Nord Stream Munitions clearance in the Finnish EEZ

Addendum to:

Final monitoring results on Munition by munition basis

January 2011

Client	Nord Stream AG
Title	Nord Stream, Munitions clearance in the Finnish EEZ, Final monitoring results on Munition by munition basis, Addendum

This Addendum

This Addendum belongs to the final report on monitoring results on Munition by Munition basis of the munitions clearance activities in the Finnish EEZ for the installation of the Nord Stream pipelines /97/, further referred to as 'Main Report'. This Addendum is necessary because: (1) the laboratory test results on sediment and benthos samples were not yet available before the closing date of the Main Report; (2) not all images of the visual inspection surveys of all cables and barrels were available before the submission date of the Main Report; (3) three munitions (F47, F48 and F49) were identified during the verification survey of targets identified in the original munitions screening survey; these munitions were not cleared by detonation but were 'lifted and shifted' to a new location outside the pipeline security corridor; and it contains corrections and new information that has been received after the submission of the Main Report. The list of References and the Annexes 1, 2 and 3, have been updated and are included in full in this Addendum. Annex 4 contains the updated version of the water quality, sediment and benthos monitoring report /59/.

Conclusions

1 All 52 munitions that had to be cleared prior pipeline installation, have been successfully cleared. This includes the three additional munitions that were successfully removed from the security corridor by a 'lift and shift' operation without detonation.

2 The completion of the analysis of the visual inspection data (as reported in the updated Annex 3) did not reveal any information that changed the conclusions as presented in the Main Report. In summary: no displacements of barrels and no impacts on cultural heritage sites or cable infrastructure were observed.

3 The analysis of sediment and benthos samples, did not show statistically significant changes in (1) concentration of contaminants in sediment and (2) benthos that could be attributed to the munitions clearance operations. The measured variations are due to natural variations in the composition of the seabed.

4 The analyses of the laboratory test results for sediment and benthos samples confirmed that the munitions clearance operations did not cause significant transboundary impacts.

5 The monitoring of the munitions clearance has been performed in accordance with the approved monitoring programmes /68/, /70/ and /71/, except in the following cases:

- during the 'before' survey of F17 the visibility was too poor to produce meaningful images, and during the 'after' survey the footage from the ROV was not recorded for an unexplained reason, resulting in no images;
- it was decided to perform visual inspection of the cable EE-SF2 not after every detonation of the FAB100 bombs (F37 – F38K) but after a few detonations to reduce the potential impact on the cable;
- it was decided to perform the monitoring of the cable Pangea Seg 3 by MBES on an ROV that could stay at greater distance from the cable to reduce risk to the cable and the ROV;
- an operational error was made resulting in missing the inspection of one barrel (R-09-326883).

After thorough consideration, as reported in this Addedndum, it is justified to state that these deviations of the original programmes did not affect the conclusions of the monitoring.

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Abbreviations and definitions

ADCP	Acoustic Doppler Current Profiler
CTD	Conductivity, temperature, depth
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EOD	Explosive Ordnance Disposal
FMI	Finnish Meteorological Institute
GoF	Gulf of Finland
KP	Kilometre Point
MBES	Multibeam Echosounder
M-by-M	Munition by Munition assessment
MP	Munitions Permit: decision 83/2009/2 of 2 October 2009 by Western Finland Environmental Permit Authority.
Q2	Second quarter of a year, from 1st of April to 30st of June
ROV	Remotely Operated Vehicle
TBT	Tributyltin
WFEPA	Western Finland Environmental Permit Authority
WP	Water Permit: decision 4/2010/4 of 12 February 2010 by Southern Finland Regional State Administrative Agency.

1 Introduction

This Chapter

This Chapter provides general background information on the purpose, status and content of this Addendum.

Link to Main Report

This Addendum belongs to the final report on monitoring results on Munition by Munition basis of the munitions clearance activities in the Finnish EEZ for the installation of the Nord Stream pipelines /97/, further referred to as 'Main Report'. This Addendum contains some corrections and new information that has been received after the submission of the Main Report, except for the list of References and the Annexes 1, 2 and 3, which have been updated and are included in full in this Addendum. Annex 4 contains the updated version of the water quality, sediment and benthos monitoring report supplemented by the sediment quality and benthos results /59/.

Why an Addendum?

This Addendum is necessary because of the following reasons:

- the laboratory test results on sediment and benthos samples were not yet available before the closing date of the Main Report (19 September 2010);
- not all images of the visual inspection surveys of all cables and barrels defined in the monitoring programmes were available before the submission date of the Main Report;
- three munitions (F47, F48 and F49) were identified during the verification survey of targets identified in the original munitions screening survey; these munitions were not cleared by detonation but were 'lifted and shifted' to a new location outside the pipeline security corridor;
- provide the corrections of the Main Report.

Clearance of additional munitions

The clearance of three additional munitions has been performed in accordance with the permit provisions as indicated in Table 1.1 and has been notified to the Authorities as listed in Table 1.2 [1].

Table 1.1 *Permit provisions relevant for the removal of the three additional munitions.*

Permit provision in..		Description	In this report…
Munitions permit	Water permit		
6	21	- Clearance of any previously unidentified munitions found in the gas pipeline installation corridor or its immediate vicinity during clearance or related surveying must comply with procedures set out in the application; - All new objects must be notified and at least the following information must be submitted before detonation: o Precise location; o Information about the neighbouring areas; o Estimate of the sediment movement and contaminants; o Grounds for the necessity of the clearance.	Ch. 2, Ch. 4, Annex 3

[1] Notifications 1 – 17 are listed in Table 1.2 of the Main Report.

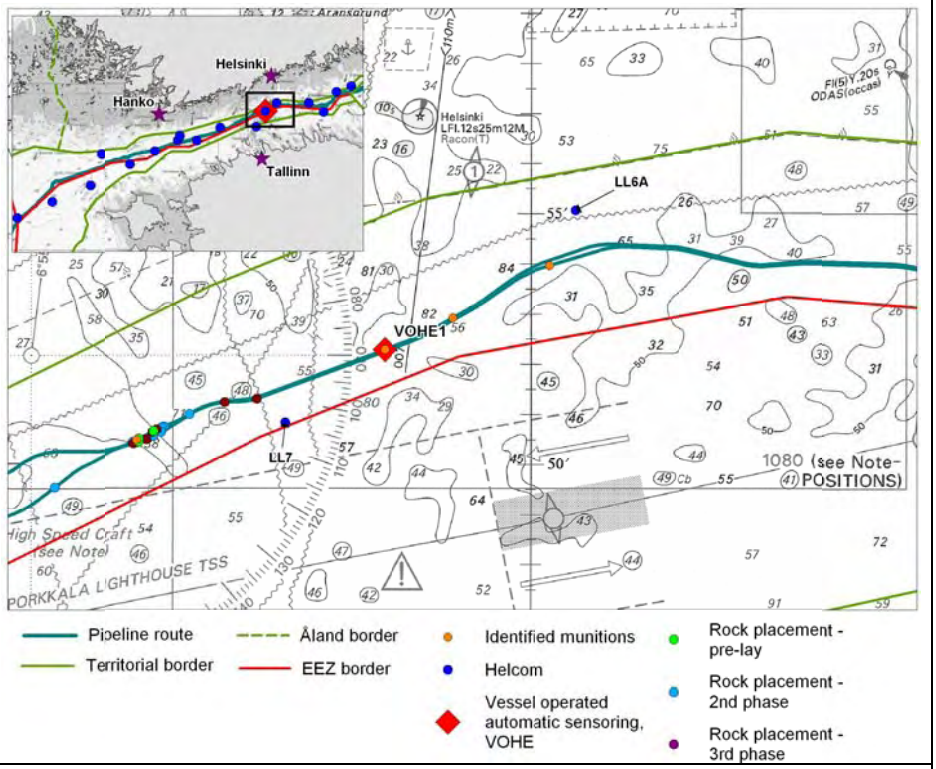
Table 1.2 *The notification as submitted to the Authorities for the removal of the three additional munitions; the notifications 1 – 17 are listed in Table 1.2 in the Main Report.*

Item	Issue	Date	Permit		Provision
			MP	WP	
18	Notification on identification of additional munitions to be removed from security corridor (F47, F48 and F49) by a 'lift and shift' operation.	12-Oct-10	✓		6
				✓	21

Corrections to the Final Report

The following Table 1.3 contains the corrections that are to be made in the Main Report /97/. Corrections in Annexes 1, 2 and 3 are not included in this Table because they are included as complete updated Annexes in this Addendum.

Table 1.3 *Overview of errata in the Main Report (excluding in Annex 1, 2 and 3).*

Location	Errata
Page 36, Fig. 3.15	Figure 3.15 is replaced by the following Figure showing the correct location of VOHE1: 
Page 51, Table 5.7	Actual crater radius F38G is 3.5 (not 0); Assumed/Actual crater radius F38G is 0.90 (not 0); Actual crater volume F38G is 2 (not uplift of seabed only) Total assumed volume is 4750 (not 4748);
Page 64, Table 5.12	Change detonation time of F38D on 4 June 2010 to 05:00 (not 05:30).

Updated Annexes

Wherever relevant, the corrections listed in above Table are included in the updated Annexes 1, 2 and 3, as part of this Addendum.

2 Munitions clearance activities

This Chapter

This Chapter elaborates on the actual munitions clearance activities for the three additional munitions.

Survey

Prior to the pipeline installation activities, a verification survey has been performed to check small objects that were found in earlier surveys. During that survey two objects, F47 at KP 191 and F48 at KP 238 were identified as naval or artillery shells (with charge weights 10 kg and 8 kg respectively) and one object F49 at KP 257 was identified as explosive float from a moored German contact sweep obstructor (with charge weight 0.8 kg).

Locations

The locations of the three additional munitions to be removed are shown in Figure 2.1. The locations of all munitions are also shown in more detail in Annex 1. The coordinates of the locations after shifting the munitions F47, F48 and F49 will be provided to the supervising authorities as a separate notification, as these are classified information.

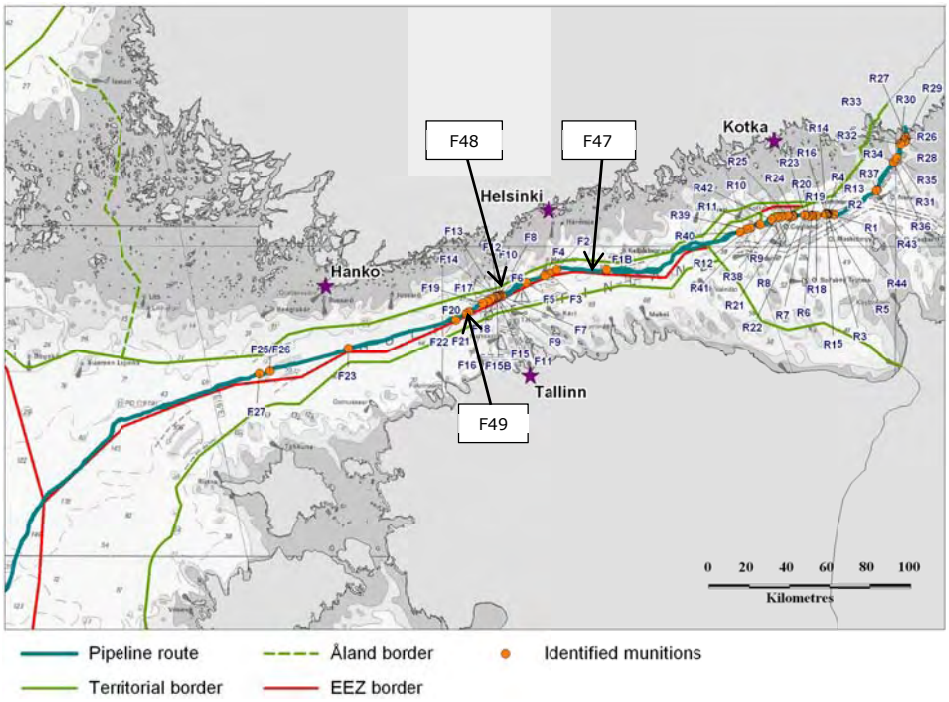


Figure 2.1 *Locations of munitions F47, F48 and F49, and all Phase 1 munitions in the Finnish EEZ and all identified munitions in Russian waters; for Phase 2 munitions see Figure 2.2 in Main Report.*

Munition clearance plan

Bactec International Ltd from the UK cleared successfully munitions F1 – F46, and also prepared 'Munitions Clearance Ordnance Removal ('Lift & Shift') Plans' for the three additional new munitions /50//51//52/. Bactec concluded that clearance by detonation was not necessary and that lifting the objects by a dedicated ROV and shifting them to a new location outside the security corridor of the pipeline would be the best method to 'clear' the munitions. This 'lift & shift' operation was carefully prepared by Bactec and MMT and performed by MMT, the survey company that has performed all route and munitions surveys for NSP, under the supervision of Bactec EOD engineer on 15 and 16 October 2010.

Included in Annex 2 and 3

The munitions were inspected visually by an ROV before and after their relocation. Relevant data of the additional munitions are included in Annex 2, and the images of the munitions prior to and after their relocation are shown in Appendix 3.

3 Monitoring activities

This Chapter

This Chapter contains the locations and methods for the sediment and benthos monitoring as reported in the updated water quality, sediment and benthos monitoring report /59/. Further reference is made to Chapter 3 of the Main Report /97/.

Sediment quality and benthos monitoring

The methods and all locations of the sediment and benthos monitoring and related water quality monitoring in the Finnish and Estonian EEZ are listed in Table 3.1. The locations are also shown in Figure 3.1.

Table 3.1

Overview of methods, stations and locations as reported in the water quality, sediment and benthos monitoring report /59/.

Methods	Station	Location
Vessel operated automatic water quality sensoring: *turbidity, salinity and temperature.* Water sampling: *heavy metals, suspended matter, turbidity and nutrients.*	VOHE1	~KP213
	VOM1	~KP366
	VOM2	~KP264
	VOM3	~KP243
	VOM4	~KP242
Sediment sampling: *Dioxins, organic tin compounds, As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg, Organic matter and nutrients, water quality were analysed also from water sample taken from VOM3/1 during pre and post sampling*	VOHE1	~KP213
	VOM1	~KP366
	VOM2	~KP264
	VOM3/SED	~KP243
	SED3(EST)	~3 km south of KP243
Benthos sampling: *Abundance of species and individuals, oxygen concentration.*	VOM3/BENT3	~KP243
	BENT3(EST)	~3 km south of KP243

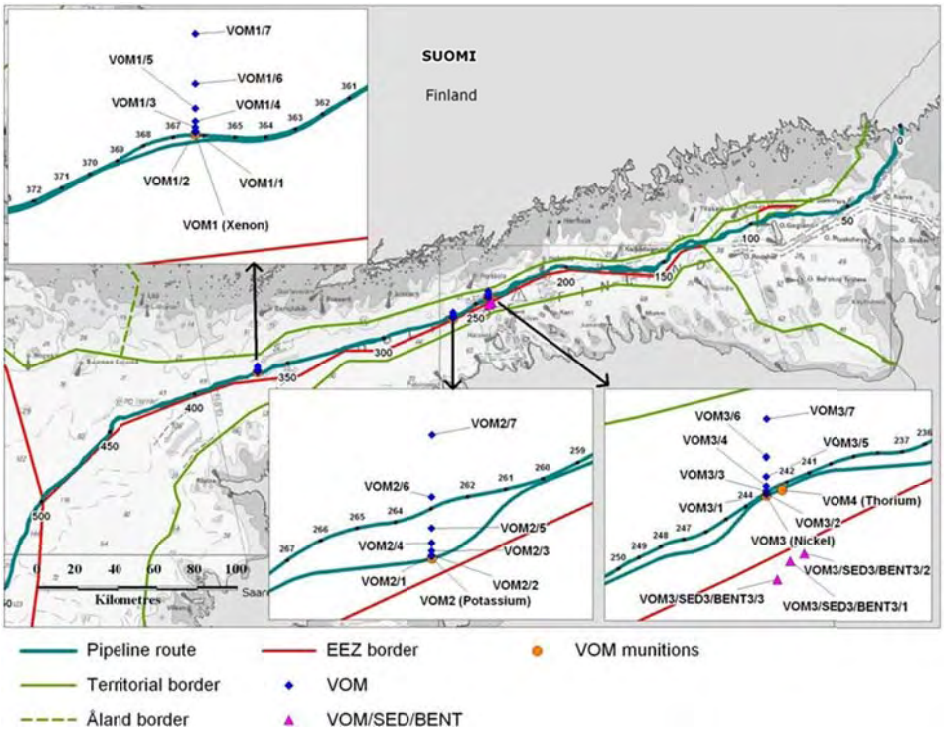


Figure 3.1 *Locations of the munition clearance monitoring sites: VOM1 - VOM4 from /59/. Purple triangle markers show monitoring locations in Estonian EEZ (the red line indicates the boundary between Finnish EEZ and Estonian EEZ).*

4 Monitoring results and impact assessment

This Chapter

This Chapter presents the results of the monitoring activities related to sediment and benthos monitoring related to the munition clearance activities in the Finnish EEZ. This Chapter should be read in conjunction with Chapter 5 of the Main Report because not all information provided in the Main Report is repeated in this Addendum. This Addendum focuses on the new available information.

Summary Table of impacts

The environmental impact assessment of the clearance activities have been presented in dedicated Summary Tables included in the assessment reports on Munition by Munition basis /72/ - /79/. Annex 2 of this Addendum contains the updated Summary Table that includes the summary of impacts as presented in this Chapter and in Chapter 5 of the Main Report.

4.1 Impacts on physical and chemical environment

Water and sediment quality monitoring

The water quality monitoring has been performed prior to and after detonation of 5 munitions and sediment quality monitoring prior to and after detonation of 4 munitions (see Table 3.1). Because of the importance of the subject, the full monitoring report from Luode Consulting /59/ is included in Annex 4, which includes all laboratory test results [2].

Sediment quality

The concentrations of harmful substances in the sediment samples taken after the clearance were observed to either decrease or be of the same order of magnitude as in the samples taken before the munitions clearance (see attachments 3 - 6 in /59/) in a rather random manner. The only exception was TBT which showed a strong increase at VOM3/SED3 and SED3(EST) stations and a smaller increase at VOM1 station after the detonations.

Cause of variations

The main cause for the observed variations is expected to be the natural heterogeneity of sediments. The 95% confidence limits of the analysed concentrations of harmful substances are according to the laboratory reports between 8% and 25% depending on the substance. Practically all organic and inorganic harmful substances (such as heavy metals, dioxins, furans), as well as nutrients, are associated either to organic matter or fine mineral (mainly clay) particles. Therefore the physical properties of sediment and changes in water depth are the main reasons for the observed natural variability of the results. No statistically significant correlation could be found for concentration changes when plotted against the measured distance from munitions. Considering this and the low turbidity levels monitored after the detonations it is unlikely that these recorded changes are related to munitions clearance activities.

Shipping lane

The relatively high concentration of TBT observed before and after the clearance is most likely caused by the presence of shipping lanes in the area. The long-term release of contaminations from ships anti-fouling is expected to be the reason.

[2] Annex 4 of this Addendum is the updated version of Annex 6.2 of the Maun Report.

Comparison with natural levels

The Finnish Ministry of the Environment has published Instructions for Dredging and Depositing Dredged Materials /60/. This publication gives instructions how the normalised concentrations of heavy metals, organotins, dioxins and furans should be compared with natural levels in sediments. Concentrations that are under the 'Level 1' represent the normal background concentration in the aquatic environment. Concentrations that exceed 'Level 1' but remain under 'Level 2' represent slightly contaminated sediment. Concentrations that exceed 'Level 2' represent contaminated sediment. From all 30 samples taken before and 30 samples taken after detonation [3], the following assessments are made from /59/:

- The sampling results show that (except for the relatively high concentrations of TBT likely caused by anti-fouling paints) the concentrations of contaminants in the sediments are low, which justifies the assumptions made during the modelling of the spreading of sediment and contaminants;
- The sampling results also show that there is no systematic change in the number of samples that are below or above the 'levels 1 or 2', before or after the clearance, which confirms that the clearance did not cause the changes;

Conclusion

The monitoring confirmed that there has been no significant impact of munitions clearance on water and sediment quality.

4.2 Impact on biotic environment

Benthos monitoring

Benthos samples have been taken at the stations VOM3/BENT3 in Finnish EEZ and BENT3(EST) in Estonian EEZ prior to and after the detonation and have been analysed and reported in Annex 4 (/59/. Benthos sampling showed that the bottom in the Finnish EEZ at BENT3 station was practically lifeless, although some macrozoobenthos was observed at locations BENT3/3 and BENT3/7 (coincide with VOM3/3 and VOM3/7 as shown in Figure 3.1). Samples taken from BENT3/3 after the clearance showed a slight decrease in benthos abundance when compared with samples taken prior to clearance from the same location. At the site BENT3(Est)/1 and to some extent in BENT3(Est)/3 (indicated as purple triagles in Figure 3.1 and located in the Estonian EEZ) there was a strong decline in the abundance and the biomass when comparing the results for the samples taken prior to clearance with samples taken after the clearance.

Cause of variations

The observed variations have carefully been considered to assess the possible cause of the variations. Not only in benthos, but variations were also observed in concentrations of organic and dry matter as found before and after munition clearance activities. Seasonal variations as possible cause are excluded because there was only 2 month time interval between the sampling. Also the level of turbidity increase caused by munitions clearance was so low that this cannot explain the observed variations. Spatial heterogeneity was indicated e.g. by the samples taken from BENT3 (Est)/2 location where the bottom was almost lifeless with little macrozoobenthos present. This location was situated only 900 m from BENT3 (Est)/1 and BENT3 (Est)/3 locations, where the amount of bottom animals were larger. Given the observed heterogeneity of the composition of the seabed, the variations in benthos are most likely caused by the uneven distribution of the macrozoobenthos at the seabed, in other words, by natural heterogeneity of the local conditions.

[3] Taking all monitoring stations into account.

Conclusion The monitoring confirmed that there has been no significant impact of munitions clearance on benthos.

4.3 Impact on economic and human conditions

Cable monitoring The monitoring of the cables proved to be difficult but was performed acceptable in most cases. In the following Table the cables are listed that were not monitored as planned for the mentioned munitions.

Cable	Event
UESF2	**F17**: During the 'before' survey the visibility was too poor to produce meaningful images; during the 'after' survey the footage from the ROV was not recorded for an unexplained reason, so no images are available /18/. All other monitoring of this cable (for F18, F19, F43 and F44) was as planned. No impacts have been noticed.
EE-SF2	**F37 – F38K** (11 FAB100 bombs): Detonation of these munitions could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations. Since the pressure waves measured close to the cable were smaller than predicted and even the predicted pressure waves were assessed to cause no impact on the cable, the modification of the monitoring procedure was regarded acceptable as part of the continuous efforts to minimise potential impact on the cable. Annex 3 provides the details.
EE-SF3	**F10, F15, F15B and F16**: The 'before and 'after' images of the cable that were not available in September 2010 have been supplemented in Annex 3. No impacts have been observed. The 'before' and 'after' images for the adjoined munitions F10, F15 and F15B were taken prior and after the disposal of all of these three munitions.
Pangea Seg 3	**F37 – F38K** (11 FAB100 bombs): The plan was to inspect this cable visually by an ROV (as all other cables, barrels and wrecks) but after a safety review this plan was abandoned. The cable is known to be in freespan from the seabed in several places close to the Nord Stream route and the consequent risks of equipment entanglement and safety of the ROV equipment and the cable itself were judged to be unacceptable /31/-/41/. Instead of the visual survey a high resolution MBES bathymetric survey was undertaken before the disposal of any of the FAB 100 bombs and after the disposal of the last (F38K). Results are included in Annex 3 for the first munition F37, which are valid for all other (F38 – F38K).

Conclusion on cables The monitoring confirmed that there has been no measureable impact of munitions clearance on cables, which is confirmed by the fact that no problems related to operability have been reported by the cable owners.

Barrels After careful review it was confirmed that the barrels R-09-49727A and R-09-49727B (potentiall impacted by F22) are actually the same object; the images are included in Annex 3 in the Section on F22 as barrel R-09-49727.

Through an operational oversight the survey of barrel R-09-326883 before and after clearance of munitions F22 was not undertaken /23/. All other 11 barrels potentially impacted by F22, however, were monitored as planned. The distance between the 'missed barrel' and F22 was 0.29 km and four of the other barrels were more close (0.24, 0.25, 0.27 and 0.29 km) and two were at the same distance. All these barrels were visually inspected before and after the clearance of F22 and no changes were observed. That justifies the statement that also barrel R-09-326883 will most likely not have been impacted, to which is added that the barrel is risk-category 1.

Conclusion on barrels

The monitoring confirmed that there has been no measurable impact of munitions clearance on barrels.

4.4 Transboundary impacts

Benthos and sediment monitoring

The results of the sediment and benthos monitoring performed at the station SED3/BENT3 (EST) in Estonian EEZ prior to and after the clearance of F17 have been presented in Chapter 4.2. The monitoring confirmed that variations in observed values were due to natural variations and were not caused by the munitions clearance operations and consequently did not cause transboundary impacts from Finland to Estonia.

5 Conclusions

1 All 52 munitions that had to be cleared prior pipeline installation, have been successfully cleared. This includes the three additional munitions that were successfully removed from the security corridor by a 'lift and shift' operation without detonation.

2 The completion of the analysis of the visual inspection data (as reported in the updated Annex 3) did not reveal any information that changed the conclusion as presented in the Main Report.
In summary:
- no displacements of barrels have been observed;
- no impacts on cultural heritage sites were observed;
- no impacts on cable infrastructure were observed.

3 The analysis of sediment and benthos samples, did not show statistically significant changes in (1) concentration of contaminants in sediment and (2) benthos that could be attributed to the munitions clearance operations. The measured variations are due to natural variations in the composition of the seabed.

