B-survey at Hvestudalur, April 2025 (fallow period), Arctic Sea Farm ehf

Akvaplan-niva AS Report:
APN 66614.B01

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Contact person	Ísak Óskarsson

Summary

Sediment was recovered at all 14 stations (100% soft bottom). Sediment samples consisted mainly of sand at stations in the eastern part of the local impact zone and the stations closest to land in the western part and mixture of sand and clay in the middle part of the western frame and clay in deeper areas under the western frame. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H_2S was recorded at eleven sampling stations and light smell at three stations. There were no signs of out-gassing. The substrate was light/grey colour at twelve stations and brown/black at two stations. Noe faeces or feeds were observed and no signs of the bacteria Beggiatoa.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment of thirteen stations received status 1 – "Very good" and one station (nr. 11) received status 2 – " Good". Overall, the index score for parameter III (sensory parameters) were comparable with the index score for the parameter II (pH/Eh), or 0.21 for parameter III and 0.49 for parameter II.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.35).

Approval

Snorri Gunnarsson
Project Manager

Rikke Stabell
Quality Control

Key information

Site details and license holder information			
Site name	Hvestudalur	Site coordinates	65°42.845' N 23°38.963' V
County	Vesturbyggð	Municipality	Vesturbyggð
MTB (estimated max biomass)	4.000 tonnes	Operations Manager / Contact	Ísak Óskarsson
License holder / customer	Arctic Sea Farm		

Production status on date of survey			
Biomass at site	0 tonnes	Total feed use	0 tonnes
Farmed species	Salmon	Total biomass produced	0 tonnes
Type/time of survey	Indicated with X	Comments	
Maximum organic load cf. chapter 7.9	☐	Sampling during fallowing period prior to putting next generation smolt to sea. Fallowing period started 24.03 2024 (12 months).	
Follow-up survey	☐		
Half maximum load	☐		
Pre-stock	☒		
Required by the state administrator - baseline survey	☐		
Other	☐		
Last fallowing period:	March 2024 - April 2025		

Results from B-survey in accordance with NS 9410:2016 (main results)			
Parameter group and index		Parameter group and status	
Gr. II. pH/Eh	0.21	Gr. II. pH/Eh	1
Gr. III. Sensory	0.49	Gr. III. Sensory	1
GR. II + III	0.35	GR. II+ III	1
Date of fieldwork	03.04 2025	Date of report	08.04 2025
Environmental status (NS 9410:2016):			**1**

Table of contents

1 Introduction

The present survey was conducted by Akvaplan-niva AS on behalf of Arctic Sea Farm in connection with the company's fish farming activities at the site Hvestudalur in Arnarfjörður municipality in Vesturbyggð county.

The purpose of a B-survey is to document the environmental status in the near zone of a fish farm by evaluating sediment condition (chemistry, sensory and presence/absence of fauna) in accordance with NS 9410:2016.

The B-survey is a tool for trend monitoring and allows to assess the status of organic enrichment beneath the net pens at different stages of the production cycle.

Figure 1 shows a map of Arnarfjörður part of Vestfirðir where Hvestudalur farm is located.

