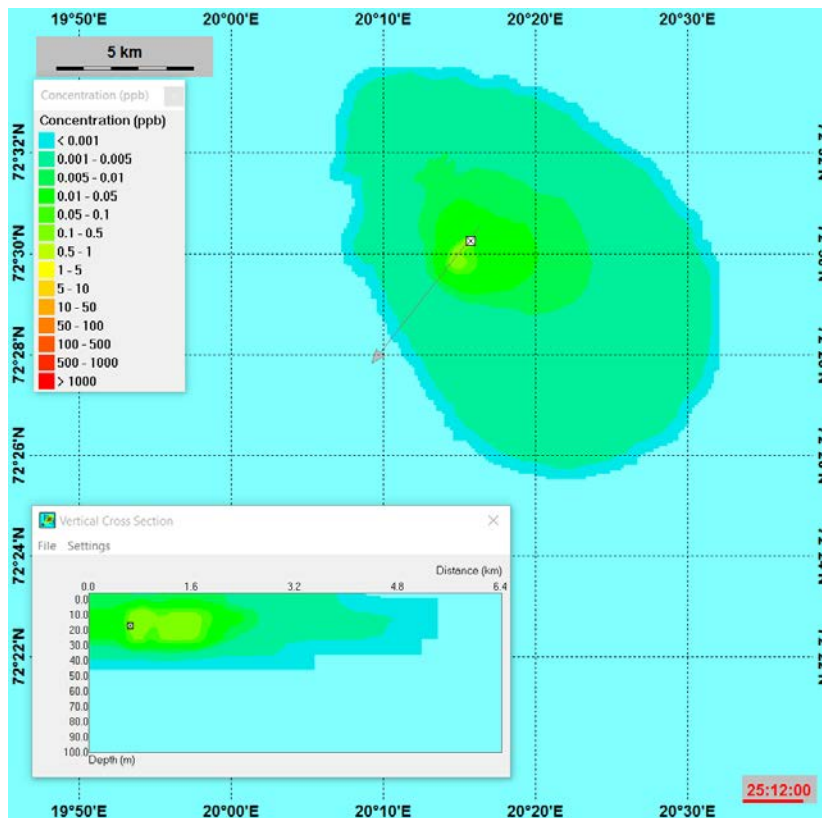


Figure 3.12 Snapshot showing concentration of biocide in the water-column at the same time step as for the maximum risk plume extent with vertical cross section for Alternative-4.

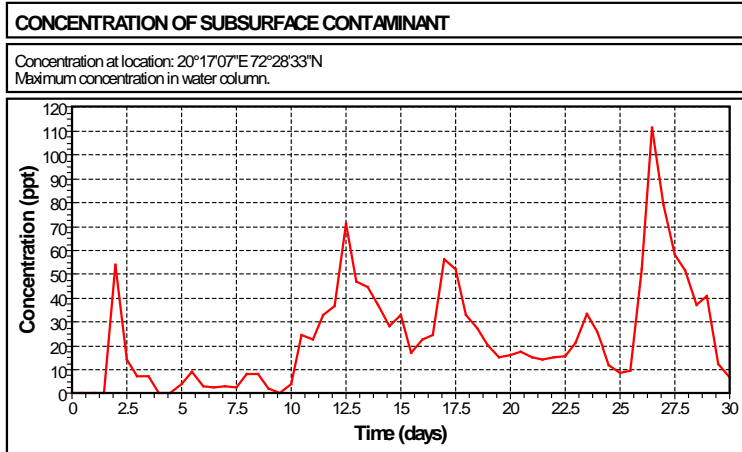
Table 3.5 Table showing maximum EIF for the water column Alternative 5.

<b>Computed max. EIF:</b>	<b>0</b>							
Time averaged EIF:	0							
<b>Components</b>	<b>Product</b>	<b>Rel.Tons/day</b>	<b>Concentration ppm</b>	<b>PNEC ppb</b>	<b>Contribution to risk</b>	<b>Contribution max EIF</b>	<b>Weight</b>	<b>Contribution time averaged EIF</b>
Total		6						
Bio 10 KI			20	0.106	100	0	1	0