4 The analyses of the laboratory test results for sediment and benthos samples confirmed that the munitions clearance operations did not cause significant transboundary impacts.

5 The monitoring of the munitions clearance has been performed in accordance with the approved monitoring programmes /68/, /70/ and /71/, except in the following cases:

- during the 'before' survey of F17 the visibility was too poor to produce meaningful images, and during the 'after' survey the footage from the ROV was not recorded for an unexplained reason, resulting in no images;
- it was decided to perform visual inspection of the cable EE-SF2 not after every detonation of the FAB100 bombs (F37 – F38K) but after a few detonations to reduce the potential impact on the cable;
- it was decided to perform the monitoring of the cable Pangea Seg 3 by MBES on an ROV that could stay at greater distance from the cable to reduce risk to the cable and the ROV;
- an operational error was made resulting in missing the inspection of one barrel (R-09-326883).

After thorough consideration, as reported in this Addendum, it is justified to state that these deviations of the original programmes did not affect the conclusions of the monitoring.

References

Colour code

The reference list below contains all references used in the Main Report and this Addendum. The references indicated with the number, revision and date in red, were included in the previous reference list but have been updated; the references indicated in red (number and text) are new.

/ 1 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Targets R-06-003 and R-W6F-10747 (Titanium and Vanadium), G-GE-MUN-REP-163-DSPRC002, rev. A-1, 24 Aug 2010. (F1B)

/ 2 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-07-004 (Cesium), G-GE-MUN-REP-163-DSPRC003, rev. A-1, 25 August 2010. (F2)

/ 3 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-07-004 (Calcium), G-GE-MUN-REP-163-DSPRC004, rev. A-1, 25 August 2010. (F3)

/ 4 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-07-2655 (Carbon), G-GE-MUN-REP-163-DSPRC005, rev. A, 9 March 2010. (F4)

/ 5 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8AG-W-014 (Chromium), G-GE-MUN-REP-163-DSPRC007, rev. A-1, 25 August 2010. (F5)

/ 6 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8AG-W-009 (Cobalt), G-GE-MUN-REP-163-DSPRC008, rev. A, 17 September 2010. (F6)

/ 7 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-E8C-10223 (Copper), G-GE-MUN-REP-163-DSPRC009, rev. A, 21 September 2010. (F7)

/ 8 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-W8A-10317-A (Tungsten), G-GE-MUN-REP-163-DSPRC010, rev. A, 21 September 2010. (F8)

/ 9 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8CG-E-004 (Gold), G-GE-MUN-REP-163-DSPRC011, rev. A, 21 September 2010. (F9)

/ 10 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Targets R-8CG-E-003 (Helium), G-GE-MUN-REP-163-DSPRC012, rev. A, 5 October 2010. (F10)

/ 11 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-W8A-10312 (Hydrogen), G-GE-MUN-REP-163-DSPRC013, rev. A, 23 September 2010. (F11)

/ 12 / Banctec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-W8A-10313 (Iron), G-GE-MUN-REP-163-DSPRC014, rev. A, 5 October 2010. (F12)

/ 13 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8-009 (Krypton), G-GE-MUN-REP-163-DSPRC015, rev. A, 5 October 2010. (F13)

/ 14 / Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-W8A-10005 (Lithium), G-GE-MUN-REP-163-DSPRC016, rev. A, 5 October 2010. (F14)

/15/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8CG-E-002 (Magnesium), G-GE-MUN-REP-163-DSPRC017, rev. A, 5 October 2010. (F15)

/16/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8-44944 (Indium), G-GE-MUN-REP-163-DSPRC128, rev. A, 4 October 2010. (F15B)

/17/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-8CG-E-001 (Neon), G-GE-MUN-REP-163-DSPRC018, rev. A, 27 October 2010. (F16)

/18/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-08-2805 (Nickel), G-GE-MUN-REP-163-DSPRC019, rev. A, 16 December 2010. (F17)

/19/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-08-159 (Nitrogen), G-GE-MUN-REP-163-DSPRC020, rev. A, 17 September 2010. (F18)

/20/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-09-27 (Zinc), G-GE-MUN-REP-163-DSPRC021, rev. A, 20 October 2010. (F19)

/21/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-09-3135 (Palladium), G-GE-MUN-REP-163-DSPRC023, rev. A, 17 September 2010. (F20)

/22/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-09-04 (Platinum), G-GE-MUN-REP-163-DSPRC024, rev. A, 12 October 2010. (F21)

/23/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-09-192 (Potassium), G-GE-MUN-REP-163-DSPRC025, rev. A, 27 October 2010. (F22)

/24/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-11-3395 (Silver), G-GE-MUN-REP-163-DSPRC026, rev. A, 5 November 2010. (F23)

/25/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-12-008 (Sculpture), G-GE-MUN-REP-163-DSPRC028, rev. A, 12 October 2010. (F25&F26)

/26/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-12-3463 (Xenon), G-GE-MUN-REP-163-DSPRC029, rev. A, 2 November 2010. (F27)

/27/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-11-200030 (Aluminum), G-GE-MUN-REP-163-DSPRC106, rev. A, 2 November 2010. (F33)

/28/ Bactec Int. Ltd, 2010, Munitions clearance Mine specific disposal record, Target R-12-51010 (Lead), G-GE-MUN-REP-163-DSPRC135, rev. A, 5 November 2010. (F34)

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Annex 1 Summary of munitions

This Annex

This Appendix contains the list of all munitions related to clearance prior construction activities of the Nord Stream pipelines. Table A1.1 contains the munitions of Phase 1 and Table A1.2 contains the munitions of Phase 2. The list contains the munitions in the order of NSP identification number. If the finally determined charge of the munitions was different from the initially assumed charge this is indicated by 'initial charge → final charge'. Munitions that have been assessed but were not cleared are indicated in *italic* and green. Figures A1.1 and A1.2 show the locations, the NSP identification number, the Bactec name and the disposal date of all considered munitions.

Table A1.1 *Summary of munitions of Phase 1.*

NSP ID	ROV ID	NAME ID	KP (C16)	Charge kg TNT	Date of clearance
F1	*R-06-003*	*Titanium*	181.140	-	12 Dec 09
F1B	R-W6F-10747	Vanadium		300	
F2	R-E7B-10466	Caesium	206.497	0.8	10 Dec 09
F3	R-07-004	Calcium	210.607	150	8 Dec 09
F4	R-07-2655	Carbon	213.402	150	6 Dec 09
F5	R-8AG-W-014	Chromium	223.229	300	15 Dec 09
F6	R-8AG-W-009	Cobalt	237.320	30	30 Apr 10
F7	R-E8C-10223	Copper	237.357	30	30 Apr 10
F8	R-W8A-10317	Tungsten	238.668	30	3 May 10
F9	R-8CG-E-004	Gold	238.596	30	3 May 10
F10	R-8CG-E-003	Helium	239.449	30	9 May 10
F11	R-W8A-10312	Hydrogen	240.094	30	12 May 10
F12	R-W8A-10313	Iron	240.198	30	16 May 10
F13	R-08-009	Krypton	240.232	30	16 May 10
F14	R-W8A-10005	Lithium	240.265	30	15 May 10
F15	R-8CG-E-002	Magnesium	239.966	30	10 May 10
F15B	R-08-44944	Indium		30	11 May 10
F16	R-8CG-E-001	Neon	240.219	300	17 May 10
F17	R-08-2805	Nickel	242.956	350 → 340	20 May 10
F18	R-08-159	Nitrogen	245.068	115	5 May 10
F19	R-09-27	Zinc	247.894	115	30 Apr 10
F20	S-09-3135	Palladium	255.893	300 → 115	25 Apr 10
F21	R-09-04	Platinum	257.385	0.8	19 Apr 10
F22	R-09-192	Potassium	263.621	115	20 Apr 10
F23	R-11-3395	Silver	319.304	100 → 200	14 Apr 10
F24	*R-11-5167*	*Sodium*	*334.210*	*250*	*No clearance: re-route*
F24B	*R-11-907818*			*250*	
F24C	*R-11-12*			*250*	
F25+ F26	R-12-008 (2 munitions)	Sulphur	360.517	64 → 0.8	10 Apr 10
F27	R-12-3463	Xenon	366.326	300	11 May 10

Table A1.2 *Summary of munitions of Phase 2.*

NSP ID	ROV ID	NAME ID	KP (C16)	Charge Kg TNT	Date of clearance
F28	*R-11-26161*	*Zirconium*	*322.192*	*115*	*No clearance: re-route*
F29	*R-11-38144*	*Scandium*	*322.257*	*115*	
F30	*R-11-25239*	*Lanthanum*	*326.354*	*240*	
F31	*R-11AG-WW-007*	*Silicon*	*326.327*	*240*	
F32	*R-11-25175*	*Tellurium*	*326.330*	*240*	
F33	R-11-200030	Aluminium	331.863	4*0.454	12 Apr 10
F34	R-12-51010	Lead	350.515	115	11 Apr 10
F35	R-13-31989	Osmium	375.664	250 → 100	9 Apr 10
F36	R-14-35290	Iridium	418.557	250 → 280	6 Apr 10
F37	R-08-2767	Rhodium	~218.110	46 → 42	27 May 10
F38	R-08-450077	Gallium		46 → 42	30 May 10
F38B	R-08-001-FAB	Terbium		46 → 42	28 May 10
F38C	R-08-002-FAB	Fluorine		46 → 42	31 May 10
F38D	R-08-003-FAB	Astatine		46 → 42	4 Jun 10
F38E	R-08-004-FAB	Nobelium		46 → 42	8 Jun 10
F38F	R-08-005-FAB	Mendelevium		46 → 42	7 Jun 10
F38G	R-08-006-FAB	Plutonium	218.148	46 → 42	10 Jun 10
F38H	R-08-007-FAB	Protactinium	~218.110	46 → 42	7 Jun 10
F38I	*R-08-008-FAB*	*Cerium*	*218.169*	*46 → 0*	*No clearance: tail fin*
F38J	R-08-009-FAB	Tritium	~218.110	46 → 42	11 Jun 10
F38K	R-08-010-FAB	Deuterium	218.329	46 → 42	11 Jun 10
F39	R-08-21000069	Germanium	223.737	20 → 8	10 May 10
F40	08-R-90	Thallium	246.670	115	2 May 10
F41	R-09-1000149	Arsenic	260.554	40 → 300	27 Apr 10
F42	R-09-1000202	Phosphorus	261.973	40	17 Apr 10
F43	R-08-44066	Polonium	241.75	300	21 May 10
F44	R-08-2000957	Thorium	241.946	300	25 May 10
F45	R-09-1116855	Samarium	258.12	60 → 136	14 May 10
F46	R-10-3227	Hafnium	298.42	200	12 May 10
F47	R-07-3400791		190.750	10	15 Oct 10
F48	R-08-3400066		238.001	8	16 Oct 10
F49	R-09-3401125		257.191	0.8	16 Oct 10

Note to F47 - F49: These munitions have no 'Bactec name' because they were 'lifted and shifted' by MMT and not cleared by detonation by Bactec.

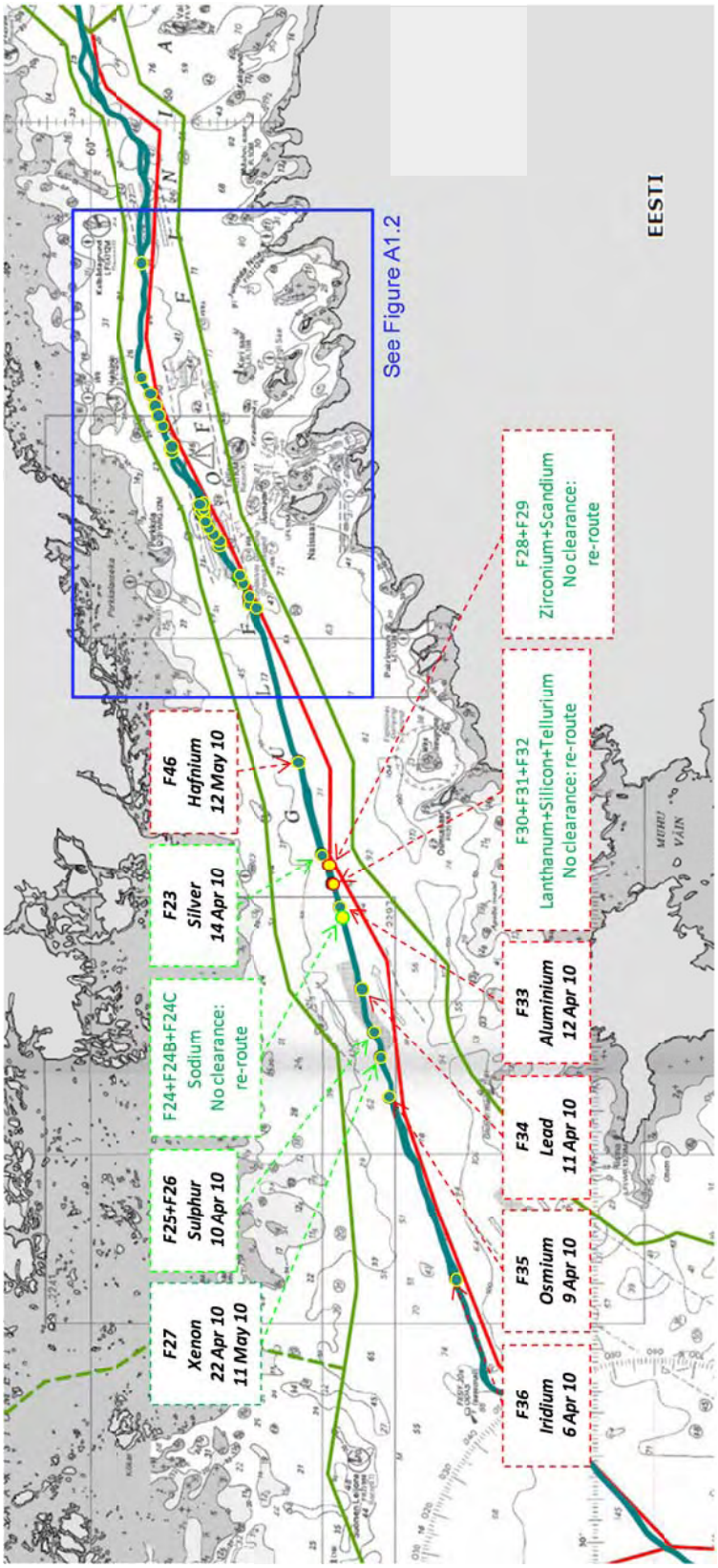


Figure A1.1 *Locations of all cleared munitions in the Finnish EEZ: Green boxes: Phase 1 munitions; Red boxes: Phase 2 munitions; the date of clearance is mentioned; the green text boxes indicate initially planned simultaneous detonations. Red line: boundary between Finland and Estonia; green lines: 12 mile limits.*

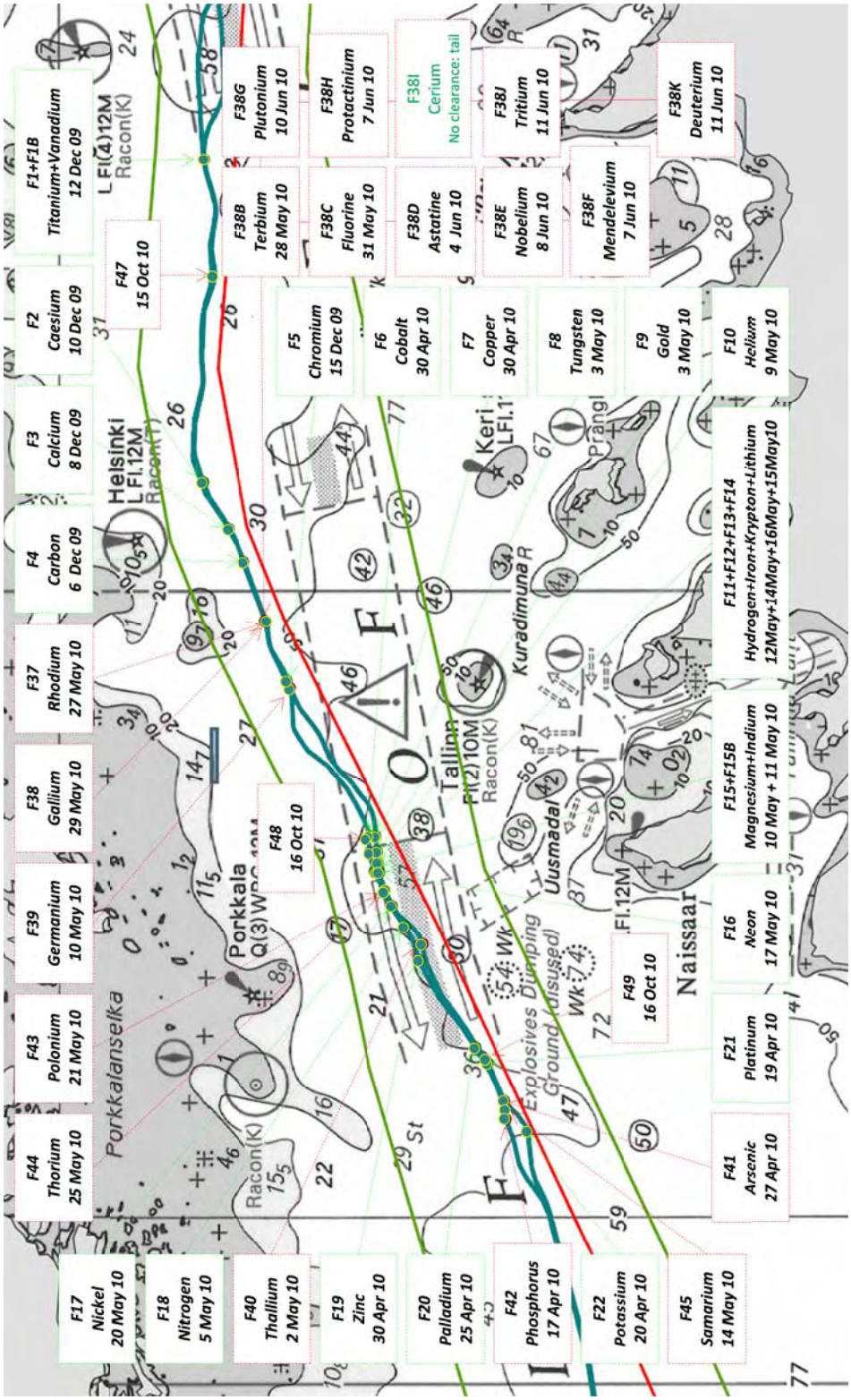


Figure A1.2 *Locations of all munitions cleared in eastern part the Finnish EEZ: Green boxes: Phase 1 munitions; Red boxes: Phase 2 munitions; the date of clearance is mentioned. Red line: boundary between Finland and Estonia; green lines: 12 mile limits.*

Annex 2 Summary Table of impacts

This Annex

This Annex presents in Table A2.1 the structure and legend, and in Table A2.2 the summary of the original assessed impacts and the observed impacts. The Table follows the same structure and layout as the Summary Tables that were included in all Munition by Munition assessment reports. Wherever relevant the initial (predicted) value is shown in brackets below the calculated value based on actual detonated charge or monitored impact. The first 4 pages present for all munitions the main information, seabed information and impacts on fish, seabirds and marine mammals; the second 4 pages present the impacts on infrastructure, cultural heritage, barrels and distances to long term monitoring stations and the Estonian EEZ.

Table A2.1 *Explanation of structure and content of the Table of impacts A2.2 for marine mammals and fish, infrastructure, cultural heritage and barrels.*

Issue	Column	Description
Munitions	MU1	Identification code of the munitions used in munition by munition impact assessment reports.
	MU2	Identification code of the munitions used by the survey company (MMT).
	MU3	Identification code of the munitions used by clearance contractor Bactec.
	MU4	Clearance phase of munitions as defined within the permitting procedure.
	MU5	Location of the munitions near the west or east pipeline route.
	MU6	Nearest KP according the route revision C16.
	MU7	Date of munitions disposal.
	MU8	The charge of the munitions as assessed by the clearance contractor during clearance campaign; (in brackets: the charge of the munitions as assessed prior to clearance campaign). This value is without the donor charge.
	MU9	Total detonated charge of munitions and detonation charge given by the clearance contractor after disposal; (in brackets: expected total charge of munitions and detonation charge to be detonated as assessed prior to clearance campaign). This value includes the donor charge.
	MU10	Water depth at location of munitions.
	MU11	Brief description of sediment and seabed type at location of munitions.
	MU12	Brief description of munitions as assessed prior to clearance campaign.
	MU13	Bactec munitions description.
	MU14	Bactec description of result of clearance works.
	MU15	Crater radius as measured from the post detonation MBES survey; (in brackets: estimated crater radius as assessed prior to clearance campaign).
	MU16	Amount of sediment that is released during clearance as measured from the post detonation MBES survey; (in brackets: estimated of amount of sediment to be released during clearance as assessed prior to clearance campaign).

<table>
<tr><td rowspan="6">Mammals and fish</td><td>MF1</td><td>Safe range [4] for mammals and fish assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: safe range for mammals and fish assessed prior to clearance campaign).</td></tr>
<tr><td>MF2</td><td>Injury range [5] for mammals and fish assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: injury range for mammals and fish assessed prior to clearance campaign).</td></tr>
<tr><td>MF3</td><td>Lethal range [6] for mammals and fish assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: lethal range for mammals and fish assessed prior to clearance campaign).</td></tr>
<tr><td>MF4</td><td>Visual observations of killed fish expressed in ‘kill level’:
<table>
<tr><th>Level</th><th>Description</th></tr>
<tr><td>0</td><td>No birds observed feeding.</td></tr>
<tr><td>1</td><td>Small flock of birds sporadically feeding for less than half an hour.</td></tr>
<tr><td>2</td><td rowspan="3">Increasing degrees of activity (based on flock size and intensity of feeding)</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td><td>Large flock of birds intensively feeding throughout the post-detonation watch period.</td></tr>
</table></td></tr>
<tr><td>MF5</td><td>Visual observations of seabirds during and after detonation as reported by dedicated Observers.</td></tr>
<tr><td>MF6</td><td>Visual observations of marine mammals as reported by Marine Mammal Observers.</td></tr>
<tr><td rowspan="5">Infrastructure</td><td>I1</td><td>Distance between munitions and cable.</td></tr>
<tr><td>I2</td><td>Peak pressure acting on cable due to shock wave assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: peak pressure acting on cable due to shock wave as assessed prior to clearance campaign).</td></tr>
<tr><td>I3</td><td>Name of cable owner.</td></tr>
<tr><td>I4</td><td>Cable route indication.</td></tr>
<tr><td>I5</td><td>Assessment of exposure or burial status of cable in seabed.</td></tr>
<tr><td rowspan="5">Cultural heritage</td><td>I6</td><td>Observations from ROV visual inspection after munitions clearance.</td></tr>
<tr><td>C1</td><td>Distance between munitions and cultural heritage site.</td></tr>
<tr><td>C2</td><td>Peak pressure acting on object due to shock wave assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: peak pressure acting on object due to shock wave as assessed prior to clearance campaign).</td></tr>
<tr><td>C3</td><td>Cultural heritage identification code.</td></tr>
<tr><td>C4</td><td>Brief description of object.</td></tr>
<tr><td>C5</td><td>Observations from ROV visual inspection after munitions clearance.</td></tr>
</table>

[4] Safe range: outside this distance unlikely to cause injury; within this distance (and outside the “injury range”) direct physical injury for mammals and probability of fish mortality 0 – 25%.
[5] Injury range: within this distance (and outside the “Lethal range”) increasing likelihood of death or severe injury leading to death in short time for mammals and probability of fish mortality 25 – 75%.
[6] Lethal range: within this distance always lethal for mammals and probability of fish mortality 75 – 100%.

Barrels	B1	Distance between munitions and barrels.
	B2	Peak pressure acting on barrel due to shock wave assessed after munitions clearance based on actual detonated charge (MU9); (in brackets: peak pressure acting on barrel due to shock wave as assessed prior to clearance campaign).
	B3	Barrel identification code.
	B4	Risk factor; as assessed by /86/.
	B5	Brief description of barrel.
	B6	Horizontal displacement from ROV visual inspection after munitions clearance; (in brackets: estimated horizontal displacement of barrel assessed prior to clearance campaign).
	B7	Observations from ROV visual inspection after munitions clearance.
Distance to long term monitoring stations		Distance in km to long term stations monitored by FMI and HELCOM.
Distance to FIN/ EST-EEZ boundary		Distance between munitions and EEZ boundary between Finland and Estonia.