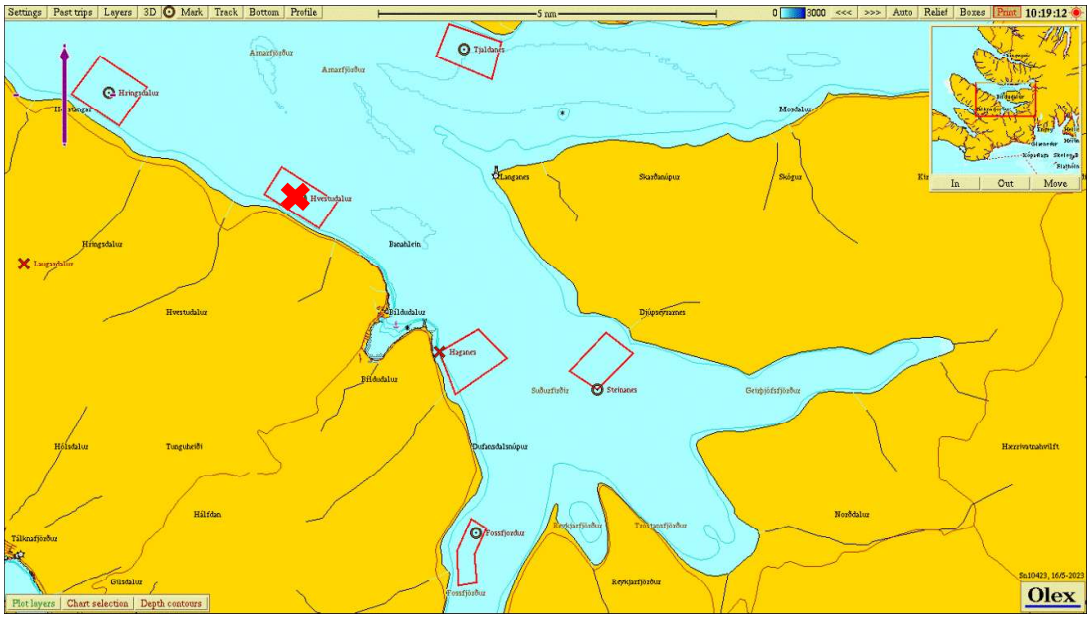

Figure 1. Overview map where Hvestudalur is marked with a red cross. Other aquaculture sites in the nearest vicinity (Arnarfjörður) are also shown.

2 Methods

Monitoring of the environmental impact of fish farming activities on the seabed is standardised and regulated. All fish farming sites that are in use must be regularly assessed. This B-survey follows guidelines and methods outlined in NS 9410:2016 and ISO 12878. The Icelandic Environmental agency (Umhverfisstofnun) can also set specific requirements regarding frequency of surveys for different fish farming sites, which can overrule the above-mentioned standards.

The B survey is a trend monitoring tool with the focus on sediment condition (benthic impact) under and in the immediate vicinity of an aquaculture site. Sediment samples are taken using a grab (min. 250 cm^2). Sediment condition for each sample is assessed applying three indicators: sediment chemistry (pH and redox potential), sensory evaluation (gas bubbles; smell, texture, colour of substrate and thickness of deposited sludge) and the presence or absence of fauna. The performance of these indicators against predefined thresholds allows to categorise the site into four different environmental statuses (Table 1), which are used to determine subsequent sampling frequency. The number of sampling stations is based on the site's allocated MTB, here the estimated max biomass of the next current generation put into sea spring/summer 2025 i.e. 4.000 tons (Personal reference, Ísak Óskarsson 2025).

Table 1. Frequency of B-survey based on environmental status at site.

Environmental status at maximum organic load (near zone)	Monitoring frequency for B survey
1-very good	At the next maximum load
2-good	Pre-stock and again at maximum load
3-poor	Pre-stock If the survey prior to restocking / end of fallowing provides: Status 1 – survey should be carried out at next maximum load. Status 2 – survey should be carried out at half the maximum load and at the next maximum load. Status 3 – survey should be carried out at half the maximum load and at maximum load. Implementation of measures to reduce impact should be planned for the next production cycle. If any surveys show the environmental status to be 4 – "very poor", the site's environmental capacity has been exceeded.
4- very poor	Environmental capacity at site is exceeded. The authorities decide further measures.