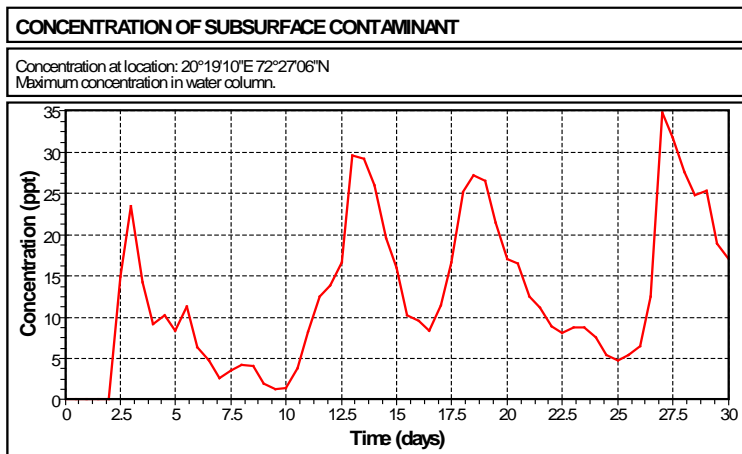
### 3.1 Concentration profiles for EIF time average (the total volume of sea water discharged over 30 days)

The concentration profiles of biocide is taken from the outer edge for each PEC/PNEC interval at the time step with maximum risk, point 1 = PEC/PNEC > 1, point 2 = PEC/PNEC 0.1-1, point 3 = PEC/PNEC 0.01-0.1, and gives the concentration at that point during 30 days simulation.