Table A2.2

The following six A3 size Tables show the original assessed impacts and the observed impacts for:

- Fish, seabirds and marine mammals;
- Infrastructure;
- cultural heritage;
- barrels

and distances to

- protected areas
- Estonian EEZ

Table A2.2 Summary Table of impacts

Munitions														Fish, seabirds and marine mammals					
MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11	MU12	MU13	MU14	MU15	MU16	MF1	MF2	MF3	MF4	MF5	MF6
Munitions Identification			Clearance Phase	Approx. KP and W or E pipe (C16)		Date of disposal	Munitions charge	Total charge (incl. donor charge)	Water Depth	Sediment / Seabed Type	Original Munition Description	Bactec Munition Description	Result of disposal	Radius crater	Released sediment	Safe range for marine mammals and fish	Injury range for marine mammals/prob. fish mortality 25-75%	Lethal range for marine mammals/prob. fish mortality 75-100%	Fish	Seabirds	Marine mammels
NSP	MMT ID	BACTEC ID		West/ East pipe	KP		kg TNT	kg TNT	m					m	m3				Kill level	Est. nr.	
F1	R-06-003	Titanium	1	East	181.140	n/a	0 (350)	0 (395)	69.1	Sand	No conclusion reached due to bad visibility on video. Maximum found charge assumed	No munition	Removed	0 (5.8)	0 (155)	n/a (2100)	n/a (280)	n/a (35)			
F1B	R-W6F-10747	Vanadium	1	East	181.135	12-Dec-09	300 (350)	14 (395)	69.0			Finnish EMZ SE Antennae mine	Low order with disruption of target	0 (5.8)	0 (155)	700 (n/a)	90 (n/a)	12 (n/a)	(2)	~100 -> 200	
F2	R-E7B-10466	Caesium	1	East	206.497	10-Dec-09	0.8 (0.8)	9 (8.3)	68.3	Gravelly sand	German burst buoy (Spreng buoy). Consider to move it out of the corridor instead of demolition.	Original description confirmed.	Total Disruption of body of munition and its explosive fill	0 (2)	0 (7)	600 (600)	80 (80)	10 (10)	(1)	Small flock	
F3	R-07-004	Calcium	1	West	210.607	08-Dec-09	150 (150)	12 (195)	78.0	Clay with coarse sediments	Contact mine Russian origin.	German UMB with charge weight of 40 kg	Disruption and neutrali-sation of explosive fill by low order detonation	0.5 (4.6)	1 (77)	700 (1700)	90 (220)	11 (30)	(0)	~100 -> 200	
F4	R-07-2655	Carbon	1	West	213.402	04-Dec-09 06-Dec-10	150 (150)	13 (195)	74.0	Very soft clay	Contact mine Russian origin.	German EMR(K) Sweep obstacle float	Complete disruption of target casing by low order detonation	2.5 (5.8)	15 (153)	700 (1700)	90 (220)	12 (30)	(2)	~100 -> 200	
F5	R-8AG-W-014	Chromium	1	West	223.229	15-Dec-09	300 (300)	15 (345)	41.0	Crystalline bedrock	German EMC mine.	Original desription confirmed, charge weight of 250 kg.	Low order with complete disruption of target	No crater; munition on bedrock		700 (2000)	90 (260)	12 (35)	(2)	~400 -> 500	
F6	R-8AG-W-009	Cobalt	1	West	237.320	30-Apr-10	30 (30)	39.9 (75)	66.0	Clay with coarse sediments	German UMA contact mine.	German contact mine UMA 30kg	High order	1.7 (4.2)	3 (59)	1000 (1200)	130 (160)	17 (20)	1	~3 -> 25	
F7	R-E8C-10223	Copper	1	East	237.357	30-Apr-10	30 (30)	39.9 (75)	66.0	Silt and fine sand/some gravel	German UMA contact mine.	German contact mine UMA 30kg	High order	2.1 (4.2)	1 (59)	1000 (1200)	130 (160)	17 (20)	2	low visibility	
F8	R-W8A-10317	Tungsten	1	West	238.668	03-May-10	30 (30)	39.9 (75)	64.5	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	2 (4.2)	2 (59)	1000 (1200)	130 (160)	17 (20)	2	~20 -> 100	
F9	R-8CG-E-004	Gold	1	East	238.596	02-May-10 03-May-10	30 (30)	39.9 (75)	65.0	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	1.5 (4.2)	2 (59)	1000 (1200)	130 (160)	17 (20)	1	~3 -> 45	None
F10	R-8CG-E-003	Helium	1	East	239.449	07-May-10 09-May-10	30 (30)	39.9 (75)	66.0	Silt and fine sand/some gravel	German UMA mine.	German contact mine UMA 30kg	High order	2.8 (3.3)	2 (29)	1000 (1200)	130 (160)	17 (20)	2	~20 -> 30	
F11	R-W8A-10312	Hydrogen	1	West	240.094	12-May-10	30 (30)	39.9 (75)	64.0	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	2.3 (4.2)	2 (59)	1000 (1200)	130 (160)	17 (20)	1 - 2	~50 -> 90	
F12	R-W8A-10313	Iron	1	West	240.198	14-May-10 16-May-10	30 (30)	39.9 (75)	65.0	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	2.6 (4.2)	3 (59)	1000 (1200)	130 (160)	17 (20)	1 - 2	~30 -> 50	
F13	G-08-009	Krypton	1	West	240.232	13-May-10 14-May-10 16-May-10	30 (30)	39.9 (75)	65.0	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	3 (4.2)	7 (59)	1000 (1200)	130 (160)	17 (20)	2	~ 50	
F14	R-W8A-10005	Lithium	1	West	240.265	13-May-10 14-May-10 15-May-10	30 (30)	39.9 (75)	64.0	Silt and fine sand	German UMA mine.	German contact mine UMA 30kg	High order	2.2 (4.2)	3 (59)	1000 (1200)	130 (160)	17 (20)	1	~30 -> 50	
F15	R-8CG-E-002	Magnesium	1	East	239.966	10-May-10	30 (30)	39.9 (75)	65.0	Silt and fine sand/gravel patches	German UMA mine.	German contact mine UMA 30kg	Simultaneous detonation: first attempt High order on F15, second attempt high order on F15B	2.5 / 1.6 (3.3)	1 (29)	First attempt simultaneously, then separate	1000 (1200)	130 (160)	17 (20)	3	~20 -> 50	
F15B	R-08-44944	Indium	1	n/a	239.666	10-May-10 11-May-10	30 (30)	45 (75)	n/a	Silt and fine sand/gravel patches	German UMA mine.	German contact mine UMA 30kg		3.8 (3.3)	6 (0)		1000 (n/a)			4	~50 -> 70
F16	R-8CG-E-001	Neon	1	East	240.219	17-May-10	300 (300)	315.1 (345)	65.0	Silt and fine sand	German EMC II mine.	German contact mine type EMC II 300 kg	High order	7.6 (7)	20 (271)		2000 (1200)	260 (160)	34 (20)	3	~15 -> 50
F17	R-08-2805	Nickel	1	East	242.956	17-May-10 20-May-10	340 (350)	356.1 (395)	71.0	Very soft clay	German EMF mine.	Geman buoyant magnetic (influence) mine, EMF 340kg	Mechanical high order of mine, only 1 piece of lower case left on sea bed	2.1 / 5.1 (7.3)	10 (310)		2100 (2100)	270 (280)	35 (35)	1	Small flock	
F18	R-08-159	Nitrogen	1	West	245.068	05-May-10	115 (115)	8.6 (160)	68.5	Silt and fine sand	Russian contact mine M-08.	Russian M08/39 contact mine, weight 115kg	Low order	2.5 (4.3)	8 (63)		600 (1600)	80 (210)	10 (30)	3	Some	
F19	R-09-27	Zinc	1	West	247.894	30-Apr-10	115 (115)	8.6 (160)	68.0	Crystalline bedrock/coarse granular	Russian contact mine M-08.	Russian M08/39 contact mine, weight 115kg	Donor charge	0 (4.3)	0 (63)		600 (1600)	80 (210)	10 (30)	2	~50	

Table A2.2 Summary Table of impacts

Munitions															Fish, seabirds and marine mammals					
MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11	MU12	MU13	MU14	MU15	MU16	MF1	MF2	MF3	MF4	MF5	MF6
Munitions Identification			Clearance Phase	Approx. KP and W or E pipe (C16)		Date of disposal	Munitions charge	Total charge (incl. donor charge)	Water Depth	Sediment / Seabed Type	Original Munition Description	Bactec Munition Description	Result of disposal	Radius crater	Released sediment	Safe range for marine mammals and fish	Injury range for marine mammals/prob. fish mortality 25-75%	Lethal range for marine mammals/prob. fish mortality 75-100%	Fish	Seabirds	Marine mammels
NSP	MMT ID	BACTEC ID		West/ East pipe	KP		kg TNT	kg TNT	m					m	m3				Kill level	Est. nr.	
F20	S-09-3135	Palladium	1	West	255.893	24-Apr-10 25-Apr-10	115 (300)	118.2 (345)	63.0	Gravelly sand/sandy clay	German EMC mine.	Russian M08/39 contact mine, weight 115kg	High order	3.3 (7)	8 (271)	1400 (2000)	190 (260)	24 (35)	3	~50 -> 150	
F21	R-09-04	Platinum	1	East	257.385	19-Apr-10	0.8 (0.8)	4.8 (8.3)	65.0	Gravelly sand	German burst buoy (Spreng buoy). Charge to clear is larger than original charge	German "type1" explosive float from a moored contact sweep obstructer	High order	0.8 (1.6)	1 (3)	500 (600)	60 (80)	8 (10)	2	~25	
F22	R-09-192	Potassium	1	East	263.621	20-Apr-10	115 (115)	124 (160)	61.0	Silt and fine sand	Russian contact mine M-08.	Russian buoyant contact mine type M08/39, 115kg	High order	5 (5.4)	7 (126)	1400 (1600)	190 (210)	25 (30)	2 - 3	~150	
F23	R-11-3395	Silver	1	West	319.304	14-Apr-10	200 (100)	212.8 (145)	81.0	Very soft clay	Finnish S-40 mine.	Finnish contact myne type S/43 100kg, possible Finnish S/38 200kg. Treated as 200kg	Donor charge only	5.2 (5.3)	46 (114)	1700 (1600)	230 (200)	30 (25)	1 - 2	~300	None
F24	R-11-5167	Sodium	1	East	334.210		xx (250)	(295)	80.0	Clay with coarse sediments	Russian contact mine.			(5.3)	(0)	xx (1900)	(250)	xx (30)			
F24B	R-11-907818		1	West	334.270		xx (250)	(295)													
F24C	R-11-12		1	West	334.220		xx (250)	(295)													
F25+F26	R-12-008	Sulphur	1	West	360.517	10-Apr-10	64 (64)	72 (109)	64.0	Gravelly sand. Large boulders	Possible 2 air dropped bombs. No mine. Charge assumed: 2 * 32 kg	Floats from a russian minesweeping device	No explosives in contacts; therefore donor charge only	1 (3.8)	1 (43)	1200 (1400)	160 (180)	21 (25)	1	~200	None
F27	R-12-3463	Xenon	1	West	366.326	22-Apr-10 11-May-10	300 (300)	311.5 (345)	78.0	Very soft clay	German EMC II mine.	Geman EMC II mine	High order	6.5 (7)	18 (271)	2000 (2000)	260 (260)	34 (35)	4	large number	1 seal

Table A2.2 Summary Table of impacts

Munitions																Fish, seabirds and marine mammals					
MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9	MU10	MU11	MU12	MU13	MU14	MU15	MU16		MF1	MF2	MF3	MF4	MF5	MF6
Munitions Identification			Clearance Phase	Approx. KP and W or E pipe (C16)		Date of disposal	Munitions charge	Total charge (incl. donor charge)	Water Depth	Sediment / Seabed Type	Original Munition Description	Bactec Munition Description	Result of disposal	Radius crater	Released sediment		Safe range for marine mammals and fish	Injury range for marine mammals/prob. fish mortality 25-75%	Lethal range for marine mammals/prob. fish mortality 75-100%	Fish	Seabirds	Marine mammels
NSP	MMT ID	BACTEC ID		West/ East pipe	KP		kg TNT	kg TNT	m					m	m3					Kill level	Est. nr.	
F28	R-11-26161	Zirconium	2	East	322.192	No clearance	xx (115)	(160)	82	Very soft clay	M08-39, Russian moored contact mine			(5.4)	(0)	Oroginaly planned simultaneously	(2900)	(260)	(35)			
F29	R-11-38144	Scandium	2	East	322.257		xx (115)	(160)	83	Very soft clay	M08-39, Russian moored contact mine			(5.4)	(0)							
F30	R-11-25239	Lanthanum	2	West	326.354		xx (240)	(285)	82	Very soft clay	M26, Russian moored contact mine still in its anchor			(6.6)	(0)	Originaly planned simultaneously	(1900)	(250)	(30)			
F31	R-11AG-WW-007	Silicon	2		326.327	No clearance	xx (240)	(285)	80	Sand	M26, Russian moored contact mine			(5.2)	(0)		(3400)	(450)	(40)			
F32	R-11-25175	Tellurium	2	West	326.330		xx (240)	(285)	80	Very soft clay	M26, Russian moored contact mine			(6.6)	(0)							
F33	R-11-200030	Aluminium	2	West	331.836	12-Apr-10	1.8 (1.82)	10.3 (9.32)	79	Clay with coarse sediment	Sweep obstructor Ru MZ26 (MK3)	Russian MZ26 Sweep Obstructer, with four of the original eight explosive cutters remaining	Donor charge only	1.8 (1.7)	2 (4)		600 (600)	80 (80)	11 (10)	1	~70	None
F34	R-12-51010	Lead	2	East	350.515	11-Apr-10	115 (115)	8.5 (160)	80	Very soft clay	M08-39, Russian moored contact mine	Russian M-08/39 buoyant contact mine 115kg	Donor charge only	2.1 (5.4)	12 (126)		600 (1600)	80 (210)	10 (30)	1	~30 - 50	
F35	R-13-31989	Osmium	2	East	375.664	09-Apr-10	100 (250)	112 (295)	70	Very soft clay	Munitions, corroded type FMB sea mine in anchor chair	Russian M12 contact mine, 115kg	High order	3.1 (6.7)	40 (232)		1400 (1900)	180 (250)	24 (30)	2	~60	
F36	R-14-35290	Iridium	2	West	418.557	06-Apr-10	280 (250)	294.4 (295)	90	Very soft clay	Munition, torpedo head	German Type G7e torpado warhead. Maximum charge 280kg	High order	4.0 / 3.0 (6.7)	3.3 (232)		1900 (1900)	250 (250)	33 (30)	3	~20 - 100	
F37	R-08-2767	Rhodium	2	West	218.200	24-May-10 27-May-10	42 (46)	51.1 (91)	75	Sand and gravel	Russian air-dropped bomb type FAB 50	Russian air-dropped bomb FAB100	No debris to be seen on the seabed	6.5 / 4.0 (3.9)	10 (48)		1100 (1300)	140 (170)	18 (25)	1	12	
F38	R-08-450077	Gallium	2	West	218.273	29-May-10 30-May-10	42 (46)	51.6 (91)	73	Sand and gravel	Russian air-dropped bomb type FAB 50	Russian air-dropped bomb FAB100	High order	0 (3.9)	2 (48)		1100 (1300)	140 (170)	18 (25)	3	2 -> 11	
F38B	R-8-001-FAB	Terbium	2	West	218.272	28-May-10	42 (46)	48.4 (91)	70	Mud/clay	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	2 (3.9)	6 (48)		1100 (1300)	140 (170)	18 (25)	4	6	
F38C	R-08-002-FAB	Fluorine	2	West	218.241	31-May-10	42 (46)	49.6 (91)	70	Soft mud/clay	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	2.5 / 3.0 (3.9)	8 (48)		1100 (1300)	140 (170)	18 (25)	1	~15 -> 40	
F38D	R-08-003-FAB	Astatine	2	East	218.233	04-Jun-10	42 (46)	48.6 (91)	70	Soft mud	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	3.7 (3.9)	17 (48)		1100 (1300)	140 (170)	18 (25)	1	0 -> 5	
F38E	R-8-004-FAB	Nobelium	2	West	218.169	06-Jun-10 08-Jun-10	42 (46)	48 (91)	70	Clay	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	2.8 (3.9)	22 (48)		1100 (1300)	140 (170)	18 (25)	3	30	
F38F	R-8-005-FAB	Mendelevium	2	East	218.188	07-Jun-10	42 (46)	46 (91)	70	Clay	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	4.2 / 3.0 (3.9)	9 (48)		1000 (1300)	140 (170)	18 (25)	2	20	
F38G	R-08-006-FAB	Plutonium	2	East	218.148	10-Jun-10	42 (46)	48 (91)	70	Soft clay/mud	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	3.5 (3.9)	2 (48)		1100 (1300)	140 (170)	18 (25)	1	12	
F38H	R-08-007-FAB	Protactium	2	East	218.140	07-Jun-10	42 (46)	48 (91)	70	Soft clay	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	3 (3.9)	3 (48)		1100 (1300)	140 (170)	18 (25)	2	15	
F38I	R-08-008-FAB	Cerium	2	East	218.169	No clearance	(46)	(91)	70		Tail from FAB100 only											None
F38J	R-08-009-FAB	Tritium	2	West	218.316	11-Jun-10	42 (46)	48.6 (91)	70	Soft clay - hard boulder clay/sand crater	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	5.8 / 3.8 (3.9)	21 (48)		1100 (1300)	140 (170)	18 (25)	4	0	
F38K	R-08-010-FAB	Deuterium	2	West	218.329	11-Jun-10	42 (46)	48.6 (91)	70	Mud/rock/sand	Russian air-dropped bomb FAB100	Russian air-dropped bomb FAB100	High order	0.8 (3.9)	4 (48)		1100 (1300)	140 (170)	18 (25)	1 - 2	3	
F39	R-08-1000069	Germanium	2	West	223.737	28-Apr-10 10-May-10	8 (20)	19.5 (65)	54	Coarse sediment	Medium sized artillery grenade	Naval or Artillery Shell, estimated 8kg	High order	0 (3.2)	1 (26)		800 (1200)	100 (160)	13 (20)	2	Small flock	
F40	08-R-90	Thallium	2	East	246.670	02-May-10	115 (115)	8.6 (160)	69	Soft clay	Russian contact mine Type M08	Russian M08/39 cotact mine, 115kg	Low order	2.0 / 7.5 (5.4)	16 (126)		600 (1600)	260 (210)	10 (30)	1	~10	
F41	R-09-1000149	Arsenic	2	East	260.554	25-Apr-10 27-Apr-10	300 (40)	312 (85)	60	Glacial till, coarse sediment with boulders	German contact mine Type UMB	German EMCII mine	High order	2 (3.5)	18 (33)		2000 (1300)	260 (170)	34 (25)	1	~20 - 30	
F42	R-09-1000202	Phosphorus	2	West	261.973	16-Apr-10 17-Apr-10	40 (40)	45.8 (85)	56	Coarse sediment	German contact mine Type UMB	German UMB buoant contact mine, 40kg	High order	2 (3.5)	7 (33)		1000 (1300)	140 (170)	18 (25)	1	~20 - 40	
F43	R-08-44066	Polonium	2	West	241.750	21-May-10	300 (300)	315.1 (345)	70	Clay / Soft clay	German EMC	German EMCII mine	High order	5.9 (7)	21 (271)		2000 (2000)	260 (260)	34 (35)	1 - 2	~40 -> 100	
F44	R-08-2000957	Thorium	2	West	241.946	25-May-10	300 (300)	316.6 (345)	70	Clay / Soft clay	German EMC	German EMCII mine	Mechanical high order	2.5 (7)	5 (271)		2000 (2000)	260 (260)	34 (35)	2 - 3	~10 -> 50	
F45	R-09-1116855	Samarium	2	West	258.120	14-May-10	136 (60)	144.6 (105)	65	Clay with coarse sediment	German WBF	German depth charge WBF 60kg or Type I 136kg	High order	3.7 (3.7)	19 (41)		1500 (1400)	200 (180)	26 (25)	4	~100	
F46	R-10-3227	Hafnium	2	West	298.420	12-May-10	200 (200)	208.6 (245)	85	Fine sediment	Depth charge or part of torpedo	Object with characteristics of a munition, max. 200kg.	High order	3.5 (6.3)	10 (192)		1700 (1800)	230 (230)	29 (30)	1	~20	
F47	R-07-3400791	*Handled by MMT*	2	West	190.724	15-Oct-10	10		62	Silt and fine sand	Naval shell	Naval or artillery shell	Lifted and shifted; not detonated	No craters								
F48	R-08-3400066		2	West	238.001	16-Oct-10	8		65													
F49	R-09-3401125		2	East	257.189	16-Oct-10	0.8		61		German explosive float from a moored contact sweep obstructer	German explosive float from a moored contact sweep obstructer										

Table A2.2 Summary Table of impacts

Munitions			Infrastructure						Cultural Heritage					Barrels							Distance to long term monitoring stations		Distance to FIN / EST-EEZ boundary
MU1	MU2	MU3	I1	I2	I3	I4	I5	I6	C1	C2	C3	C4	C5	B1	B2	B3	B4	B5	B6	B7			
Munitions Identification			Distance	Peak pressure	Owner Cable	From / to	Status	Observations	Distance	Peak pressure	ID	Description	Observations	Distance	Peak pressure	Barrel ID	Risk factor	Description	Horizontal displacement	Observations			
NSP	MMT ID	BACTEC ID	km	MPa					km	MPa				km	MPa				m		km	St.	km
F1	R-06-003	Titanium												0.48	0 (1.01)	R-06-20629	1	The barrel is quite corroded; unknown content; openings on both sides.	0 (0.7)	Intact	8.1	LL5	2.35
F1B	R-W6F-10747	Vanadium												0.53	0.14 (1.01)								
F2	R-E7B-10466	Caesium																			2.2	LL6A	2.72
F3	R-07-004	Calcium							0.70	0.1 (0.27)	R-07-41172	The wreck is of a small vessel of wooden construction about 12m long. The height above	No Impact										1.46
F4	R-07-2655	Carbon							1.17	0.05 (0.15)	MB-07-2736	Rusalka: Ironclad vessel built in 1868, sank in storm in 1893; half embedded in seabed.	No Impact	0.10	0.88 (2.45)	07-S-73	3	Slightly corroded; undamaged.	0 (2)	Intact	4.6	LL7	1.27
F5	R-8AG-W-014	Chromium																					1.94
F6	R-8AG-W-009	Cobalt	0.67	n/a (0.2)					0.98	0.06 (0.13)	S-08-2939	Wooden sailing vessel. Est. age latter half of the 19th century. Considered to be of cultural heritage interest.	No Impact	0.03	5.25 (6.66)	R-W8A-10041	0	Metal debris. Small metal drum.	0 (3)				1.65
														0.70	0.15 (0.19)	R-08-2938	0		0 (0.1)				
														0.88	0.12 (0.15)	R-08-321109	3	200 lt barrel, one end closed, other not visible, quite corroded but apparently undamaged	0 (0.3)				
														0.50	0.22 (0.28)	R-08-42672	0		0 (0.2)				
														0.44	0.25 (0.32)	R-08-44156	0		0 (0.3)				
														0.90	0.11 (0.14)	R-08-45979	3	200 lt barrel, both ends closed, fairly corroded but apperently undamaged	0 (0.2)				
F7	R-E8C-10223	Copper	0.92	n/a (0.14)					0.88	0.07 (0.15)	3_9	Wreck identified from SSS only. Significance of the wreck is not assessed	No Impact	1.30	0.07 (0.09)	R-08-321109	3	200 lt barrel, one end closed, other not visible, quite corroded but apparently undamaged	0 (0.3)		12.0	GF1	1.19
														0.85	0.12 (0.15)	R-08-42672	0		0 (0.2)				
														0.45	0.25 (0.31)	R-08-44156	0		0 (0.3)				
														1.33	0.07 (0.09)	R-08-45979	3	200 lt barrel, both ends closed, fairly corroded but apparently undamaged	0 (0.2)				
F8	R-W8A-10317	Tungsten	0.34	n/a (0.43)										0.91	0.11 (0.14)	R-08-46223	0		0 (0.1)				2.2
														0.54	0.2 (0.25)	R-W8A-10041	0		0 (3)				
														0.93	0.11 (0.14)	R-08-42672	0		0 (0.2)				
														0.50	0.22 (0.28)	R-08-44339	0		0 (1.4)				
														0.22	0.55 (0.7)	R-08-44744	0		0 (0.7)				
														0.43	0.26 (0.33)	08-S-33	0		0 (0.9)				
F9	R-8CG-E-004	Gold	0.14	n/a (1.16)	Elion: EE-SF3	Lauttasaari (FIN)- Meremoisa (LAT)	Detected. Buried between 0.2 to 0.5 m.	No impact	0.90	0.07 (0.14)	3_9	See above	No Impact	0.19									1.63
														0.96	0.1 (0.13)	R-08-321109	3	200 lt barrel, one end closed, other not visible, quite corroded but apparently undamaged	0 (0.3)				
														0.11	1.21 (1.53)	R-08-44339	0		0 (1.4)				
														0.49	0.22 (0.28)	R-08-44744	0		0 (0.7)				
														0.76	0.14 (0.17)	R-08-45575	0		0 (0.1)				
														0.59	0.18 (0.23)	R-08-45629	0		0 (0.1)				
														0.99	0.1 (0.13)	R-08-45979	3	200 lt barrel, both ends closed, fairly corroded but apparently undamaged	0 (0.2)	Intact			
														0.65	0.16 (0.21)	R-08-46223	0		0 (0.1)				
														0.90	0.11 (0.14)	R-E8C-10226A	0		0 (2.4)				
														(Nearest: F15B) 0.35	0.33 (0.82, Maximum F15/F15B)	R-08-58162	3	200 lt barrel, top and cap hole closed, quite corroded.	0 (2)				
														(Nearest: F15B) 0.44	0.25 (0.65, Maximum F15/F15B)	R-E8C-10226B	3	200 lt barrel, top and cap hole closed, quite corroded.	0 (2.6)				
														(Nearest: F15B) 0.43	0.26 (0.65, Maximum F15/F15B)	R-E8C-10227	3	200 lt barrel, top and cap hole closed, quite corroded.	0 (2.6)				
F10	R-8CG-E-003	Helium	0.39	n/a (0.37)																			1.95
F11	R-W8A-10312	Hydrogen	0.98	n/a (0.13)																			2.44
F12	R-W8A-10313	Iron	1.02	n/a (0.12)																			2.45
F13	G-08-009	Krypton	1.01	n/a (0.13)																			2.42
F14	R-W8A-10005	Lithium	1.02	n/a (0.12)																			2.44
F15	R-8CG-E-002	Magnesium	0.70	n/a (0.19)																			2.13
F15B	R-08-44944	Indium	0.70	n/a (0.19)																			
F16	R-8CG-E-001	Neon	0.83	n/a (0.28)																			2.2
F17	R-08-2805	Nickel	0.47	n/a (0.56)	Telenor Sweden: UESF2	Helsinki (FIN)- Hangö (FIN)	Partly exposed	No impact							0.31 (0.32)	R-08-45237		200 lt barrel, both ends closed and cap hole clogged; quite corroded and slightly contracted but apparently undamaged.	0 (0.2)				2.44
F18	R-08-159	Nitrogen	1.01	0.07 (0.23)	Estlink: Energia	Helsinki (FIN)- Tallinn (EST)	Partly exposed	No impact						0.49	0.13 (0.38)	R-08-44979	1		0 (0.2)				2.31
			0.44	Measuring unsuccesful (0.42)																			
			0.47	n/a (0.4)	Elisa: FEC1	Porkkala-Kakumäe	Partly exposed	No impact															
			0.58	n/a (0.31)	Telenor Sweden: UESF2	Helsinki (FIN)- Hangö (FIN)	Partly exposed	No impact						0.47	0.13 (0.4)	R-09-48197	0		0 (0.2)	Damaged by ROV			2.44
F19	R-09-27	Zinc	0.35	n/a (0.74)										0.47	0.13 (0.4)	R-09-48198	0		0 (0.2)	Intact			