The following equipment was used in this survey:
Grab: Van Veen grab (0.1 m^2)
Sieve 1 mm: Akvaplan-niva
pH meter: Electrode, YSI Professional Plus
Redox meter: Electrode, YSI Professional Plus
Position determination – GPS map 62s
Digital camera

3 Site, production and survey design

3.1 Site characteristics and production

Hvestudalur is located in the southern part of Arnarfjörður, approximately 2,5 nm northwest of the town of Bíldudalur. The fish farm at the site is two frame mooring system with a western frame having possibility for 5 cages and an eastern frame with a possibility for 6 cages with 160-200 m circumference. The frame is positioned in north-north-westerly direction from land (350°) with depth below the cages ranging from ca. 45-78 m.

Previously there has been farmed one generation fish at the site with just over 6000-ton production and around 7000-ton feed use. During the last production cycle 9 cages of the total 11 were used (excl. cages 6 and 11). The fallow period started in March 2024, so the site has been in fallow state for about 12 months at the date of the survey.

Table 2 shows production and feed use for the previous generation.

Table 2. Production and feed use for farm site Hvestudalur. Data provided by customer.

Generation of fish (G)	Production (tonnes)	Feed use (tonnes)
Generation (2022-2024) salmon	6.058	7.049

3.2 Current and past surveys

Table 3 provides an overview on results and time of sampling for the last B-surveys at site.

Table 3. Present and previously conducted B-surveys at the site.

Date of sampling	Report number	Production status	Location condition
03.04 2025	APN-66614.B01	B survey fallow period	1
13.09 2023	APN-65201.B01	B survey max biomass	1
11.05.2022	APN 64085.B01	B-survey new site	1

3.3 Hydrodynamic conditions

Measurement of dispersing current has been done at the site in April-May 2022 at 51 m, which is the dispersing depth for Hvestudalur (Hermansen, 2022). Main current flow at 51 m is in south-easterly direction (150 degrees) (Figure 2). Average current speed is 6,6 cm/s. Highest current speed is 20,6 cm/s and 5,3 % of the measurements are <1 cm/s.

3.4 Survey design

Sampling stations were placed following an assessment of site configuration and local environmental conditions, i.e. bathymetry and hydrodynamics. An overview of the total 14 sampling stations can be found in Figure 2 with coordinates and depth provided in Table 4. Sampling stations were placed to represent the environmental conditions within the near zone and cover thus both the deeper and shallower areas. The typical depth in the local impact zone is in the range from 45-78 m, with a slightly deeper area into the fjord in northern direction. Samples were collected from depths ranging from 50-75 metres. The client has stated that nine out of the total eleven cages at the site were used at some point during the last production cycle (pers. Comm Ísak Óskarsson). The station placement is considered representative for an environmental survey of the farm's near-zone and in accordance with the requirements outlined in NS 9410:2016.