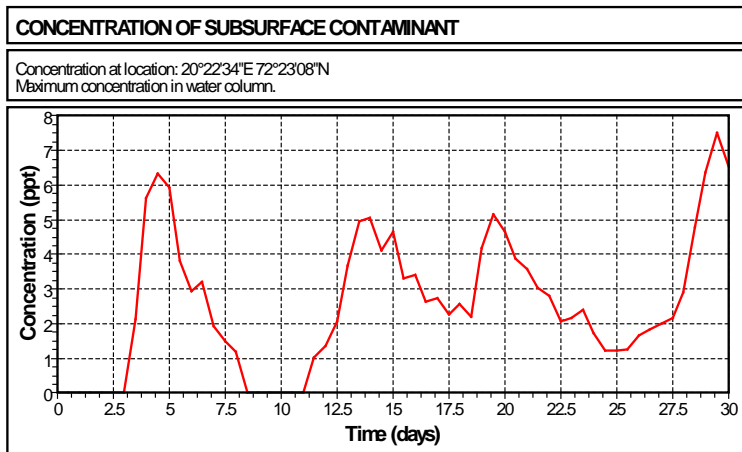
#### Alternative 1, Point 1



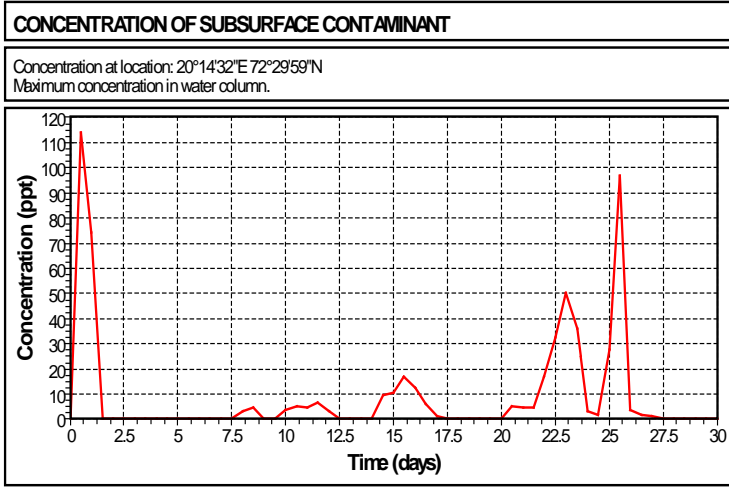
#### Point 2



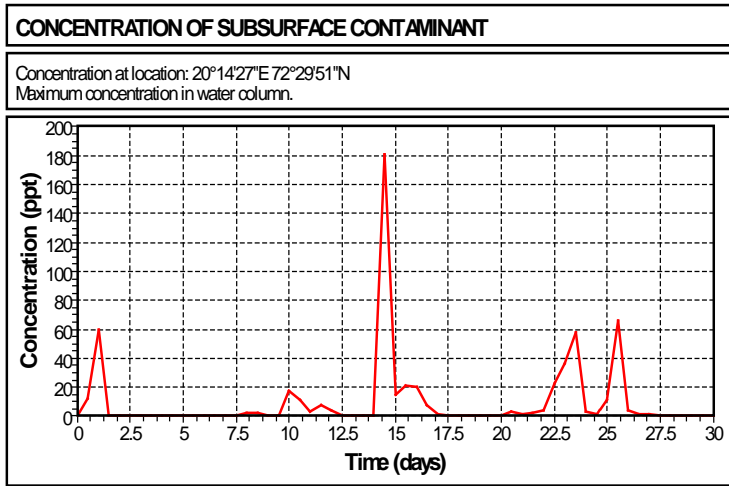
#### Point 3



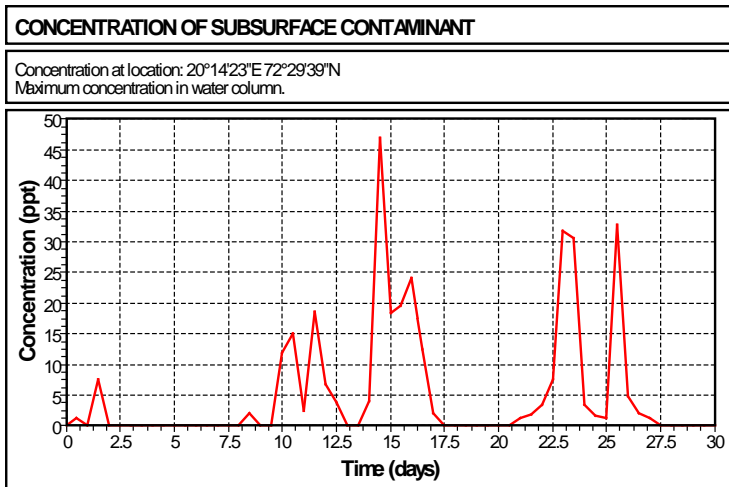
Alternative 2, Point 1



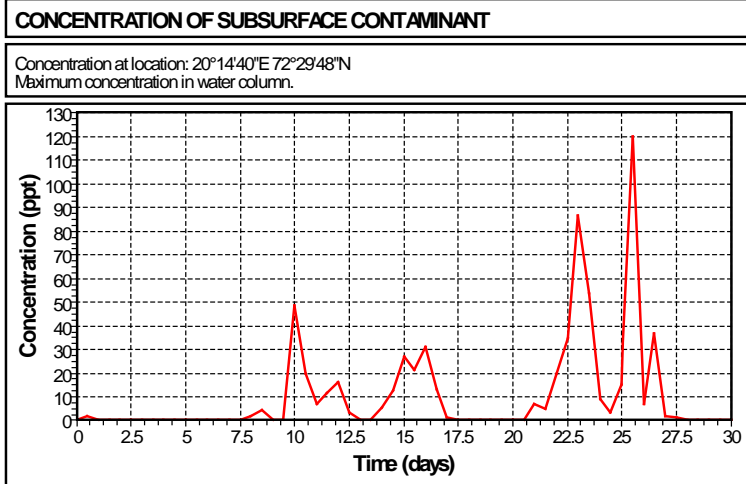
Point 2



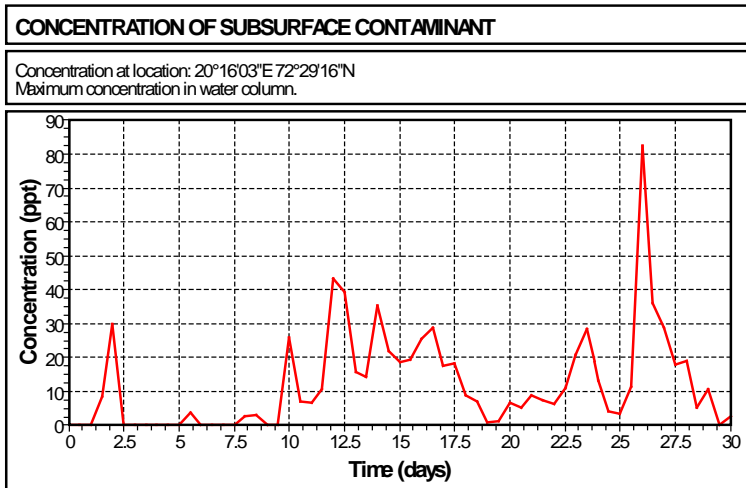