Table A2.2 Summary Table of impacts

Munitions			Infrastructure						Cultural Heritage					Barrels							Distance to long term monitoring stations		Distance to FIN / EST-EEZ boundary
MU1	MU2	MU3	I1	I2	I3	I4	I5	I6	C1	C2	C3	C4	C5	B1	B2	B3	B4	B5	B6	B7			
Munitions Identification			Distance	Peak pressure	Owner Cable	From / to	Status	Observations	Distance	Peak pressure	ID	Description	Observations	Distance	Peak pressure	Barrel ID	Risk factor	Description	Horizontal displacement	Observations			
NSP	MMT ID	BACTEC ID	km	MPa					km	MPa				km	MPa				m		km	St.	km
F20	S-09-3135	Palladium																					1.37
F21	R-09-04	Platinum							0.54	0.08 (0.1)	4_9	Wreck identified from SSS only. Significance of the wreck is not assessed	No Impact	0.37	0.14 (0.17)	R-09-49088	1	200 lt barrel; both ends closed; small hole; fairly good condition.	0 (0.1)				1.04
									0.87	0.05 (0.06)	S-09-49167	Possible wreck	No Impact	0.85	0.05 (0.07)	R-09-48535	0	100 lt container; top open and quite corroded.	0 (0)				
														0.78	0.06 (0.07)	R-09-47641	0	200 lt barrel; one end open. Slightly corroded, but apparently undamaged.	0 (0)				
														0.82	0.06 (0.07)	R-09-48737	3	100 lt container; top closed. Quite corroded and contracted, but apparently undamaged.	0 (1.2)				
														0.93	0.05 (0.06)	09-S-14	1	200 lt barrel; both ends closed, but cap hole open. Slightly corroded, but apparently undamaged.	0 (0)				
F22	R-09-192	Potassium												0.29	0.61 (0.67)	R-09-49750	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.5)		5.8	LL9	0.46
														0.24	0.76 (0.84)	R-09-49727	1	100 lt container; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.7)				
														0.25	0.72 (0.8)	R-09-326892	0	200 lt barrel; slightly corroded; open end; partly embedded in seabed.	0 (0.6)				
														0.31	0.57 (0.63)	R-09-49742	0	200 lt barrel; one end open; badly corroded and punctured.	0 (0.5)				
														0.29	0.62 (0.68)	R-09-49716	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.5)				
														0.29	0.61 (0.67)	R-09-326883	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.5)				
														0.32	0.56 (0.62)	R-09-49718	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.5)				
														0.34	0.51 (0.56)	R-09-49717	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.4)				
														0.27	0.68 (0.75)	R-09-49719	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.6)				
														0.33	0.54 (0.59)	R-09-49740	0		0 (0.4)				
														0.28	0.65 (0.71)	R-09-49736	1	200 lt barrel; other end open, but with an artificial "resinlike" cover? Other end not visible. Quite corroded, but apparently undamaged.	0 (0.6)				
														0.94	0.2 (0.17)	R-11-3397	1	200 lt barrel; one end possibly open, slightly corroded, but apparently undamaged.	0 (0.1)				
F23	R-11-3395	Silver							1.29	0.05 (0.1)	S-11-3138	Wreck of a typical coastal vessel from the 20th century. Many parts of the wreck are broken up.	No Impact	0.54	0.38 (0.33)	R-11-25197 = RPS-11-2218	0	200 lt barrel; one end likely open.	0 (0.2)	Intact	26.0	JML	1.81
														0.72	0.27 (0.24)	R-11-26043	0	Broken barrel and plastic bag	0 (0.1)				
														0.60	0.33 (0.29)	R-11-26112	0	Plastic bag	0 (0.1)				
														0.59	0.34 (0.29)	R-11-26249	0		0 (0.1)				
														0.15	1.6 (1.39)	R-11-300686 = RPS-11-2219	0	200 lt barrel; One end open; nearly empty.	0 (1.1)				
														0.86	0.22 (0.19)	R-11-3321	0	50 lt container; one end open.	0 (0.1)				
														0.83	0.23 (0.2)	RPS-11-1330	1	200 lt barrel; Small rupture in the bottom, some debris nearby.	0 (0.1)				
														0.77	0.25 (0.22)	RPS-11-2216	3	200 lt barrel; fairly good condition; no openings observed	0 (0.1)		13.0	LL11A	
														0.77	0.25 (0.22)	R-11-3396	2	200 lt barrel; one end likely open.	0 (0.1)				
														0.65	0.31 (0.27)	R-11-25305	0	200 lt barrel; hole 20 x 20 cm cut on one side; bottom also cut open or broken	0 (0.1)				
														0.92	0.21 (0.18)	RPS-11-241	3	70 lt container; closed ; fairly good condition.	0 (0.1)				
														0.59	0.34 (0.29)	R-11-26257	3	60 lt container; both ends closed.	0 (0.1)				
														0.62	0.32 (0.28)	R-11-26567	1	30 lt container; one end closed; one end flattened and buried in the seabed and most probably open.	0 (0.1)				
														0.65	0.3 (0.26)	R-11-26568	0	70 lt container; one end open; other enbd closed.	0 (0.1)		8.5	LL11	
														0.62	0.32 (0.28)	R-11-26250	0	70 lt container; top open; some solids in.	0 (0.1)				
														0.56	0.36 (0.31)	R-11-25639	0	0.4 m diameter container; open top, nearly empty.	0 (0.2)				
														1.00	0.19 (0.16)	RPS-11-41	3	70 lt container; closed, seems quite old but fairly good condition.	0 (0)				
														0.92	0.21 (0.18)	RPS-11-42	0	70 lt container; one end open; nearly empty.	0 (0.1)				
														0.82	0.24 (0.2)	R-11-26569A = R-11-26569B	3	30-100 lt container; one end open; other end closed.	0 (0.1)				
														1.00	0.19 (0.16)	R-11-26247	0	200 lt barrel; top open; some solids in.	0 (0)				
F24	R-11-5167	Sodium																			2.5	LL12	3.97
F24B	R-11-907818																						
F24C	R-11-12																						
F25+F26	R-12-008	Sulphur												0.71	0.18 (0.21)	R-12-380	0	Corroded metal barrel slightly inclined in seabed	0 (0.1)	Intact	8.4	LL13	4.79
F27	R-12-3463	Xenon												0.39	0.63 (0.65)	R-12-130141	2	200 lt barrel; one end closed; other badly visible (possibly open); small opening on one end; slightly corroded.	0 (0.5)		25.0	AS7	4.00
																					45.0	LL15	
																					86.0	LL17	
																					124.0	NCB	

Table A2.2 Summary Table of impacts

Munitions			Infrastructure						Cultural Heritage					Barrels							Distance to long term monitoring stations		Distance to FIN / EST-EEZ boundary
MU1	MU2	MU3	I1	I2	I3	I4	I5	I6	C1	C2	C3	C4	C5	B1	B2	B3	B4	B5	B6	B7			
Munitions Identification			Distance	Peak pressure	Owner Cable	From / to	Status	Observations	Distance	Peak pressure	ID	Description	Observations	Distance	Peak pressure	Barrel ID	Risk factor	Description	Horizontal displacement	Observations			
NSP	MMT ID	BACTEC ID	km	MPa					km	MPa				km	MPa				m		km	St.	km
F28	R-11-26161	Zirconium																			10.9	22 (HELCOM)	1.20
F29	R-11-38144	Scandium																			10.9		1.19
F30	R-11-25239	Lanthanum																			9.7	LL12 (HELCOM)	2.58
F31	R-11AG-WW-007	Silicon																			9.7		2.49
F32	R-11-25175	Tellurium																			9.0		2.52
F33	R-11-200030	Aluminium												0.89	0.07 (0.07)	R-11-26172	2	200lt barrel in fairly good condition, cap hole open	0 (0)	Intact	4.5		3.45
														0.08	1.04 (1)	R-11-3362	3	200lt oil barrel in good condition, probably open cap	0 (0.7)				
F34	R-12-51010	Lead	0.63	n/a (0.28)	Russian military	St.Petersburg-Kaliningrad	Conservatively assumed that cable is exposed all along route	No impact													14.5		6.39
F35	R-13-31989	Osmium							0.48	0.15 (0.49)	S-13-32852	Steel hulled vessel with wooden superstructure from 20th century.	No impact	1.01	0.15 (0.21)	R-13-33554	2	200lt barrel in fairly good condition, cap hole open	0 (0.1)	Intact	14.6	LL13 (FIMR)	3.05
F36	R-14-35290	Iridium																			3.5	BY27 (HELCOM Sweden)	47.00
F37	R-08-2767	Rhodium	0.12	n/a (1.5)	TeliaSonera (EE-SF2)	Finland-Estonia															1.3		1.39
F38	R-08-450077	Gallium	0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin															1.3		1.46
F38B	R-8-001-FAB	Terbium	0.12	n/a (1.5)	TeliaSonera (EE-SF2)	Finland-Estonia															1.4		1.10
F38C	R-08-002-FAB	Fluorine	0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin															1.4		1.10
F38D	R-08-003-FAB	Astatine	0.12	0.61 (1.32)	TeliaSonera (EE-SF2)	Finland-Estonia															1.4		1.10
F38E	R-8-004-FAB	Nobelium	0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin															6.1		1.96
F38F	R-8-005-FAB	Mendelevium	0.12	0.84 (1.32)	TeliaSonera (EE-SF2)	Finland-Estonia															17.7	GF1 (FIMR)	1.66
F38G	R-08-006-FAB	Plutonium	0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin															7.5	LL9 (FIMR)	1.06
F38H	R-08-007-FAB	Protactium	0.12	0.7 (1.32)	TeliaSonera (EE-SF2)	Finland-Estonia															6.1		1.54
			0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin																	2.40
F38I	R-08-008-FAB	Cerium																					2.22
F38J	R-08-009-FAB	Tritium	0.12	0.53 (1.32)	TeliaSonera (EE-SF2)	Finland-Estonia															7.5	LL7 (HELCOM)	1.04
F38K	R-08-010-FAB	Deuterium	0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin															6.0		5.70
			0.085	1.63 (1.9)	TeliaSonera (EE-SF2)	Finland-Estonia															2.2	LL6A	2.70
			0.78	n/a (0.16)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin																	1.90
			0.12	0.5 (1.32)	TeliaSonera (EE-SF2)	Finland-Estonia																	1.00
			0.87	n/a (0.14)	Linx telecoms: Pangea Seg 3	Helsinki to Tallin																	
F39	R-08-1000069	Germanium																					
F40	08-R-90	Thallium	0.53	too low (0.35)	Elisa: FEC1	Porkkala-Kakumäe		No Impact						0.22	0.31 (0.92)	R-09-327236	3	Drum	0 (0.8)	Damaged by ROV			
F41	R-09-1000149	Arsenic							0.40	0.18 (0.37)	R-9-10009	Steel wreck in several sections	No Impact										
F42	R-09-1000202	Phosphorus							0.50	0.14 (0.29)	S-09-3025	Battleship	No Impact										
F43	R-08-44066	Polonium	0.53	n/a (0.46)	Telenor Sweden: UESF2	Helsinki (FIN) - Hanko (FIN)	Partly burried	No impact															
F44	R-08-2000957	Thorium	0.59	measuring unsuccesful (0.41)																			
F45	R-09-1116855	Samarium							0.73	0.08 (0.2)	S-09-49489	Remains of vessel very broken up	No Impact	0.12	1.78 (1.58)	R-09-48737	3	100 lt container, top closed, quite corroded but apparantly undamaged	0 (1.2)	Intact			
F46	R-10-3227	Hafnium							0.77	0.08 (0.19)	S-09-49490		No Impact	0.72	0.27 (0.29)	R-10-52996	3	60 lt container, both ends closed fairly good condition	0 (0.1)				
														0.56	0.36 (0.38)	R-10-53214	3	200 lt container, not barrel, both ends closed, fairly good condition	0 (0.2)				
F47	R-07-3400791	Handled by MMT												0.52	0.39 (0.41)	R-10-53215	3	200 lt barrel, both ends closed, quete corroded but apparently undamaged	0 (0.3)				
F48	R-08-3400066		0.04	No detonation	Elion: EE-SF3	Lauttasaari(FIN)-Meremoisa(LAT)	Detected: buried between 0.2-0.5m	No impact						0.12	2.04 (2.17)	R-10-54053	2	30 lt container, both ends closed, fairly good condition	0 (1.6)				
F49	R-09-3401125																						

Annex 3 Visual and acoustic inspections

This Annex

This Annex presents typical stills from the video footage that have been taken before and after the detonation of each of the munitions to confirm that the munitions have successfully have been cleared, that no damage has been done to infrastructure (cables), the cultural heritage sites (wrecks) and that the barrels have not been damaged by the detonations. All images are taken from the mine specific disposal records /1/ - /49/. Below the images of the munitions are the plots of the detailed seabed bathymetry taken with the ROV mounted MBES to show the impact of the clearance on the seabed, such as crater forming or remaining debris after clearance.

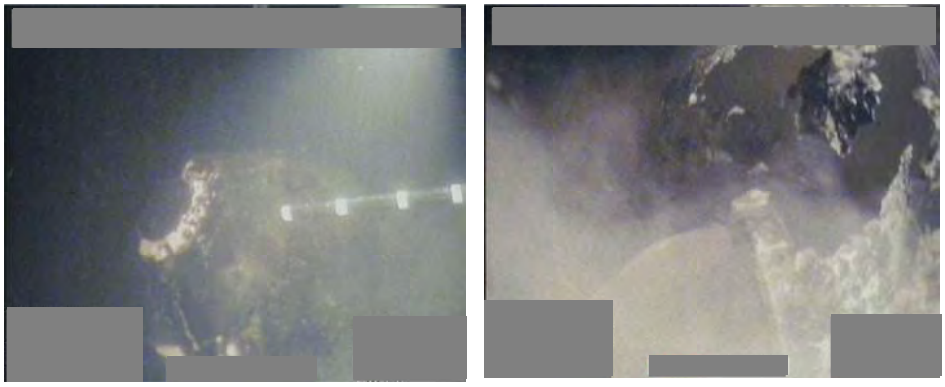
Dates and times

The date and time given for each munition is that of final clearance; the dates and times of the visual inspections are given on the images.

F1B (R-W6F-10747) **Vanadium**

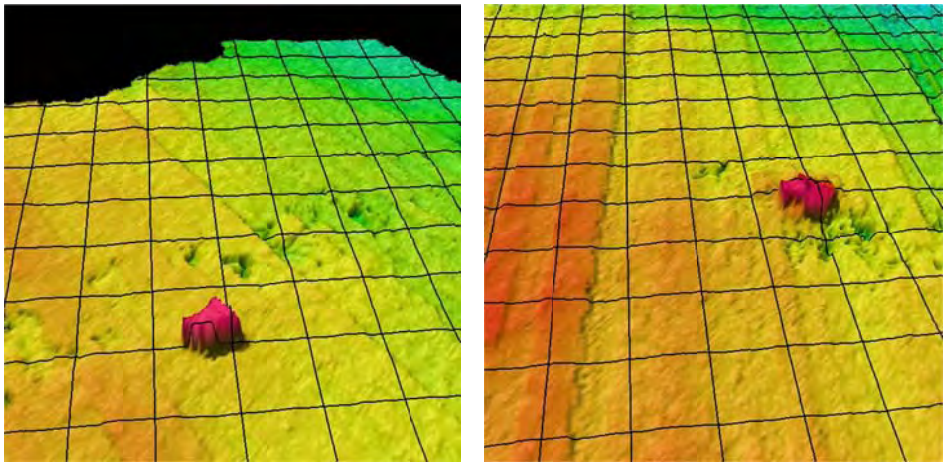
General

Clearance of **F1B**, R-W6F-10747, **Vanadium**, on 12 December 2009 at 11:00 UTC; see Figure A3.1 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /1/.



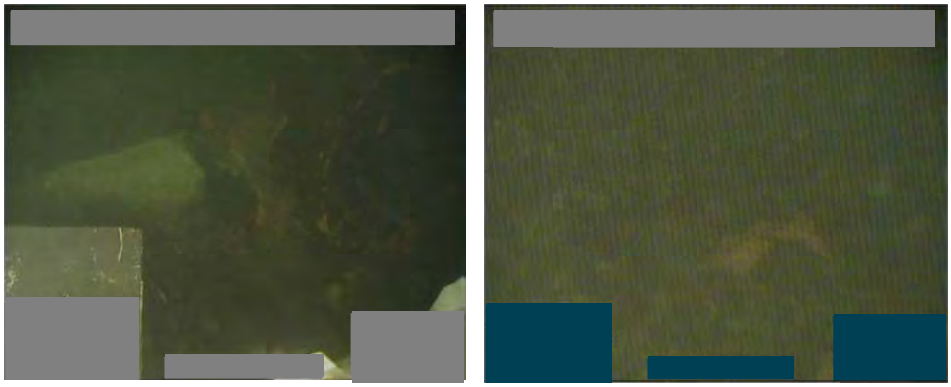
Before *After*

Figure A3.1a *Images of munitions before and after clearance.*



Before *After*

Figure A3.1b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



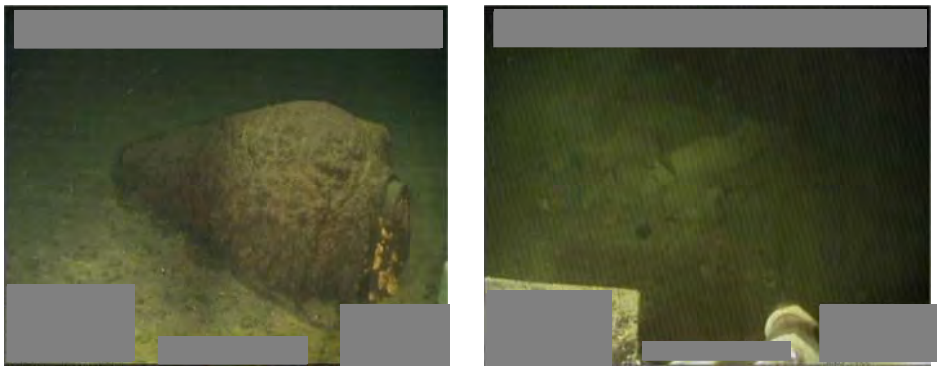
Before *After*

Figure A3.1c *Images of barrel R-06-20629.*

F2 (R-E7B-10466) **Caesium**

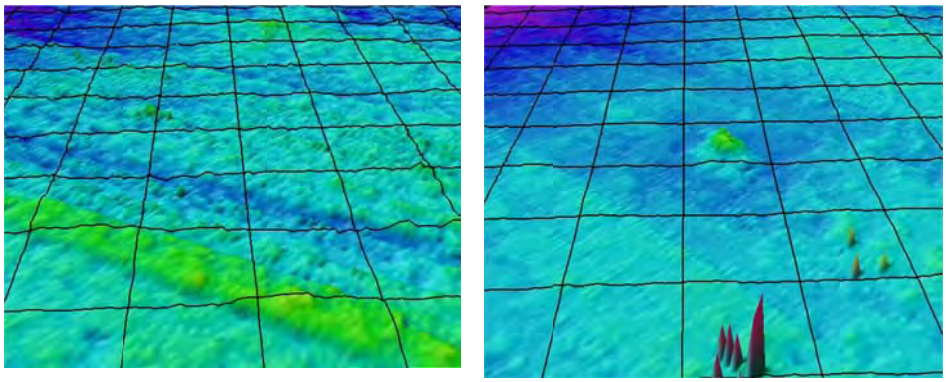
General

Clearance of **F2**, R-E7B-10466, **Caesium**; on 10 December 2009 at 15:00 UTC; see Figure A3.2 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /2/.



Before *After*

Figure A3.2a *Images of munitions before and after clearance.*



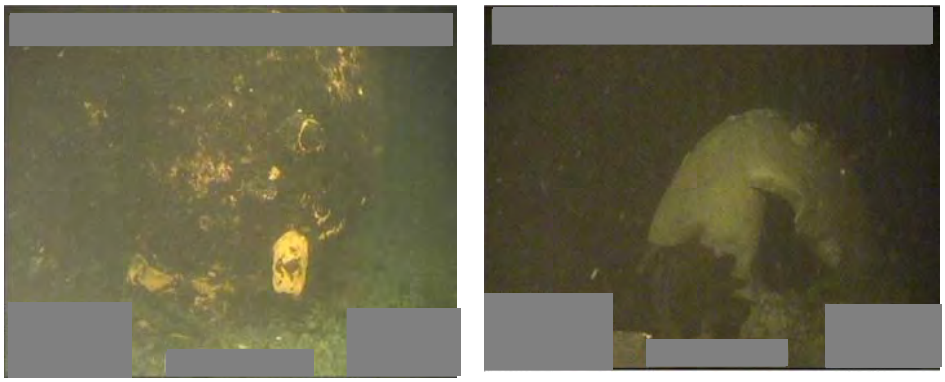
Before *After*

Figure A3.2b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

F3 (R-07-004) **Calcium**

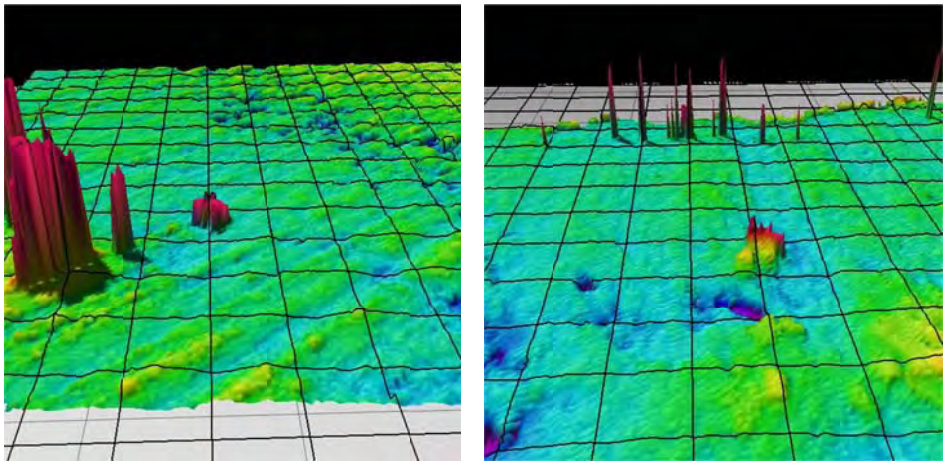
General

Clearance of **F3**, R-07-004, **Calcium**; on 8 December 2009 at 11:30 UTC; see Figure A3.3 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /3/.