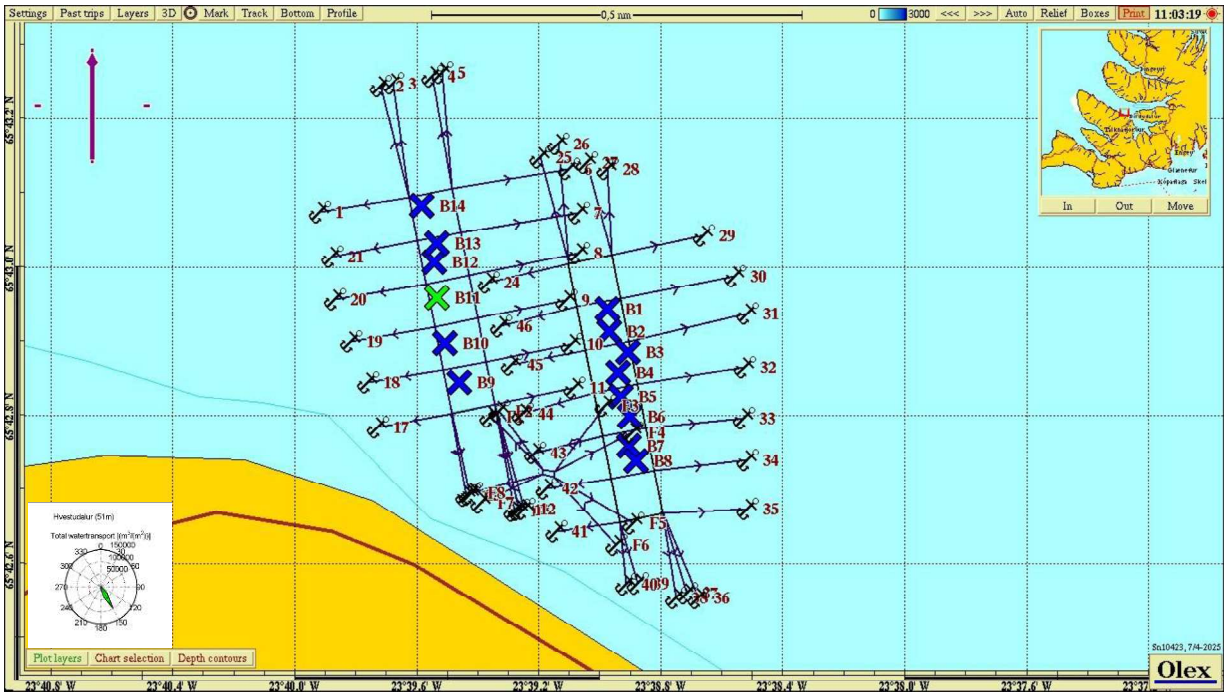

Figure 2. Overview map showing site configuration at Hvestudalur. Sampling stations are marked by crosses and colour coded to visualise the environmental status at the respective station following the classification outlined in NS 9410:2016, chapter 7.11 (1 = blue, 2 = green, 3 = yellow, 4 = red). The current rose in the left corner shows the direction of water transport at dispersal depths at the site (Hermansen, 2022).

Table 4. Position and depth of the sampling stations of this survey.

Station number	Northing	Westing	Depth [m]
St 1	65°42,962	23°38,942	69
St 2	65°42,912	23°38,970	67
St 3	65°42,885	23°38,909	67
St 4	65°42,857	23°38,939	66
St 5	65°42,824	23°38,930	65
St 6	65°42,798	23°38,903	63
St 7	65°42,758	23°38,906	59
St 8	65°42,738	23°38,881	60
St 9	65°42,843	23°39,461	50
St 10	65°42,898	23°39,508	57
St 11	65°42,958	23°39,533	64
St 12	65°43,006	23°39,543	68
St 13	65°43,033	23°39,535	70
St 14	65°43,082	23°39,583	75

4 Results

Classified survey results for the different parameter categories as well as the assigned environmental status of the site are shown in Table 5. The complete survey assessment form with results and classifications for each station can be found in the attachment.

Table 5. Results from the environmental assessment of the near zone of Hvestudalur.

Parameter	Status
Group II parameters (pH/Eh)	1
Group III parameters (sensory)	1
Group II + III – parameters (mean)	1
Environmental status (site)	1

Sediment was recovered at all 14 stations (100% soft bottom). Sediment samples consisted mainly of sand at stations in the eastern part of the local impact zone and the stations closest to land in the western part and mixture of sand and clay in the middle part of the western frame and clay in deeper areas under the western frame. Fauna was recorded to be present at all stations mainly in the form of polychaetes. No smell of H_2S was recorded at eleven sampling stations and light smell at three stations. There were no signs of out-gassing. The substrate was light/grey colour at twelve stations and brown/black at two stations. No faeces or feeds were observed and no signs of the bacteria Beggiatoa.

Based on the classification of sediment chemistry (pH/Eh) and the sensory assessment of thirteen stations received status 1 – "Very good" and one station (nr. 11) received status 2 – " Good". Overall, the index score for parameter III (sensory parameters) were comparable with the index score for the parameter II (pH/Eh), or 0.21 for parameter III and 0.49 for parameter II.

In summary, the site receives the environmental status 1 - "Very good" (average group II-III index =0.35).