Point 3



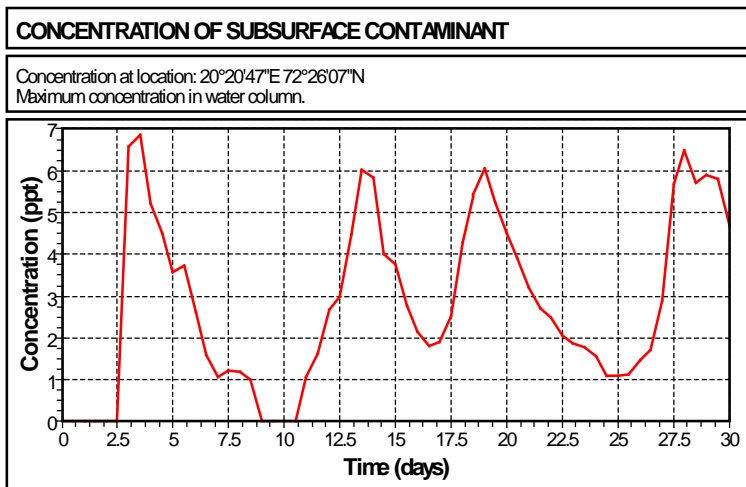
Alternative 3, Point 1



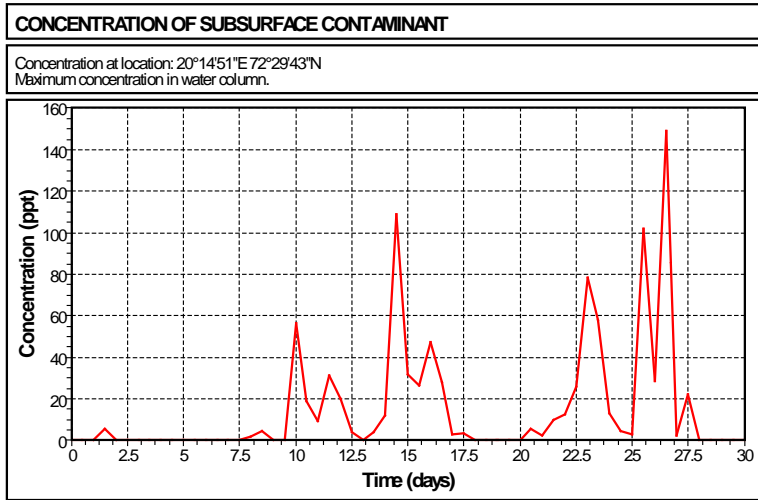
Point 2



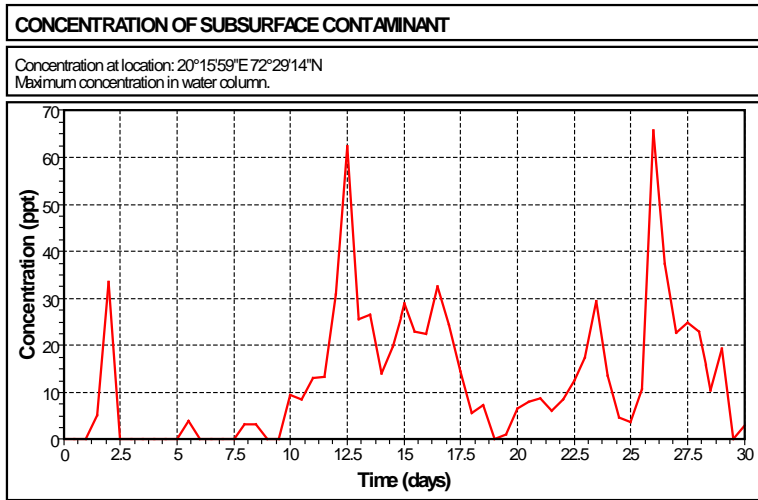
Point 3



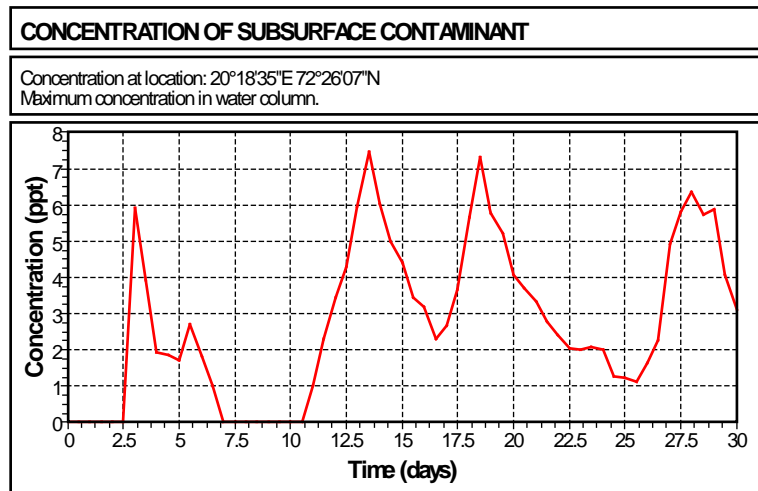
### Alternative 4, Point 1



### Point 2



### Point 3







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