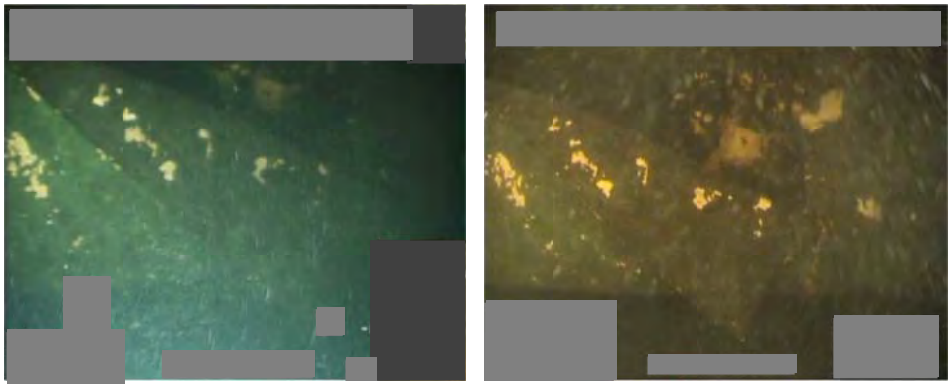
Before After

Figure A3.3a *Images of munitions before and after clearance.*



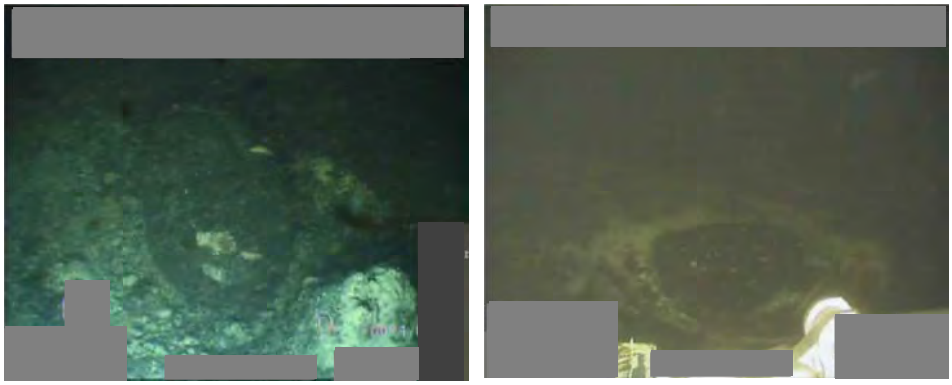
Before After

Figure A3.3b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before After

Figure A3.3c *Images of wreck R-07-41172.*



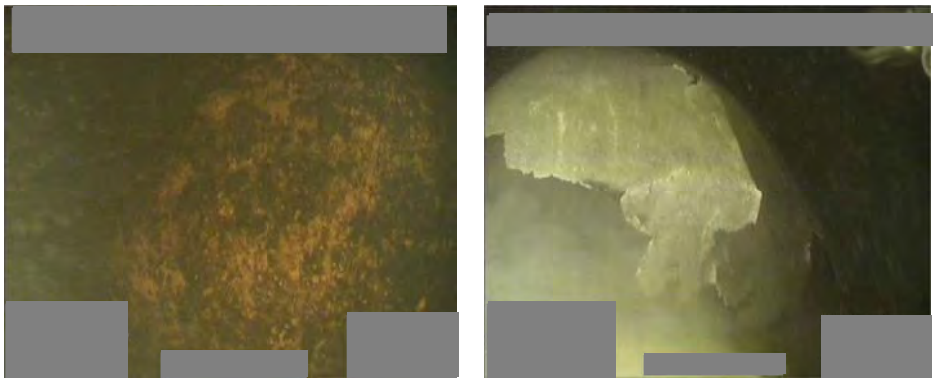
Before *After*

Figure A3.3d *Images of 'barrel' R-08-40688, which most likely is a stone.*

F4 (R-07-2655) **Carbon**

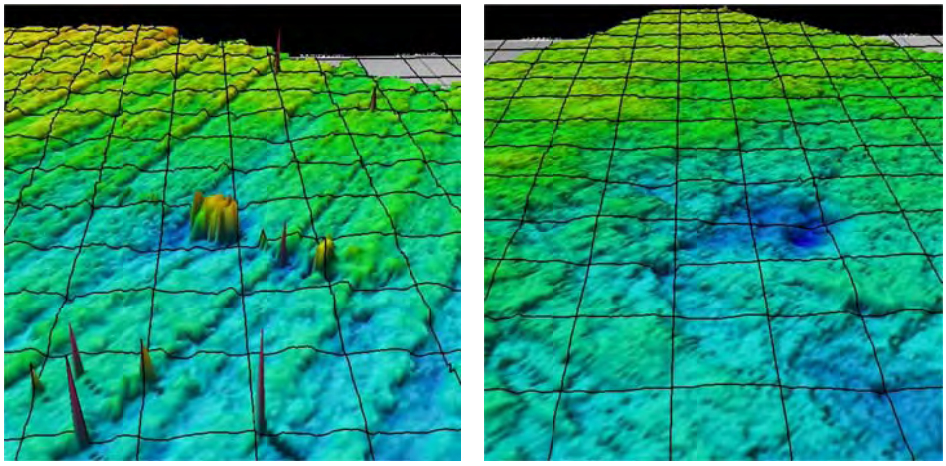
General

Clearance of **F4**, R-07-2655, **Carbon**; on 6 December 2009 at 12:30 UTC; see Figure A3.4 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /4/.



Before *After*

Figure A3.4a *Images of munitions before and after clearance.*

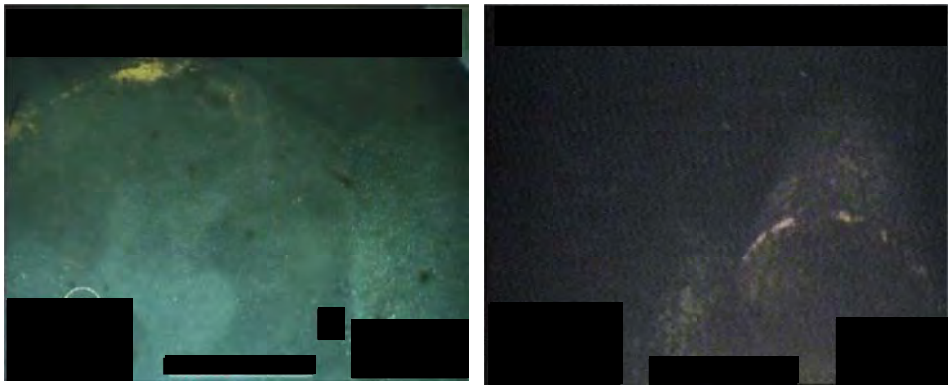


Before *After*

Figure A3.4b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.4c *Images of wreck MB-07-2736 'Rusalka'.*



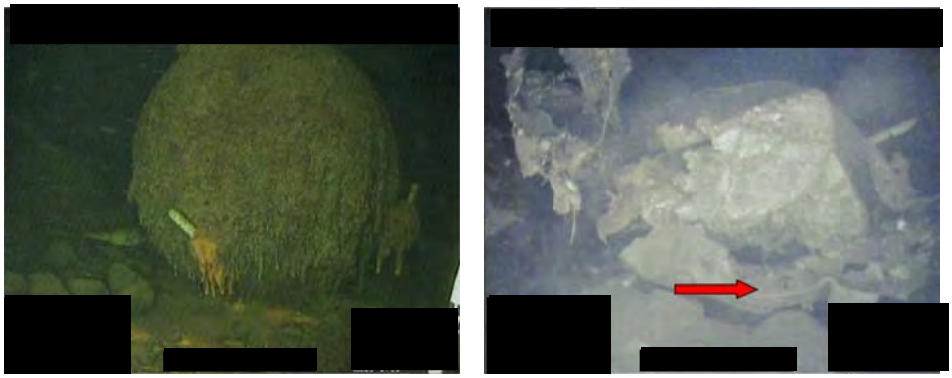
Before *After*

Figure A3.4d *Images of barrel 07-S-73.*

F5 (R-8AG-W-014) **Chromium**

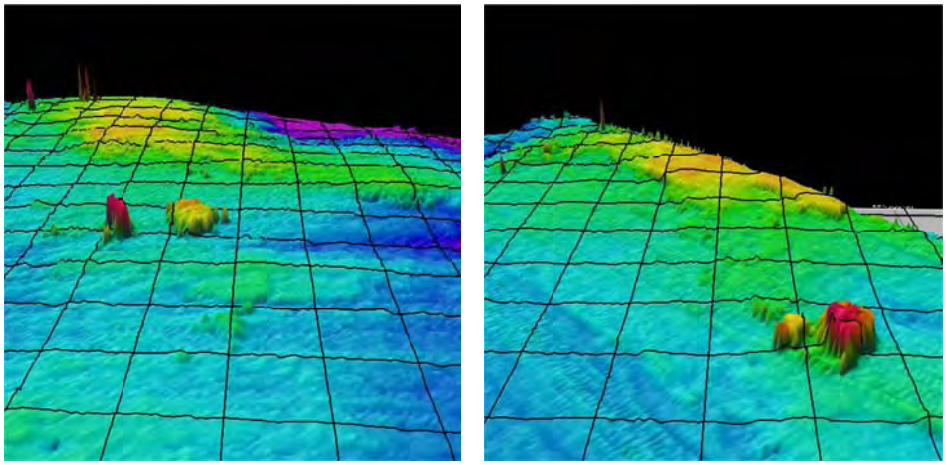
General

Clearance of **F5**, R-8AG-W-014, **Chromium**; on 15 December 2009 at 13:30 UTC; see Figure A3.5 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /5/.



Before *After*

Figure A3.5a *Images of munitions before and after clearance.*



Before *After*

Figure A3.5b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

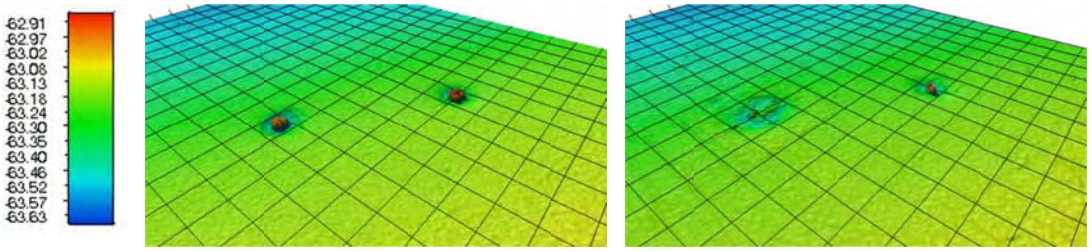
F6 (R-8AG-W-009) **Cobalt**

General

Clearance of **F6**, R-8AG-W-009, **Cobalt**, on 30 April 2010 at 09:00 UTC. See Figure A3.6 for images of the munitions, seabed bathymetry, near barrels, wreck and cable before and after the detonation. Details of the disposal of this munition are given in /6/.

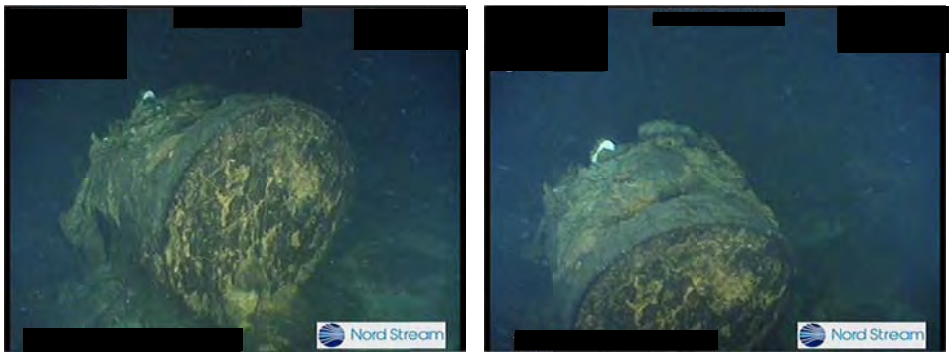
Before *After*

Figure A3.6a *Images of munitions before and after clearance.*



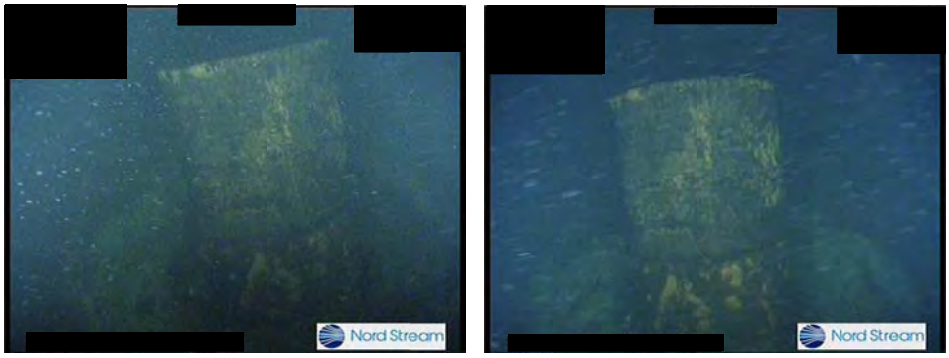
Before *After*

Figure A3.6b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



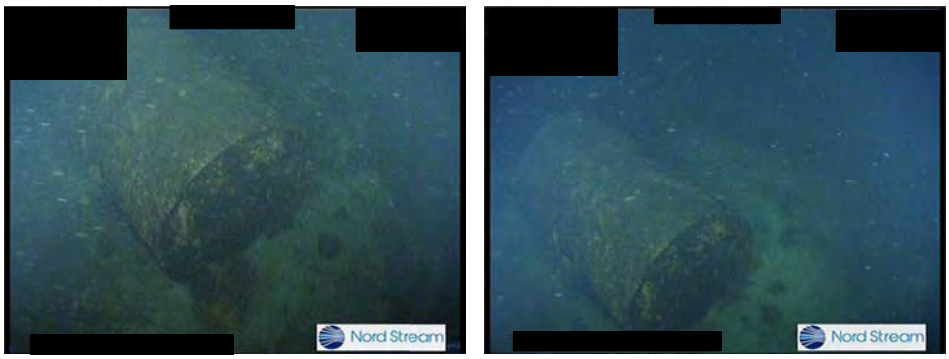
Before *After*

Figure A3.6c *Images of barrel R-08-42672; taken after clearance of F6, F7 and F8.*



Before *After*

Figure A3.6d *Images of barrel R-08-44156; taken after clearance of F6 and F7.*

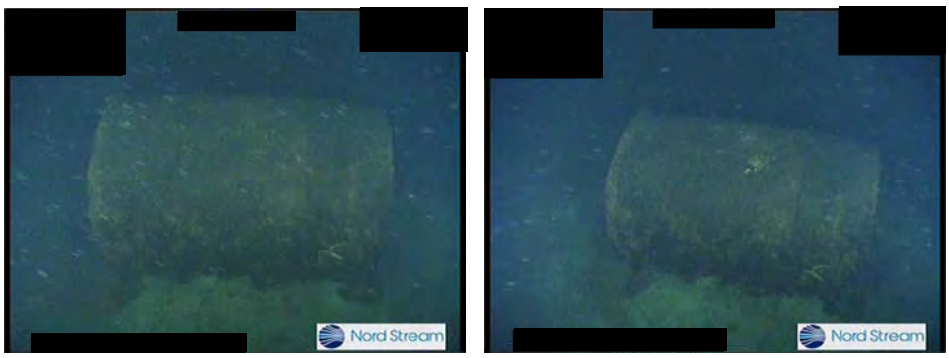


Before *After*

Figure A3.6e *Images of barrel R-08-45979; taken after clearance of F6, F7 and F9.*

Before *After*

Figure A3.6f *Images of barrel R-08-2938.*



Before *After*

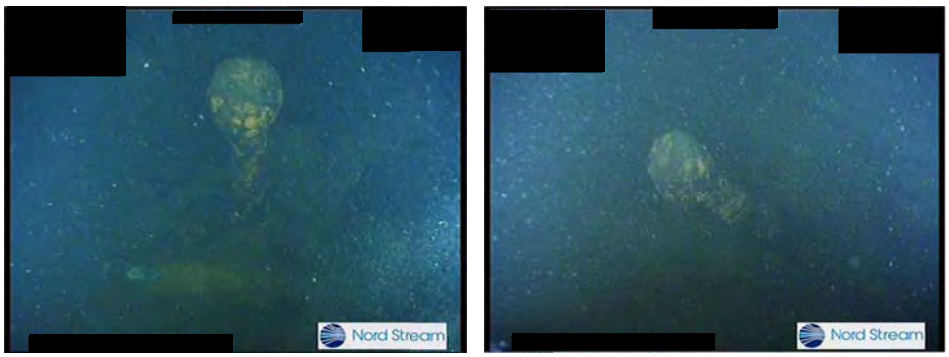
Figure A3.6g *Images of barrel R-08-321109; taken after clearance of F6, F7 and F9.*

Before *After*

Figure A3.6h *Images of barrel R-WBA-10041; taken after clearance of F6 and F7.*

Before *After*

Figure A3.6i *Images of cable EE-SF3; taken after clearance of F6 and F7.*



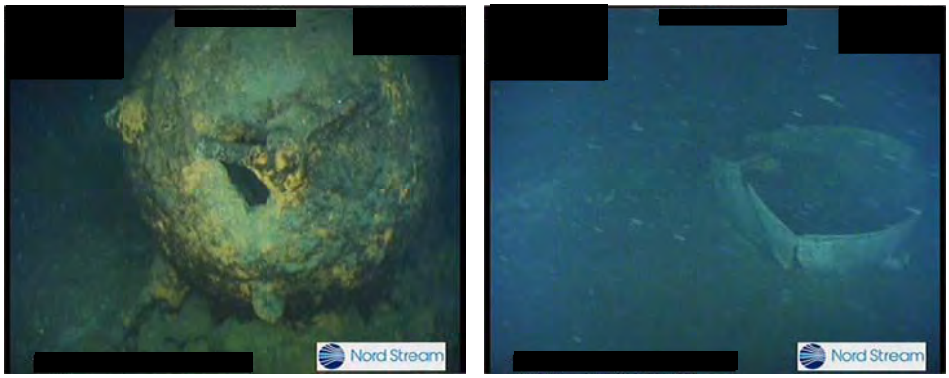
Before *After*

Figure A3.6j *Images of wreck S-08-2939*

F7 (R-E8C-10223) **Copper**

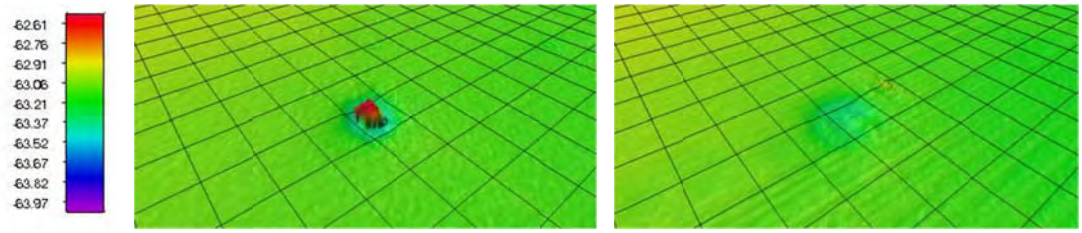
General

Clearance of **F7**, R-E8C-10223, **Copper,** on 30 April 2010 at 16:30 UTC. See Figure A3.7 for images of the munitions, the seabed bathymetry and near barrels before and after the detonation. Details of the disposal of this munition are given in /7/.



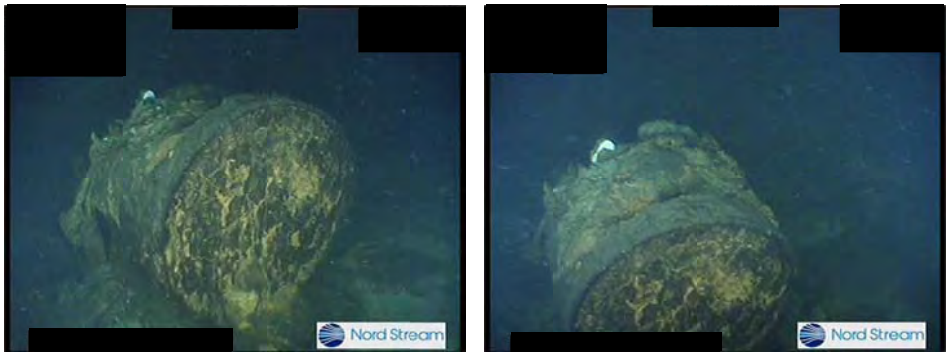
Before *After*

Figure A3.7a *Images of munitions before and after clearance.*



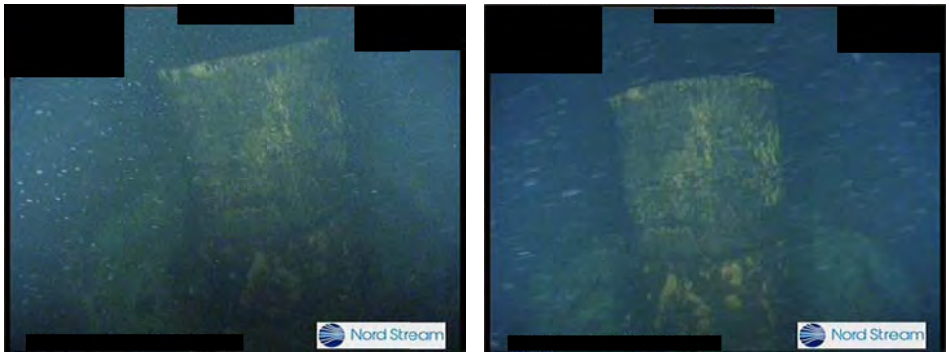
Before *After*

Figure A3.7b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



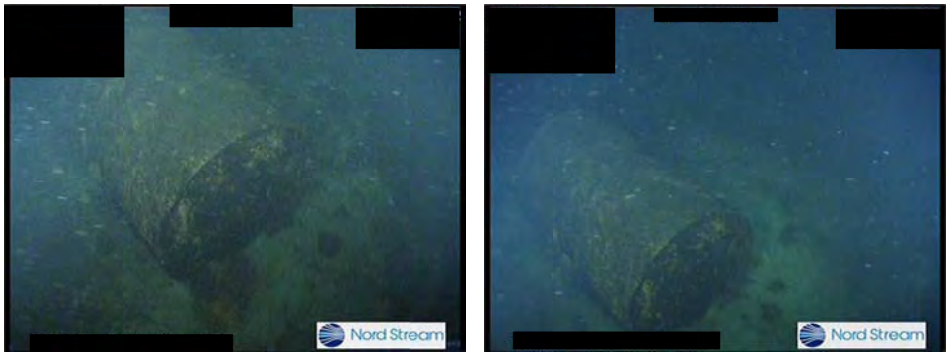
Before *After*

Figure A3.7c *Images of barrel R-08-42672; taken after clearance of F6, F7 and F8.*



Before *After*

Figure A3.7d *Images of barrel R-083-44156; taken after clearance of F6 and F7.*

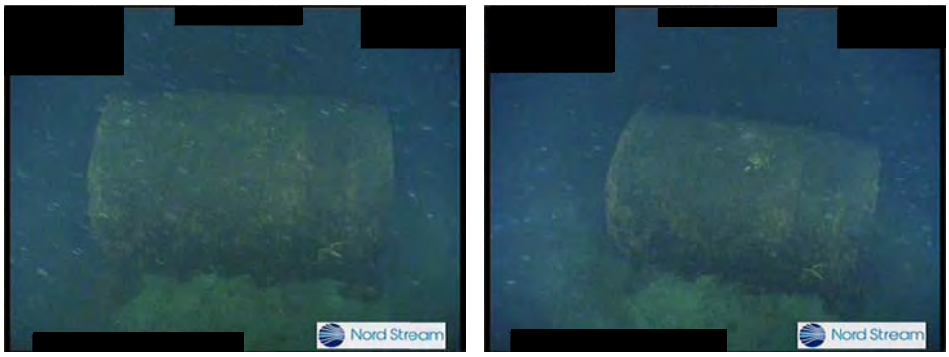


Before *After*

Figure A3.7e *Images of barrel R-083-45979; taken after clearance of F6, F7 and F9.*

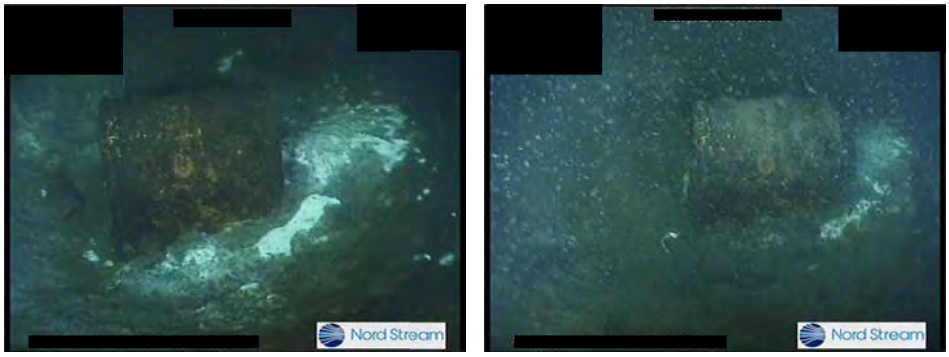
Before *After*

Figure A3.7f *Images of barrel R-083-46223; taken after clearance of F7 and F9.*



Before *After*

Figure A3.7g *Images of barrel R-083-321109; taken after clearance of F6, F7 and F9.*



Before *After*

Figure A3.7h *Images of barrel R-WBA-10041; taken after clearance of F6 and F7.*

Before *After*

Figure A3.7i *Images of wreck 3_9; taken after clearance of F6 and F7.*

Before *After*

Figure A3.7j *Images of cable EE-SF3; taken after clearance of F6 and F7.*

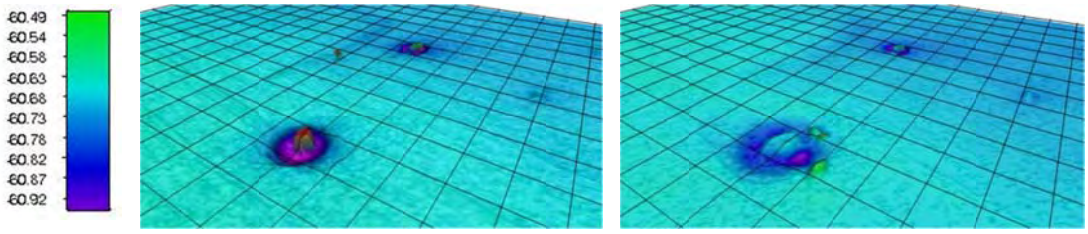
F8 (R-W8A-10317) **Tungsten**

General

Clearance of **F8**, R-W8A-10317, **Tungsten**; on 3 May 2010 at 17:00 UTC; see Figure A3.8 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /8/.