5 Summary

Applying the indicator thresholds and classification outlined in NS 9410:2016 it is shown that the site Hvestudalur receives overall site status 1 – "Very good" at the time of this B survey (fallow period). Samples were collected with a Van Veen grab (0.1 m^2) at 14 stations distributed around the nine cages in use during last production cycle. Sediment was successfully collected at all the 14 stations and thirteen stations received status 1 **–** "Very good" and one station (nr. 11) received status 2 **–** " Good".

The results indicate relatively little organic enrichment except for small part at intermediate dept at the at the bottom of the western frame (mainly due to low pH and ORP values). The two station closest to land at the eastern frame (stations 7 and 8) were also observed with brown/black color, light smell and soft consistency indicating some organic residues despite scoring rather well on pH/ORP values.

Previous B survey carried out at max biomass in September 2023 (Gunnarsson, 2023) indicated that in in all parts of the local impact zone there were some signs of organic load both in deeper and more shallow areas. The present results indicate that the bottom has recovered to some point during the fallow period with indications of organic residues being less apparent in the local impact zone. The environmental conditions seem therefore to have improved during the 12 month fallow period.

The site is given environmental status 1 – "Very good" following the criteria outlined in NS 9410:2016.

6 References

Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.

Gunnarsson, S. 2023. Hvestudalur, Arctic Sea Farm B survey, September 2023 (max biomass). Akvaplan-niva AS report nr. 65201.B01.

Gustavsson, A. 2022. Hvestudalur, Arctic Sea Farm. B survey (baseline-new site), May 2022. Akvaplan-niva AS report nr. 64085.B01.

Hermansen, A. 2022. Current measuremets at Hvestudalur, 2022. Akvaplan-niva AS report nr. 63924.01.

ISO 12878:2012. Environmental monitoring of the impacts from marine finfish farms on soft bottom.

ISO 5667-19:2004. Guidance on sampling of marine sediments.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakulturanlegg.

Personal reference. Ísak Óskarsson, Area manager south, Arctic Sea Farm. 2025.

7 Attachments

7.1 Form (B.1 and B.2) NS 9410:2016

Sample scheme B.1

Company	Arctic Sea Farm	Date:	03.04 2025
Site:	Hvestudalur	Site no.:	SiteItem.LokalitetsID
Fieldworker:	Snorri Gunnarsson		

Gr	Parameter	Point	Sample number									
			1	2	3	4	5	6	7	8	9	10
	Bottom type: S (soft) eller H (hard)		S	S	S	S	S	S	S	S	S	S
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0
II	pH	value	7,63	7,61	7,65	7,34	7,46	7,56	7,69	7,64	7,37	7,63
	Eh (mV)	ORP	136	138	124	105	201	80	179	162	164	217
		plus ref. verdi	336	338	324	305	401	280	379	362	364	417
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0
	Status station		1	1	1	1	1	1	1	1	1	1
			Buffer-temp	5,0 C		Sea temp	2,5 C		Sediment temp		2,9 C	
	pH sea	7,98	ORP sea	195,0 mV		Eh sea	395,0 mV		Reference electrode		200,0 mV	
III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0	0	0
	Colour	Light/grey (0)	0	0	0	0	0	0			0	0
		Brown/black (2)							2	2		
	Smell	None (0)	0	0	0	0		0			0	0
		Light (2)					2		2	2		
		Strong (4)										
	Consistency	Solid (0)	0	0	0	0	0	0				0
		Soft (2)							2	2	2	
		Aqueous (4)										
	Grab volume (v)	v < 1/4 (0)									0	0
		1/4 < v < 3/4 (1)	1	1	1	1	1	1	1	1		
		v > 3/4 (2)										
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0
		2 < t < 8 cm (1)										
		t > 8 cm (2)										
		Sum	1,0	1,0	1,0	1,0	3,0	1,0	7,0	7,0	2,0	0,0
		Corrected (*0,22)	0,2	0,2	0,2	0,2	0,7	0,2	1,5	1,5	0,4	0,0
	Status station		1	1	1	1	1	1	2	2	1	1
	Average group II & III		0,1	0,1	0,1	0,1	0,3	0,1	0,8	0,8	0,2	0,0
	Status station		1	1	1	1	1	1	1	1	1	1