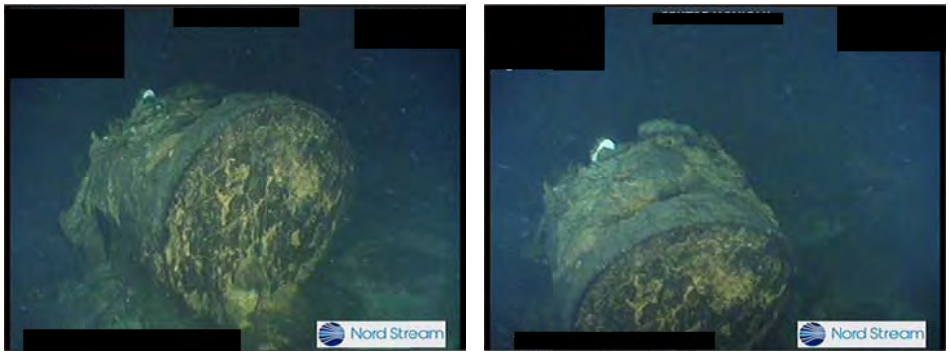
Before *After*

Figure A3.8a *Images of munitions before and after clearance.*



Before *After*

Figure A3.8b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

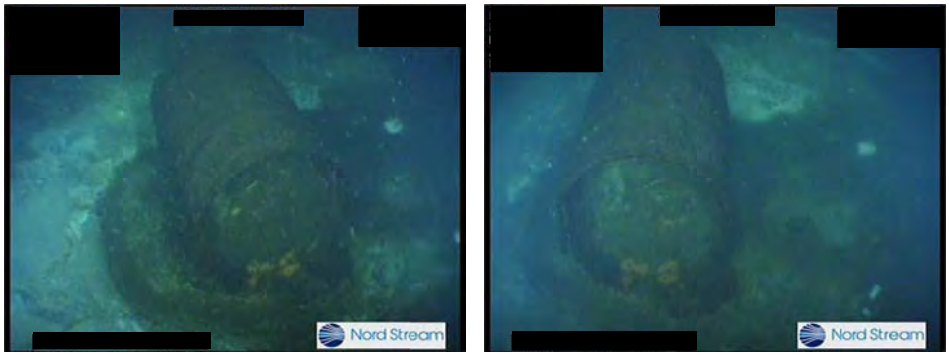


Before *After*

Figure A3.8c *Images of barrel R-08-42672; taken after clearance of F6, F7 and F8.*

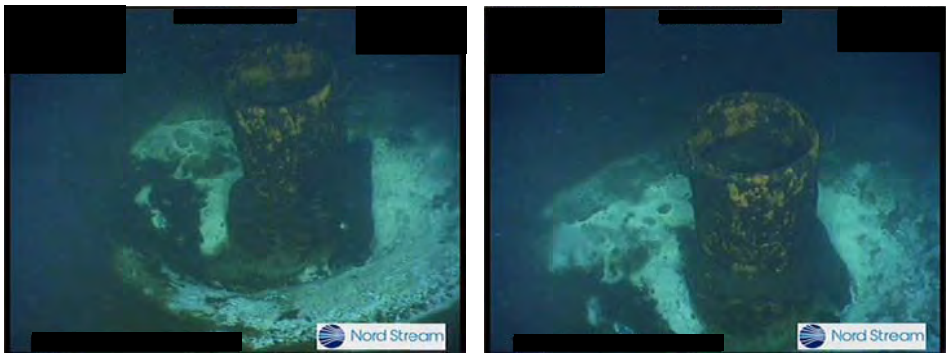
Before *After*

Figure A3.8d *Images of barrel R-08-44744; taken after clearance of F8 and F9.*



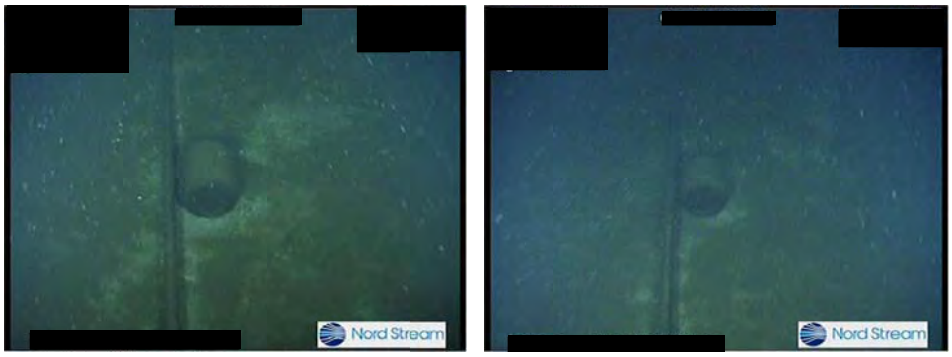
Before *After*

Figure A3.8e *Images of barrel 08-S-33; taken after clearance of F8 and F9.*



Before *After*

Figure A3.8f *Images of barrel R-08-44339; taken after clearance of F8 and F9.*



Before *After*

Figure A3.8g *Images of cable EE-SF3.*

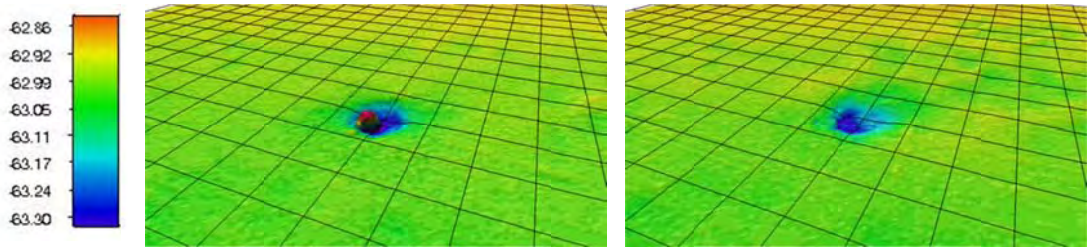
F9 (R-8CG-E-004) **Gold**

General

Clearance of **F9**, R-8CG-E-004, **Gold**; on 3 May 2010 at 11:00 UTC; see Figure A3.9 for images of the munitions, the seabed bathymetry and near cable and barrels before and after the detonation. Details of the disposal of this munition are given in /9/.

Before *After*

Figure A3.9a *Images of munitions before and after clearance.*



Before *After*

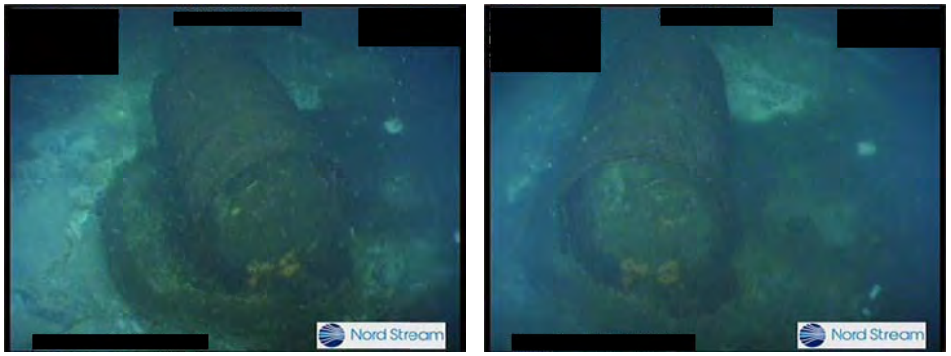
Figure A3.9b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.9c *Images of barrel R-08-45979; taken after clearance of F6, F7 and F9.*

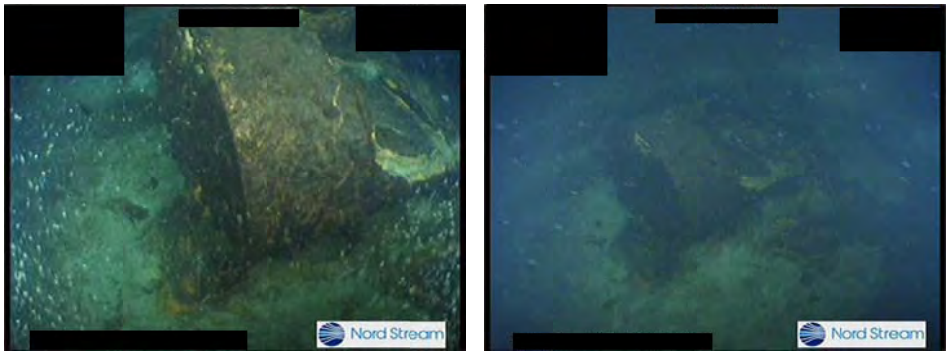
Before *After*

Figure A3.9d *Images of barrel R-08-321109; taken after clearance of F6, F7 and F9.*



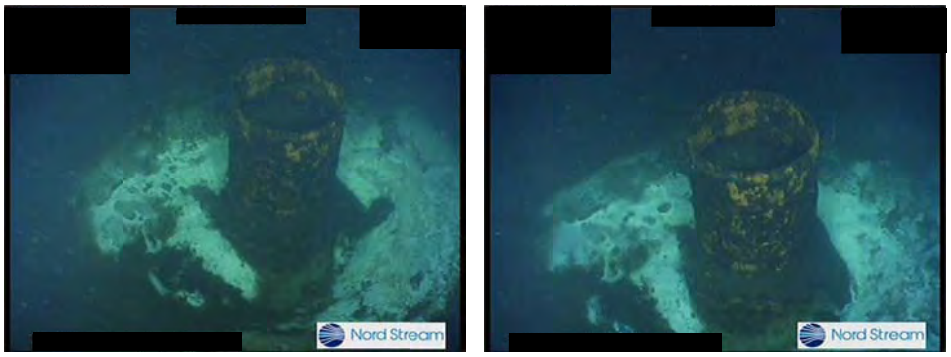
Before *After*

Figure A3.9e *Images of barrel 08-S-33; taken after clearance of F8 and F9.*



Before *After*

Figure A3.9f *Images of barrel R-08-46223; taken after clearance of F7 and F9.*



Before *After*

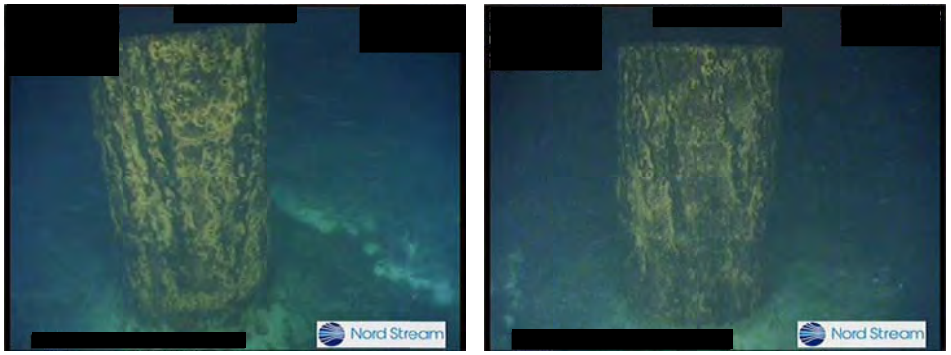
Figure A3.9g *Images of barrel R-08-44339; taken after clearance of F8 and F9.*

Before After

Figure A3.9h *Images of barrel R-08-44744; taken after clearance of F8 and F9.*

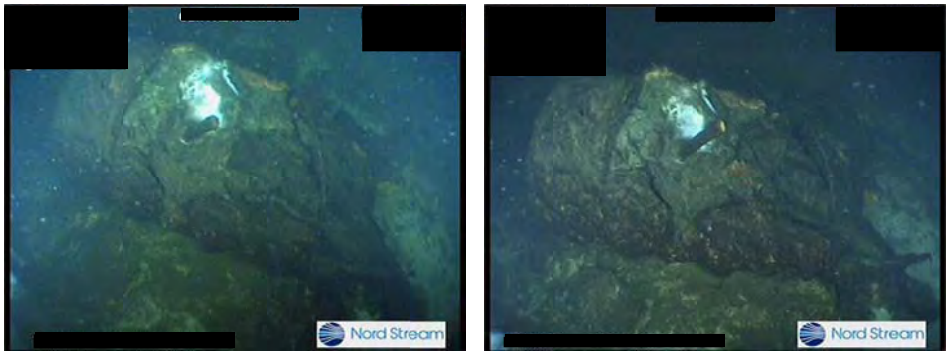
Before After

Figure A3.9i *Images of barrel R-E8C-10227.*



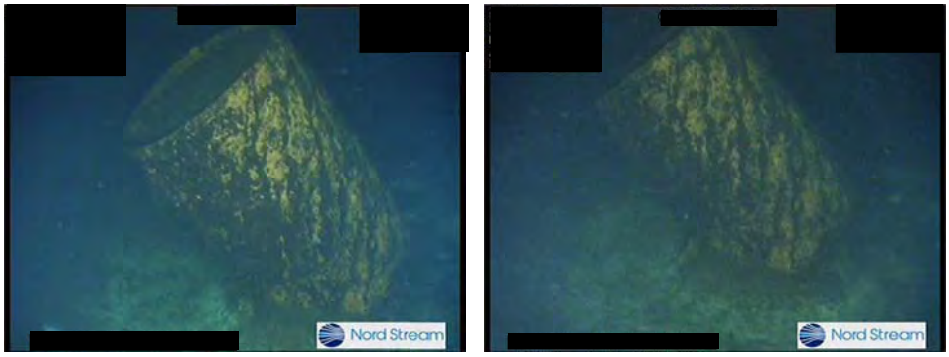
Before After

Figure A3.9j *Images of barrel R-E8C-10226.*



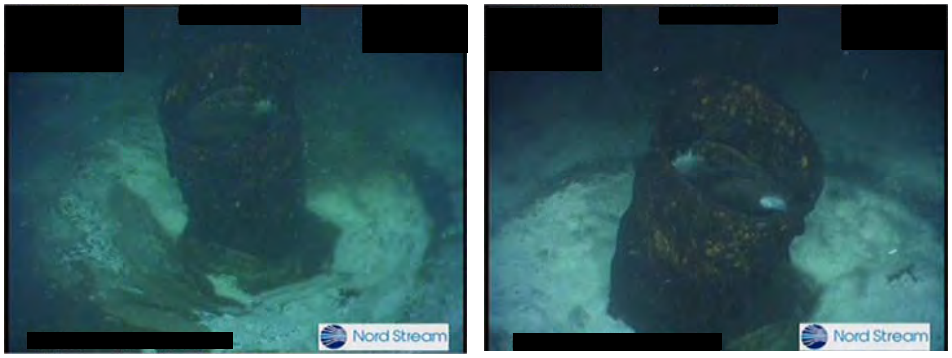
Before After

Figure A3.9k *Images of barrel R-08-45629.*



Before *After*

Figure A3.9l *Images of barrel R-08-58162.*



Before *After*

Figure A3.9m *Images of barrel R-08-45575.*

Before *After*

Figure A3.9n *Images of wreck 3_9; taken after clearance of F6 and F7.*

Before *After*

Figure A3.9o *Images of cable EE-SF3; taken after clearance of F7.*

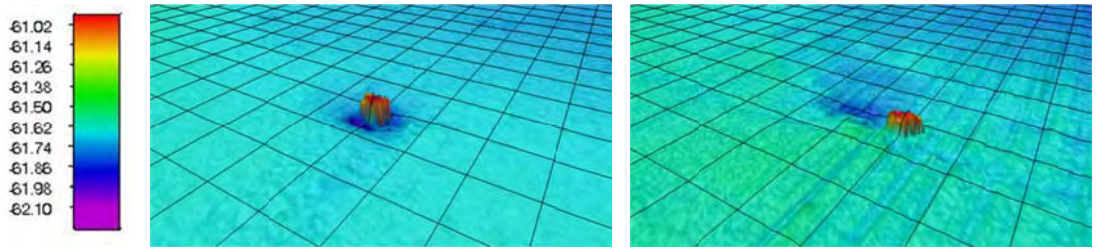
F10 (R-8CG-E-003) **Helium**

General

Clearance of **F10**, R-8CG-E-003, **Helium**; on 9 May 2010 15:00 UTC; see Figure A3.10 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /10/.

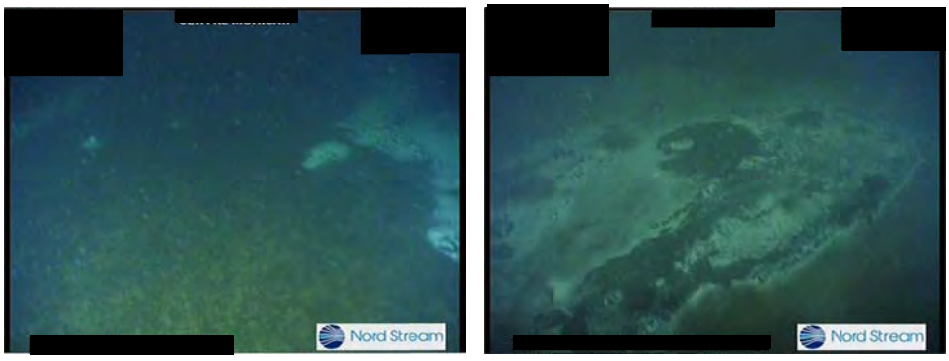
Before *After*

Figure A3.10a *Images of munitions before and after clearance.*



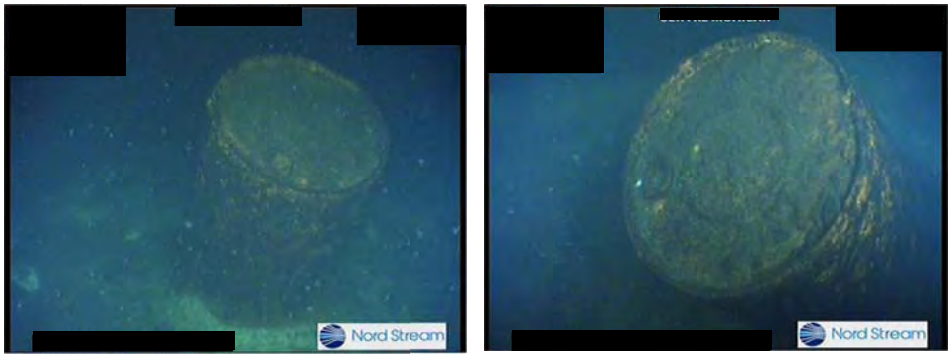
Before *After*

Figure A3.10b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



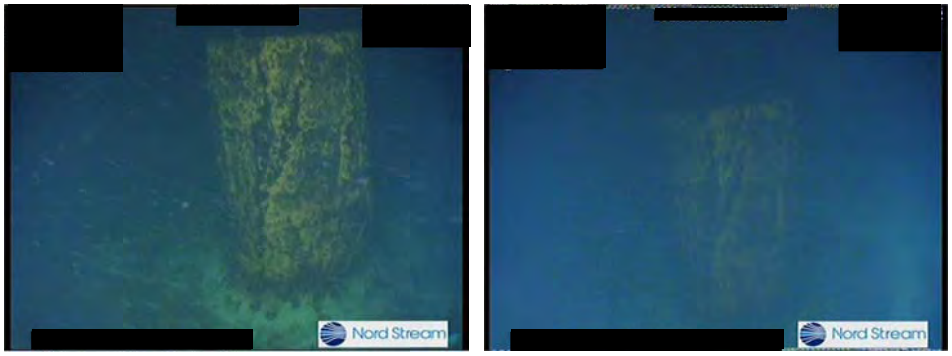
Before *After*

Figure A3.10c *Images of cable EE-SF3; the images were taken before and after the disposal of F10 and two adjoining munitions F15 and F15B.*



Before *After*

Figure A3.10d *Images of barrel R-08-58162; the images were taken before and after the disposal of F10 and nine adjoining munitions F8, F9, F11, F12, F13, F14, F15, F15B and F16.*



Before *After*

Figure A3.10e *Images of barrel R-E8C-10226B; the images were taken before and after the disposal of F10 and nine adjoining munitions F8, F9, F11, F12, F13, F14, F15, F15B and F16.*

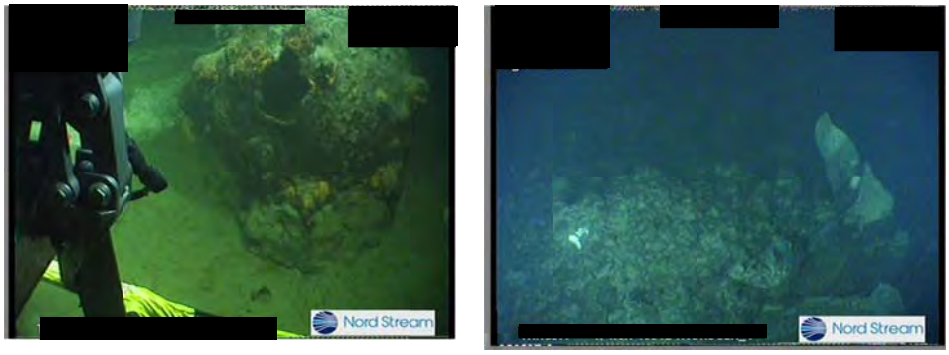
Before *After*

Figure A3.10f *Images of barrel R-E8C-10227; the images were taken before and after the disposal of F10 and eight adjoining munitions F8, F9, F11, F12, F13, F14, F15 and F15B.*

F11 (R-W8A-10312) **Hydrogen**

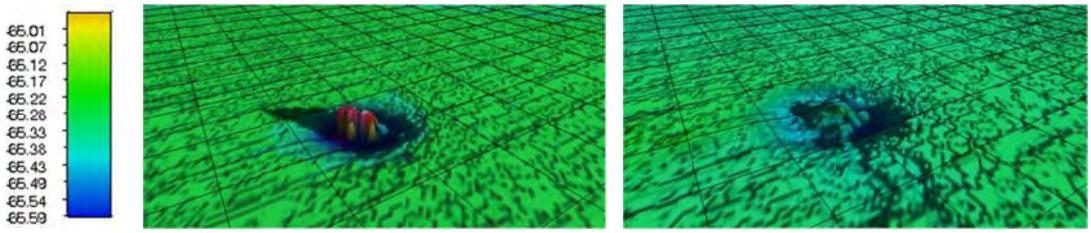
General

Clearance of **F11**, R-W8A-10312, **Hydrogen**; on 12 May 2010 at 11:00; see Figure A3.11 for images of the munitions, the seabed bathymetry and near barrels and cable before and after the detonation. Details of the disposal of this munition are given in /11/.



Before *After*

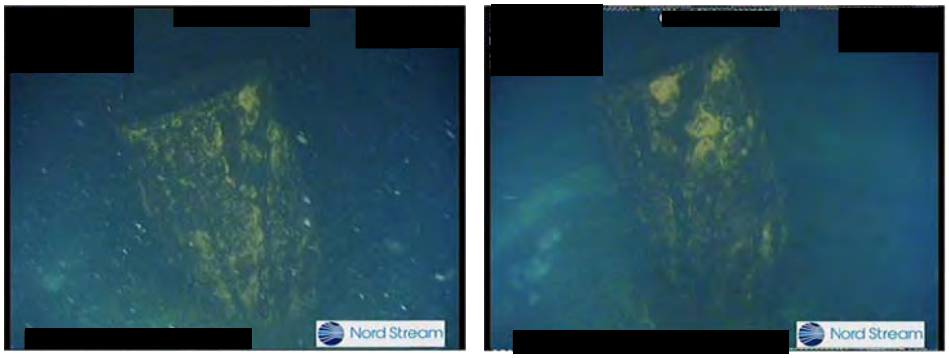
Figure A3.11a *Images of munitions before and after clearance.*



Before *After*

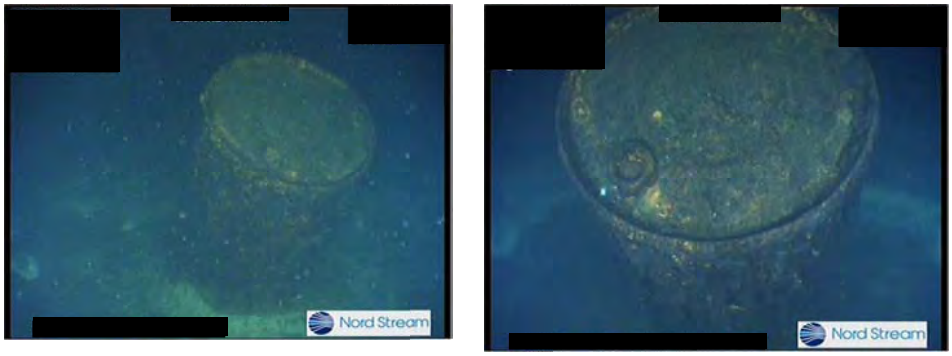
Figure A3.11b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Figure A3.11c



Before *After*

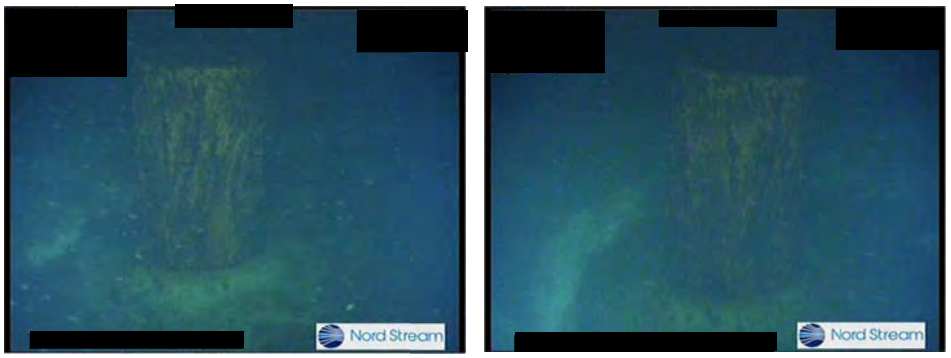
Figure A3.11d *Images of barrel R-E8C-10227.*



Before *After*

Figure A3.11e *Images of barrel R-08-58162.*

Figure A3.11f



Before *After*

Figure A3.11g *Images of barrel R-E8C-10226*

Before *After*

Figure A3.11h *Images of Cable EE-SF3.*

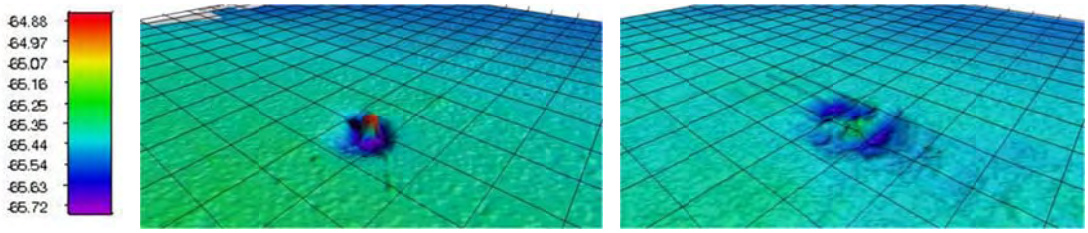
F12 (R-W8A-10313) **Iron**

General

Clearance of **F12**, R-W8A-10313, **Iron**; on 16 May 2010 at 13:00 UTC; see Figure A3.12 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /12/.