Grab ID	K-3
pH / Eh ID	YSI professional plus

Sample scheme B.1

Company:	**Arctic Sea Farm**	**Date:**	**03.04 2025**
Site:	**Hvestudalur**	**Site no.:**	**eltem.Lokalitets**
Fieldworker:	**Snorri Gunnarsson**		

Gr	Parameter	Point	Sample number 11	12	13	14	15	16	17	18	19	20	Index S%	H%
	Bottom type: S (soft) or H (hard)		S	S	S	S							100	0
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0								
II	pH	value	7,05	7,61	7,58	7,69								
	Eh (mV)	ORP	-183	103	155	178								
		plus ref. verdi	17	303	355	378								
	pH/Eh	from figure	3	0	0	0							0,21	
		Status station	3	1	1	1								
		Status group II	1											
		pH sea 7,98	ORP sea	195 mV		Eh sea	395 mV		Reference electrode		200 mV			
			Buffer temp	5,0 C			Sea temp	2,5 C		Sediment temp	2,9 C			
III	Gas bubbles	Yes (4) No (0)	0	0	0	0								
	Colour	Light/grey (0)	0	0	0	0								
		Brown/black (2)												
	Smell	None (0)	0	0	0	0								
		Light (2)												
		Strong (4)												
	Consistency	Solid (0)	0	0	0	0								
		Soft (2)												
		Aqueous (4)												
	Grab volume (v)	v < 1/4 (0)												
		1/4 < v < 3/4 (1)	1											
		v > 3/4 (2)		2	2	2								
	Thickness of slidge (t)	t < 2 cm (0)	0	0	0	0								
		2 < t < 8 cm (1)												
		t > 8 cm (2)												
		Sum	1,0	2,0	2,0	2,0								
		Corrected (*0,22)	0,2	0,4	0,4	0,4							0,49	
		Status station	1	1	1	1								
		Status group III	1											
		Average group II & III	1,6	0,2	0,2	0,2							0,35	
		Status station	2	1	1	1								
		Status group I & II	1											

pH/Eh Corr.sum Index Average	**Status**
< 1,1	1
1,1 - <2,1	2
2,1 - <3,1	3
≥3,1	4

Status site: 1

Grab ID	K-3
pH / Eh ID	YSI professional plus

Sample scheme B.2

Company:	Arctic Sea Farm	Date:	03.04 2025
Site:	Hvestudalur	Site no.:	{{SiteItem.LokalitetsID}}
Fieldworker:	Snorri Gunnarsson		

Sample number		1	2	3	4	5	6	7	8	9	10
Depth (m)		69	67	67	66	65	63	59	60	50	57
Number of trials		1	2	1	1	1	1	1	1	1	1
Gas bubbles (in sample)		No	No	No	No	No	No	No	No	No	No
Sediment type	Clay										x
	Silt										x
	Sand	x	x	x	x	x	x	x	x	x	x
	Gravel										
	Shellsand										
Some black algae (dead)		x		x	x	x	x	x	x	x	
Rocky bottom (cobbles, boulders)											
Echinodermata, count											
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>20	>10	>20	>10	>10	>50	>20	>20	>20	>20
Other animals, count											
Beggiatoa											
Feed											
Faeces											

Comments				
Grab	Area [m^2]	0,1	Grab ID	K-3

Sample scheme B.2

Company:	Arctic Sea Farm	Date:	03.04 2025
Site:	Hvestudalur	Site no.:	{{SiteItem.LokalitetsID}}
Fieldworker:	Snorri Gunnarsson		

Sample number		11	12	13	14	15	16	17	18	19	20
Depth (m)		64	68	70	75						
Number of trials		1	1	1	1						
Gas bubbles (in sample)		No	No	No	No						
Sediment type	Clay	X	X	X	X						
	Silt	X									
	Sand	X									
	Gravel										
	Shellsand										
Reef											
Rocky bottom (cobbles, boulders)											
Echinodermata, count				2							
Crustaceans, count											
Molluscs, count											
Polychaetes, count		>10	>10	>30	>10						
Other animals, count											
Beggiatoa											
Feed											
Faeces											
Comments											

Grab	Area [m^2]	0,1	Grab ID	K-3
Signature fieldworker:				

7.2 Images of samples at Hvestudalur

St	*Image before sieving*	*Image after sieving*
St 1		
St 2		
St 3		
St 4		
St 5		

St 6		
St 7		
St 8		
St 9		
St 10		

St 11		
St 12		
St 13		
St 14		

7.3 3D-bathymetry

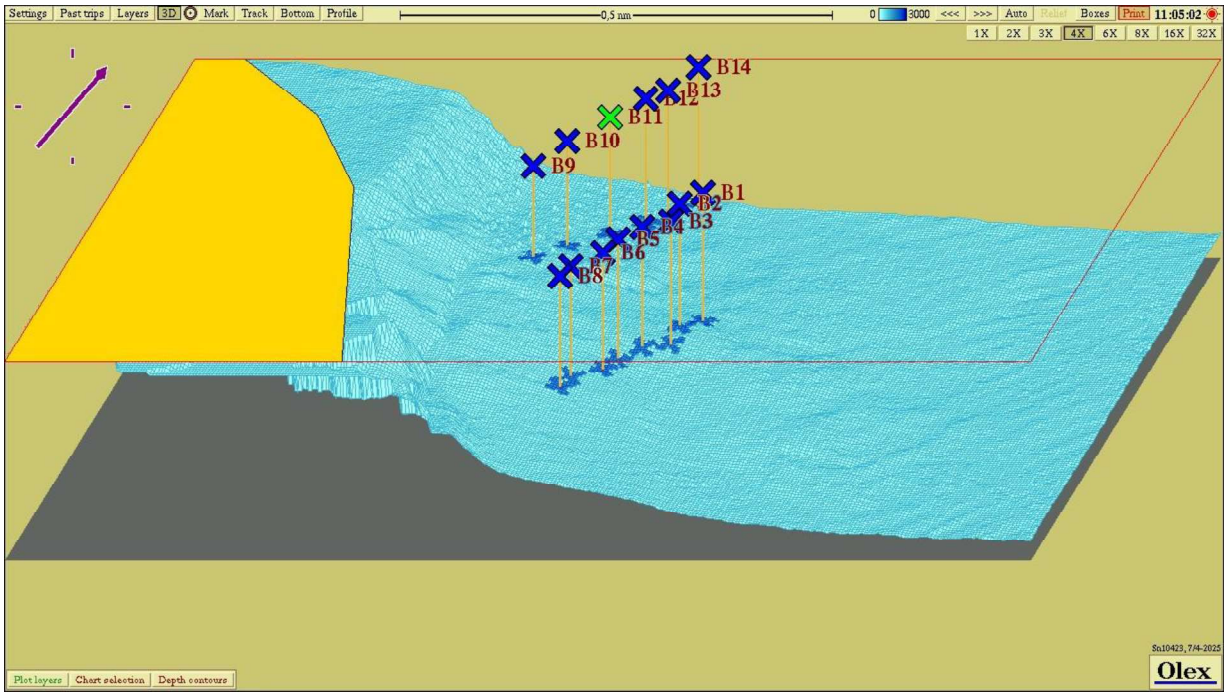

Figure 3. 3D-view of bathymetry at Hvestudalur with stations as shown in Figure 2 and Table 4.