Before *After*

Figure A3.12a *Images of munitions before and after clearance.*

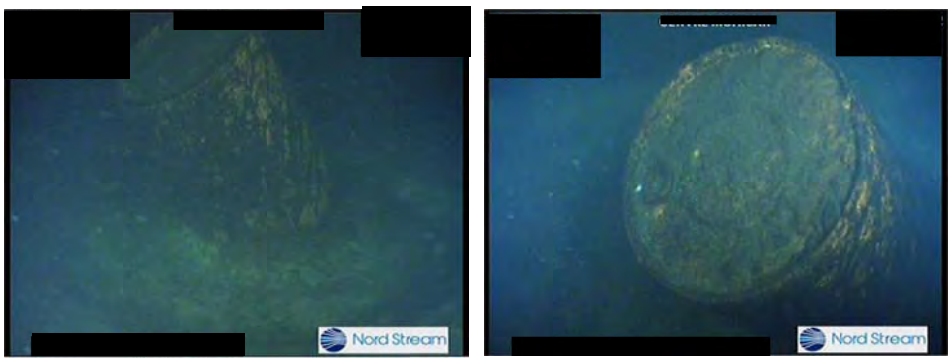


Before *After*

Figure A3.12b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.12c *Images of cable EE-SF3.*



Before *After*

Figure A3.12d *Images of barrel R-08-58162.*

Before *After*

Figure A3.12e *Images of barrel R-E8C-10226B.*

Before *After*

Figure A3.12f *Images of barrel R-E8C-10227.*

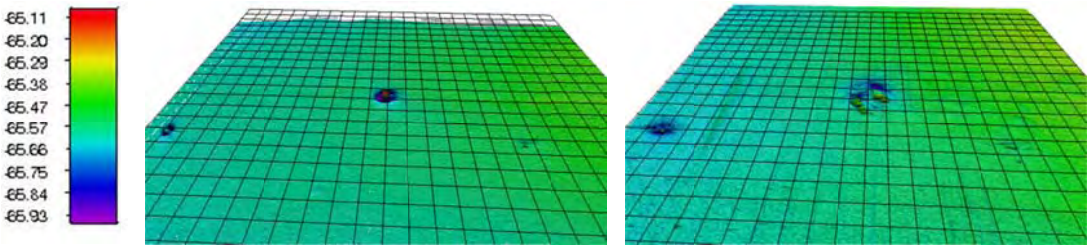
F13 (G-08-009) **Krypton**

General

Clearance of **F13**, G-08-009, **Krypton**; on 16 May 2010 at 8:00 UTC; see Figure A3.13 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /13/.

Before *After*

Figure A3.13a *Images of munitions before and after clearance.*

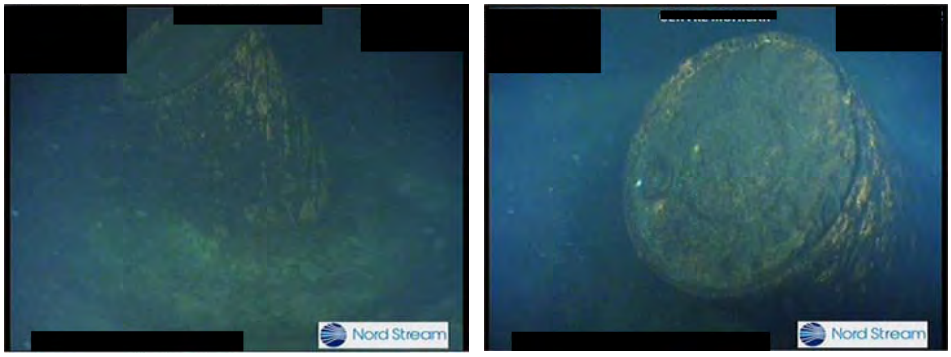


Before *After*

Figure A3.13b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.13c *Images of cable EE-SF3.*



Before *After*

Figure A3.13d *Images of barrel R-08-58162.*

Before *After*

Figure A3.13e *Images of barrel R-E8C-10226B.*

Before *After*

Figure A3.13f *Images of barrel R-E8C-10227.*

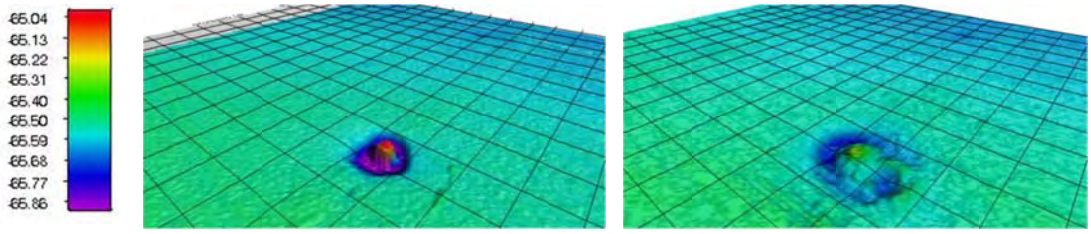
F14 (R-W8A-10005) **Lithium**

General

Clearance of **F14**, R-W8A-10005, **Lithium**; on 15 May 2010 at 08:30 UTC; see Figure A3.14 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /14/.

Before *After*

Figure A3.14a *Images of munitions before and after final clearance.*

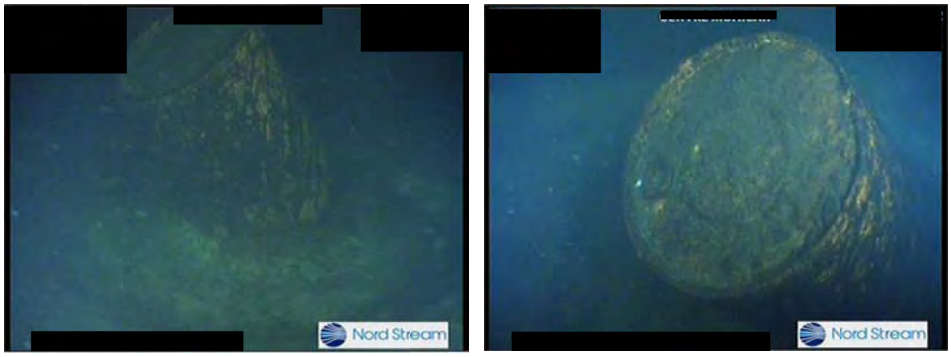


Before *After*

Figure A3.14b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

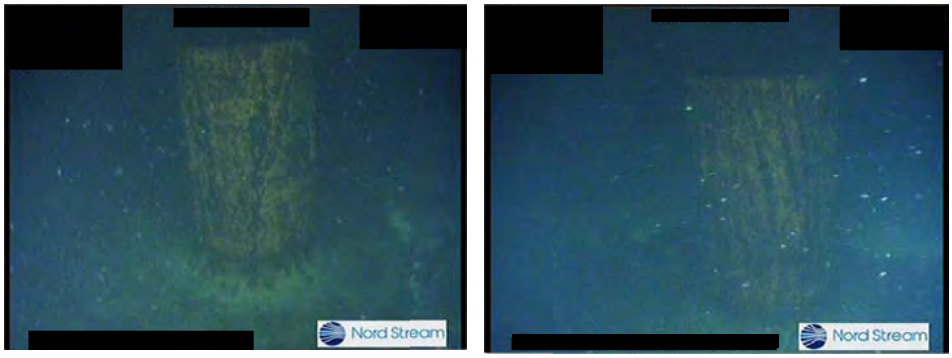
Before *After*

Figure A3.14c *Images of cable EE-SF3.*



Before *After*

Figure A3.14d *Images of barrel R-08-58162.*



Before *After*

Figure A3.14e *Images of barrel R-E8C-10226B.*

Before *After*

Figure A3.14f *Images of barrel R-E8C-10227.*

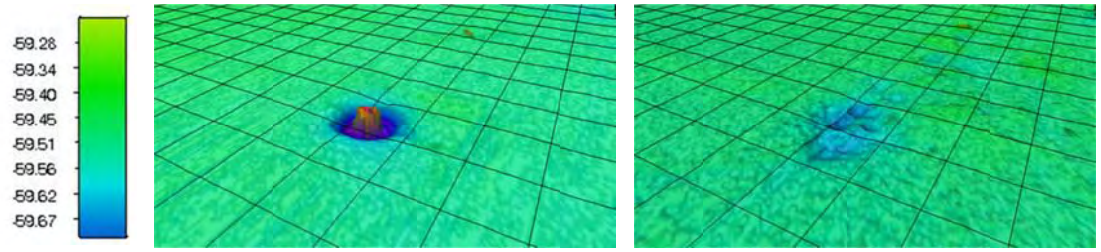
F15 (R-8CG-E-002) **Magnesium**

General

Clearance of **F15**, R-8CG-E-002, **Magnesium**; on 10 May 2010 at 15:00; see Figure A3.15 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /15/.

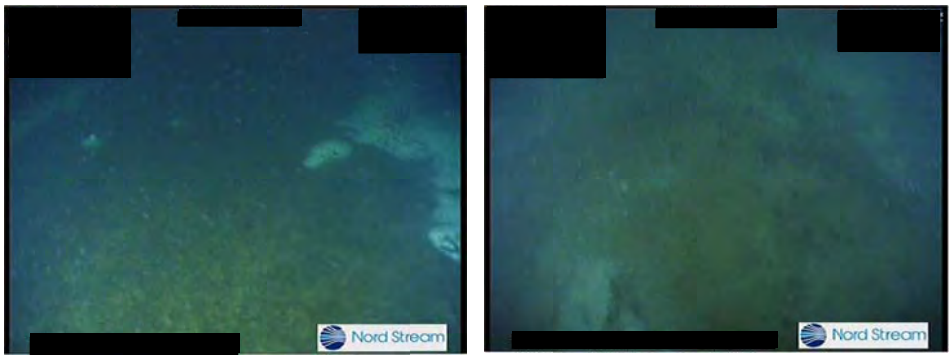
Before *After*

Figure A3.15a *Images of munitions before and after clearance.*



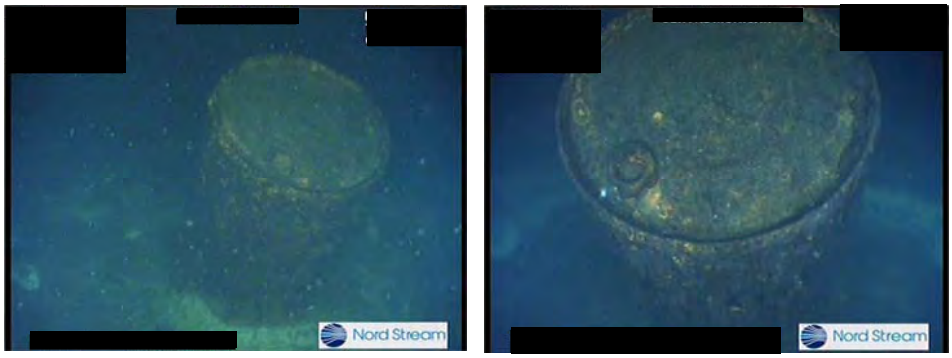
Before *After*

Figure A3.15b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



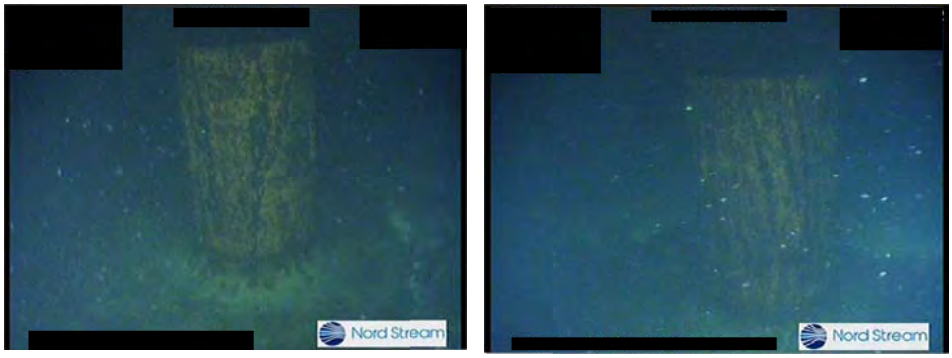
Before *After*

Figure A3.15c *Images of cable EE-SF3.*



Before *After*

Figure A3.15d *Images of barrel R-08-58162.*



Before *After*

Figure A3.15e *Images of barrel R-E8C-10226B.*

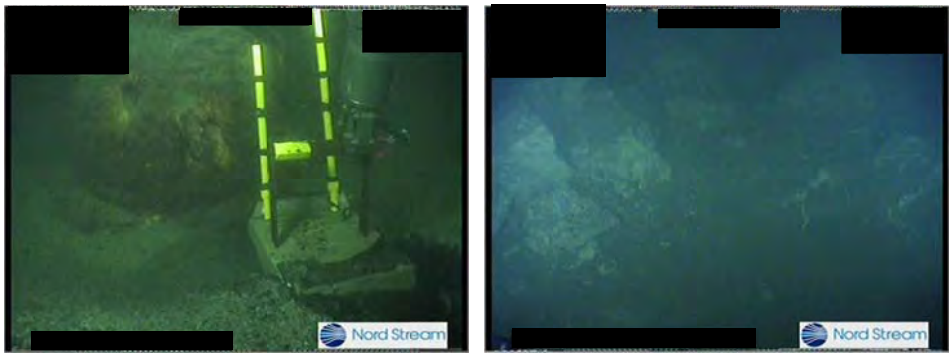
Before *After*

Figure A3.15f *Images of barrel R-E8C-10227.*

F15B (R-08-44944) **Indium**

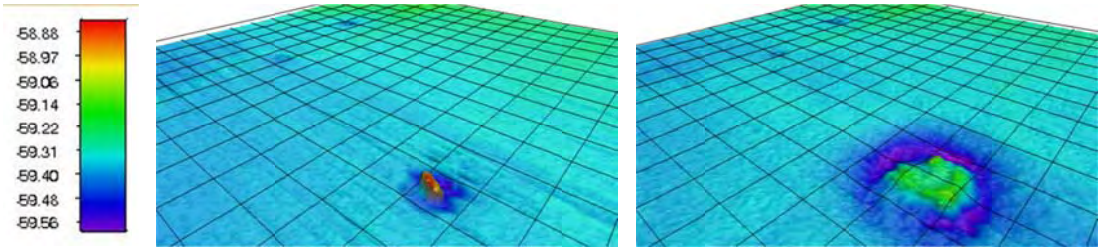
General

Clearance of **F15B**, R-08-44944, **Indium**; on 11 May 2010 at 09:00 UTC; see Figure A3.16 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /16/.



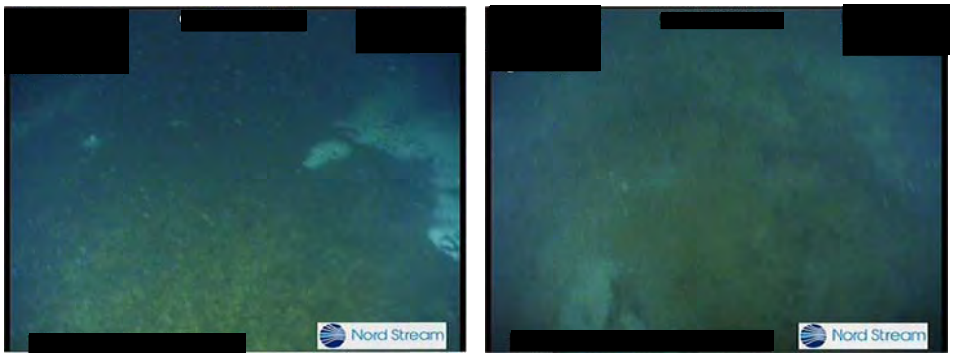
Before *After*

Figure A3.16a *Images of munitions before and after clearance.*



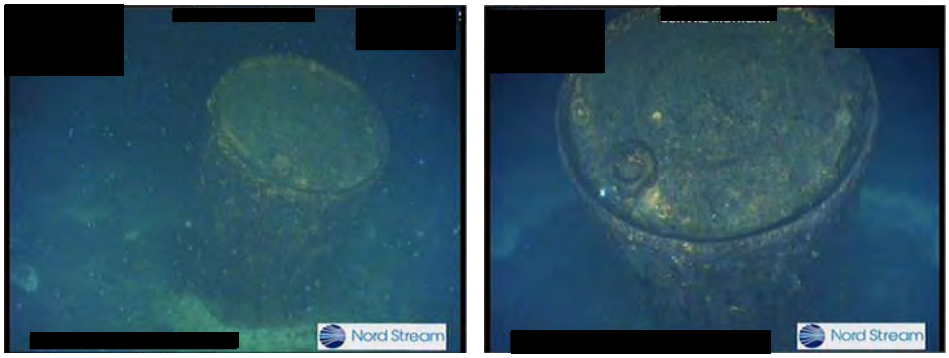
Before *After*

Figure A3.16b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.16c *Images of cable EE-SF3.*



Before *After*

Figure A3.16d *Images of barrel R-08-58162.*

Before *After*

Figure A3.16e *Images of barrel R-E8C-10226B.*

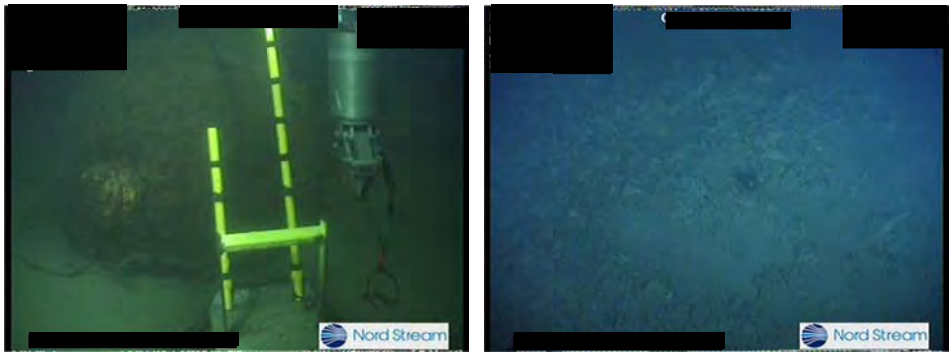
Before *After*

Figure A3.16f *Images of barrel R-E8C-10227.*

F16 (R-8CG-E-001) **Neon**

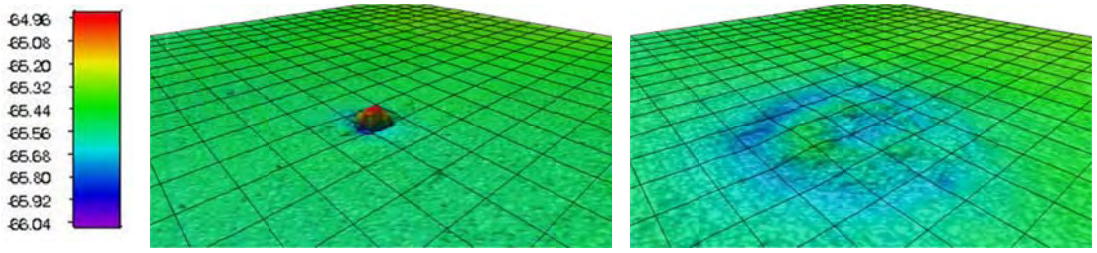
General

Clearance of **F16**, R-8CG-E-001, **Neon**; on 17 May 2010 at 13:00 UTC; see Figure A3.17 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /17/.



Before *After*

Figure A3.17a *Images of munitions before and after clearance.*

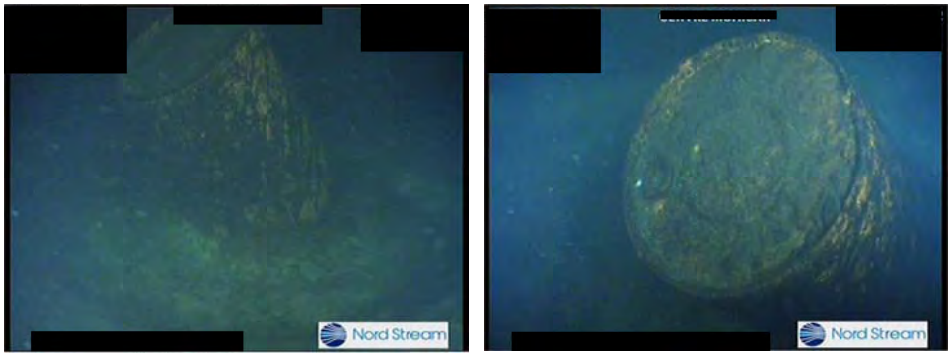


Before *After*

Figure A3.17b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

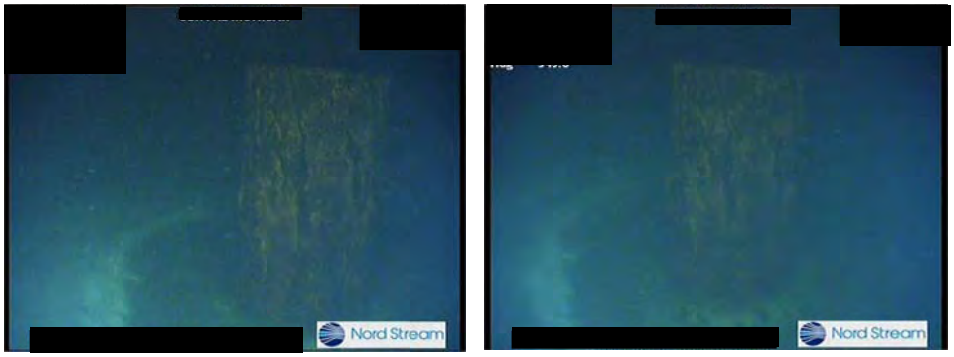
Before *After*

Figure A3.17c *Images of cable EE-SF3.*



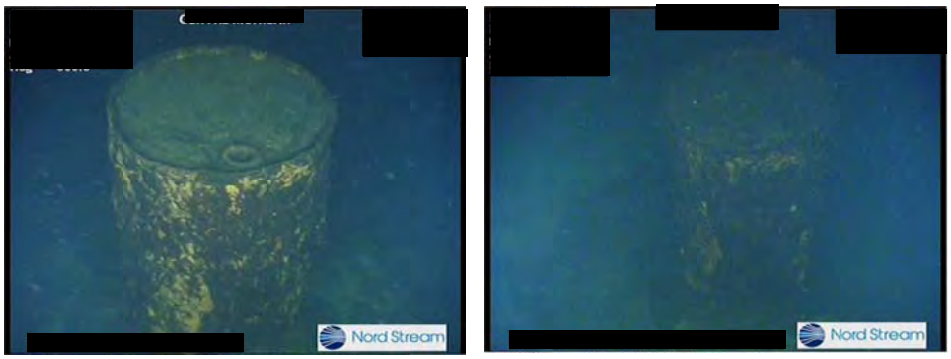
Before *After*

Figure A3.17c *Images of barrel R-08-58162.*



Before *After*

Figure A3.17c *Images of barrel R-E8C-10226B.*



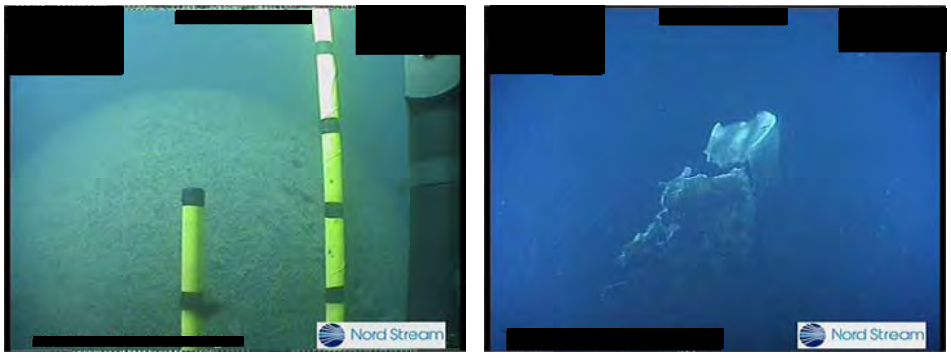
Before *After*

Figure A3.17c *Images of barrel R-E8C-10227.*

F17 (R-08-2805) **Nickel**

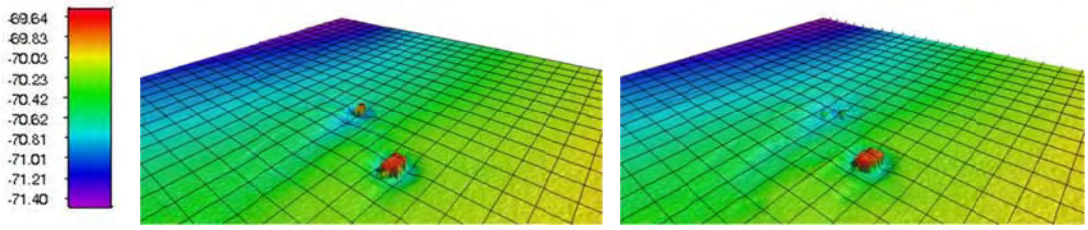
General

Clearance of **F17**, R-08-2805, **Nickel**; on 20 May 2010 at 10:00 UTC; see Figure A3.18 for images of the munitions, the seabed bathymetry and a barrel before and after the detonation. Details of the disposal of this munition are given in /18/.



Before *After*

Figure A3.18a *Images of munitions before and after clearance.*



Before *After*

Figure A3.18b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.18c *Images of barrel R-08-45237.*

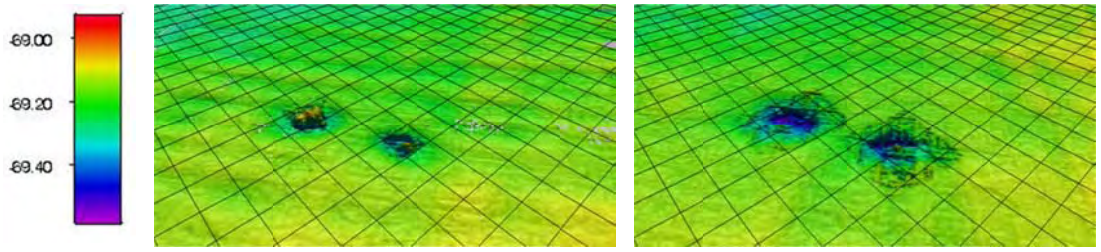
F18 (R-08-159) **Nitrogen**

General

Clearance of **F18**, R-08-159, **Nitrogen**; on 5 May 2010 at 12:30 UTC; see Figure A3.19 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /19/.

Before *After*

Figure A3.19a *Images of munitions before and after clearance.*

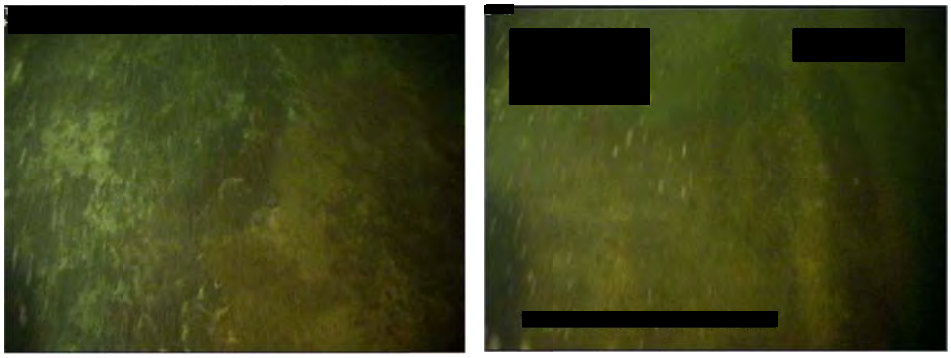


Before *After*

Figure A3.19b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

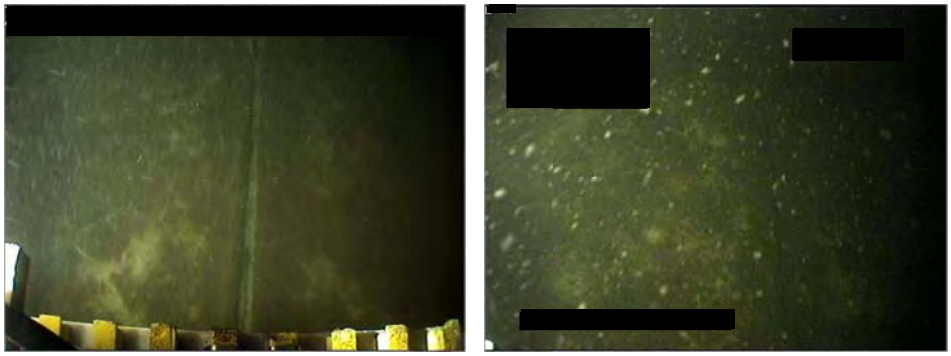
Before *After*

Figure A3.19c *Images of cable UESF2.*



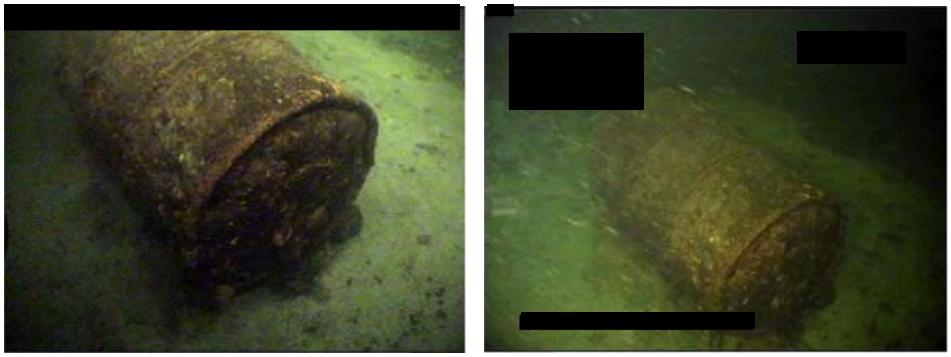
Before After

Figure A3.19d *Images of Estlink cable.*



Before After

Figure A3.19e *Images of cable FEC1.*



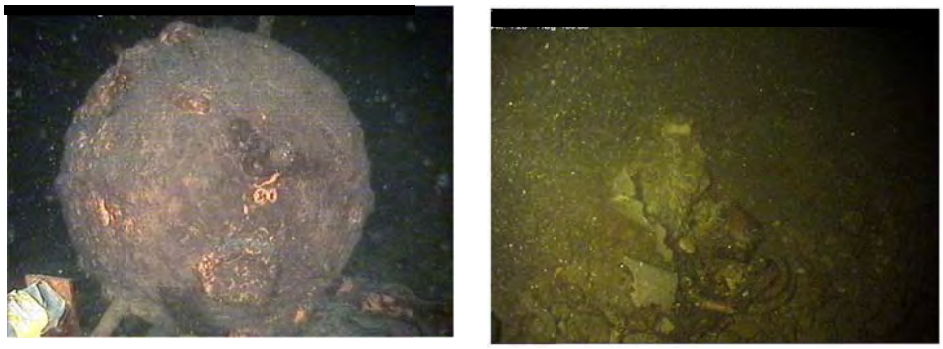
Before After

Figure A3.19f *Images of barrel R-08-44979.*

F19 (R-09-27) **Zinc**

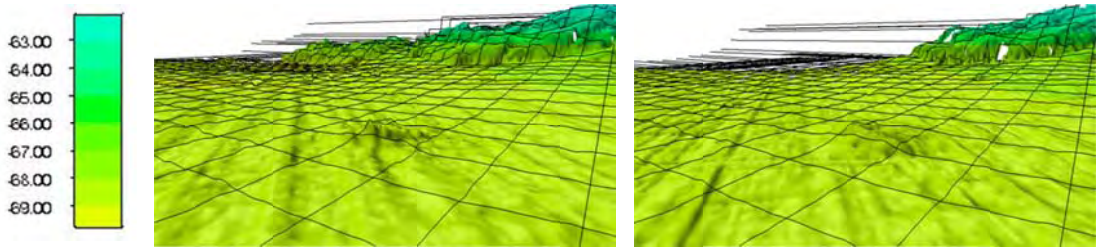
General

Clearance of **F19**, R-09-27, **Zinc**; on 30 April 2010 at 15:00 UTC; see Figure A3.20 for images of the munitions, the seabed bathymetry and near barrels and cable before and after the detonation. Details of the disposal of this munition are given in /20/.



Before *After*

Figure A3.20a *Images of munitions before and after clearance.*



Before *After*

Figure A3.20b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.20c *Images of barrel R-09-48197. Barrel was hit by ROV during the "before" video recording.*

Before

After

Figure A3.20d *Images of barrel R-09-48198.*

Before

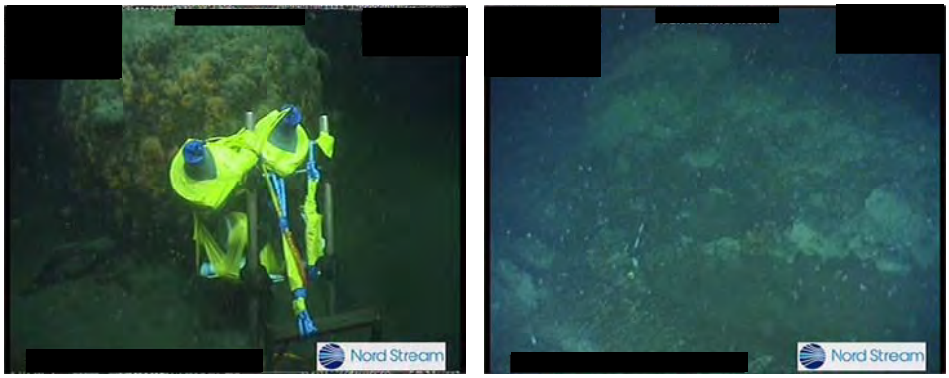
After

Figure A3.20e *Images of cable UESF2 cable.*

F20 (S-09-3135) **Palladium**

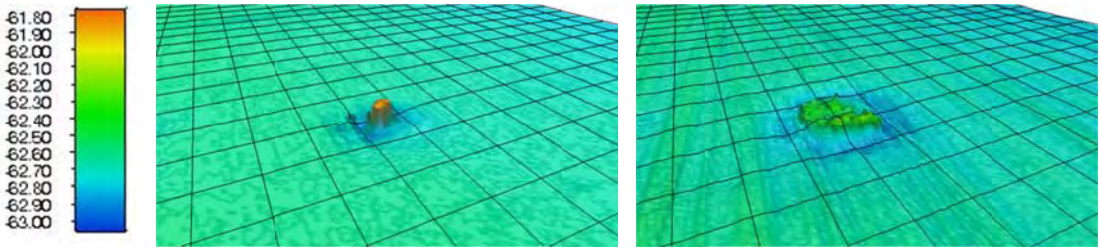
General

Clearance of **F20**, S-09-3135, **Palladium**; on 25 April 2010 at 07:00; see Figure A3.21 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /21/.



Before *After*

Figure A3.21a *Images of munitions before and after clearance.*



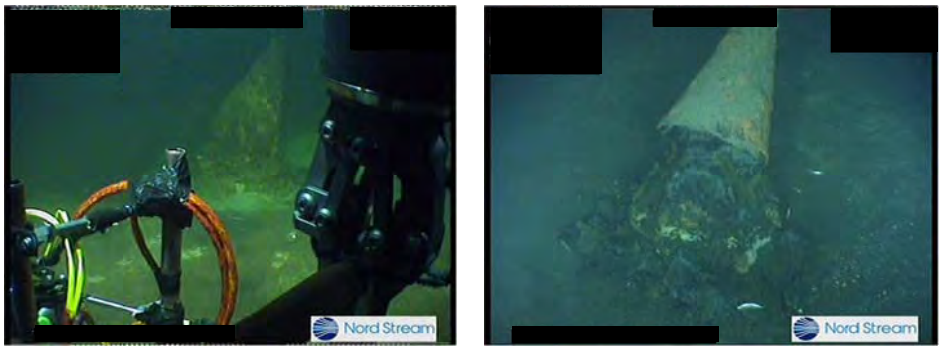
Before *After*

Figure A3.21b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

F21 (R-09-04) **Platinum**

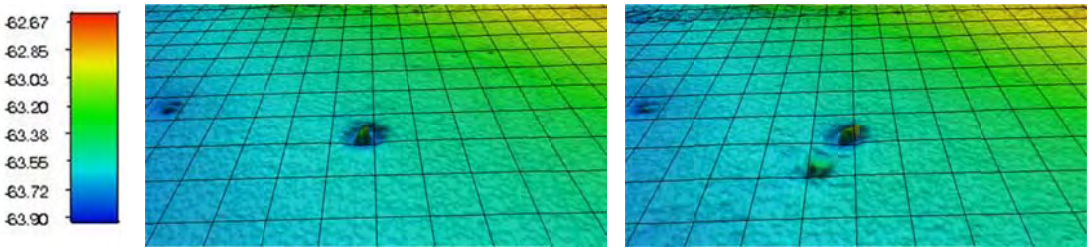
General

Clearance of **F21**, R-09-04, **Platinum**; on 19 April 2010 at 11:59 UTC; see Figure A3.22 for images of the munitions, the seabed bathymetry and near barrels and wrecks before and after the detonation. Details of the disposal of this munition are given in /22/.



Before *After*

Figure A3.22a *Images of munitions before and after clearance.*



Before *After*

Figure A3.22b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.22c *Images of barrel R-09-49088*

Before

After

Figure A3.22d *Images of barrel R-09-48535*

Before

After

Figure A3.22e *Images of barrel R-09-47641.*

Before

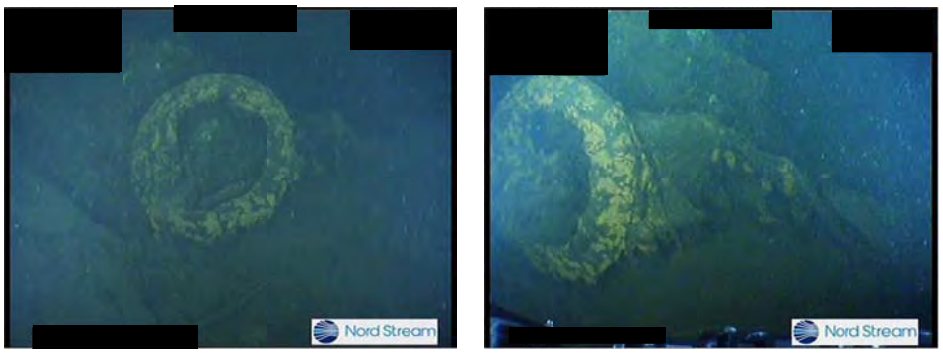
After

Figure A3.22f *Images of barrel R-09-48737.*

Before

After

Figure A3.22g *Images of barrel 09-S-14.*



Before *After*

Figure A3.22h *Images of wreck 4_9.*

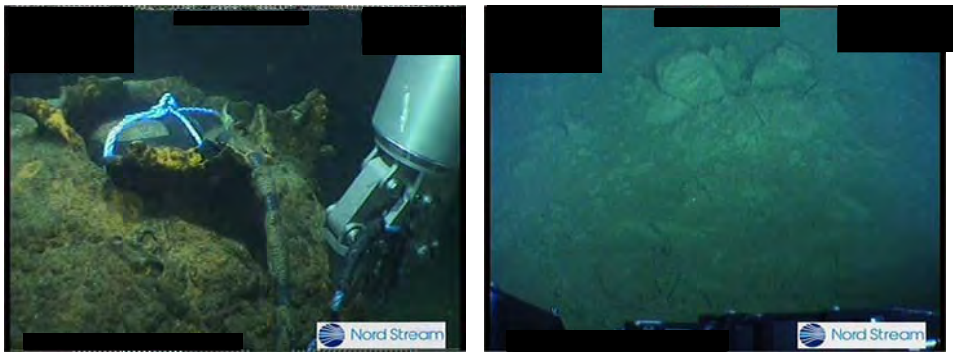
Before *After*

Figure A3.22i *Images of wreck R-9-49167*

F22 (R-09-192) **Potassium**

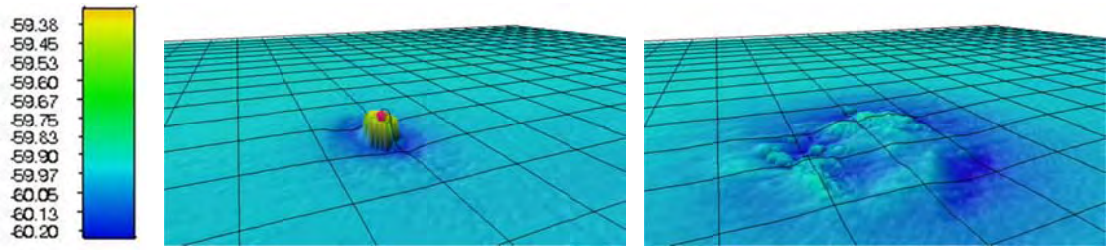
General

Clearance of **F22**, R-09-192, **Potassium**; on 20 April 2010 at 09:30 UTC; see Figure A3.23 for images of the munitions, the seabed bathymetry and near barrels before and after the detonation. Details of the disposal of this munition are given in /23/.



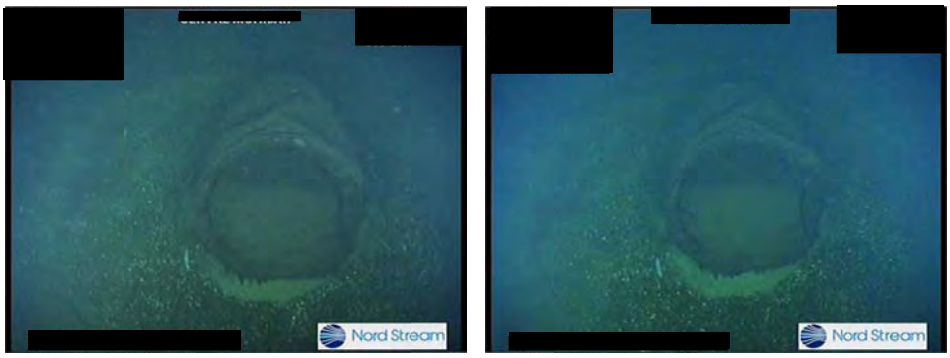
Before *After*

Figure A3.23a *Images of munitions before and after clearance. Note that the detonation charge is placed within the ruptured mine case before detonation.*



Before *After*

Figure A3.23b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

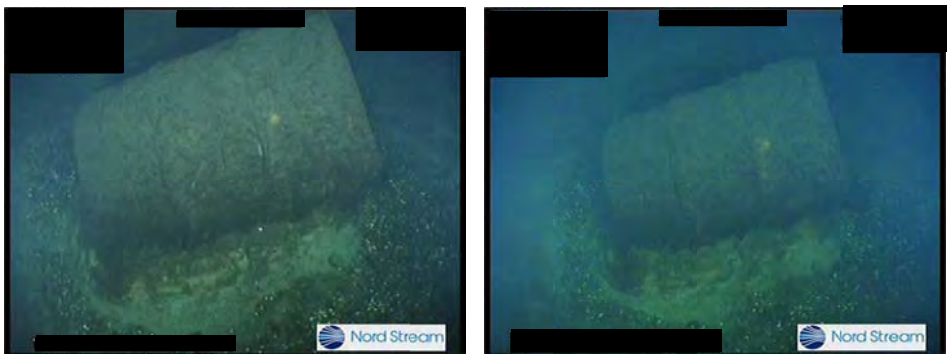
Figure A3.23c *Images of barrel R-09-49716.*

Before *After*

Figure A3.23d *Images of barrel R-09-49717*

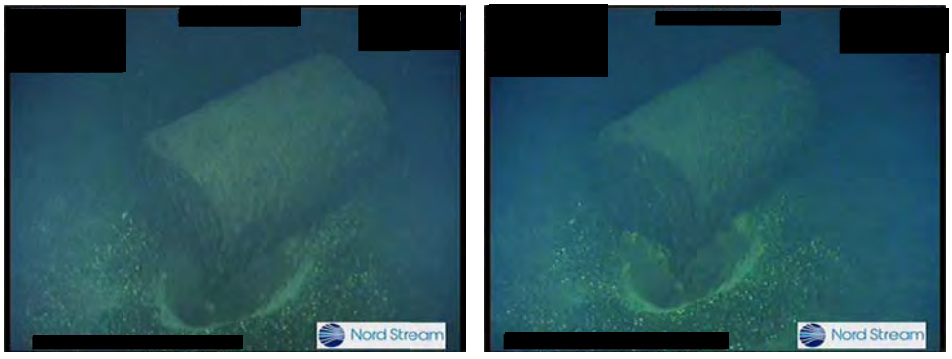
Before *After*

Figure A3.23e *Images of barrel R-09-49718*



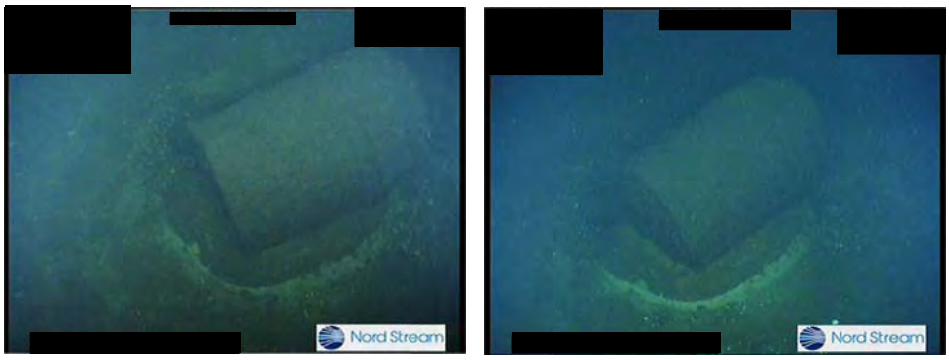
Before *After*

Figure A3.23f *Images of barrel R-09-49719*



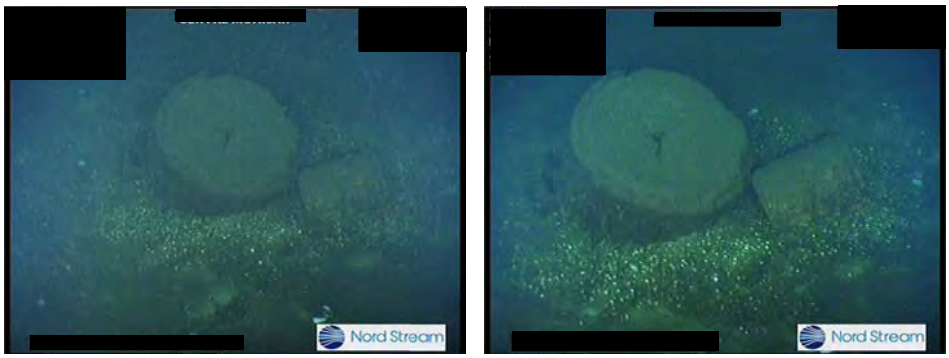
Before *After*

Figure A3.23g *Images of barrel R-09-49727.*



Before *After*

Figure A3.23h *Images of barrel R-09-49736*



Before *After*

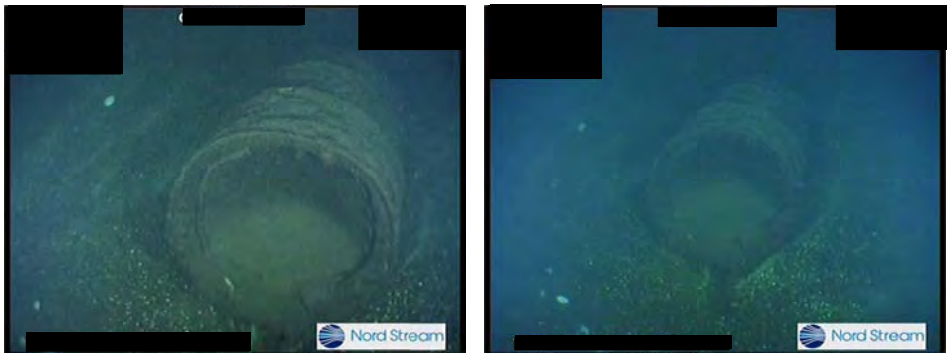
Figure A3.23i *Images of barrel R-09-49740*

Before *After*

Figure A3.23j *Images of barrel R-09-49742*

Before *After*

Figure A3.23k *Images of barrel R-09-49750*



Before *After*

Figure A3.23l *Images of barrel R-09-326892.*

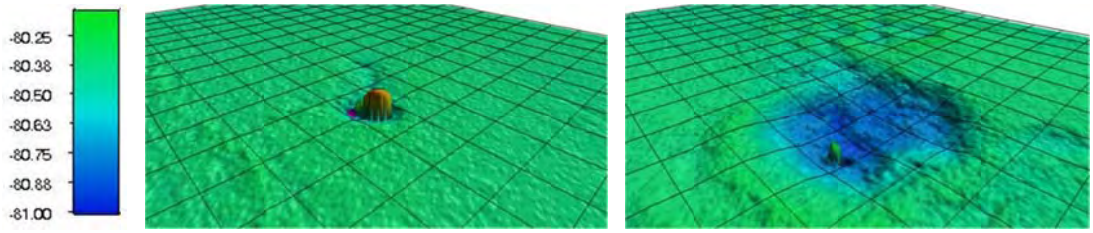
F23 (R-11-3395) **Silver**

General

Clearance of **F23**, R-11-3395, **Silver**; on 14 April 2010 at 15:00 UTC; see Figure A3.24 for images of the munitions, the seabed bathymetry and near barrels and wreck before and after the detonation. Details of the disposal of this munition are given in /24/.

Before *After*

Figure A3.24a *Images of munitions before and after clearance.*

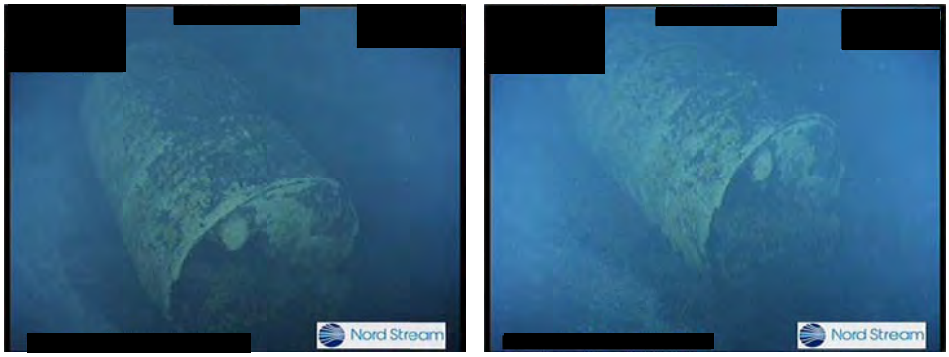


Before *After*

Figure A3.24b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

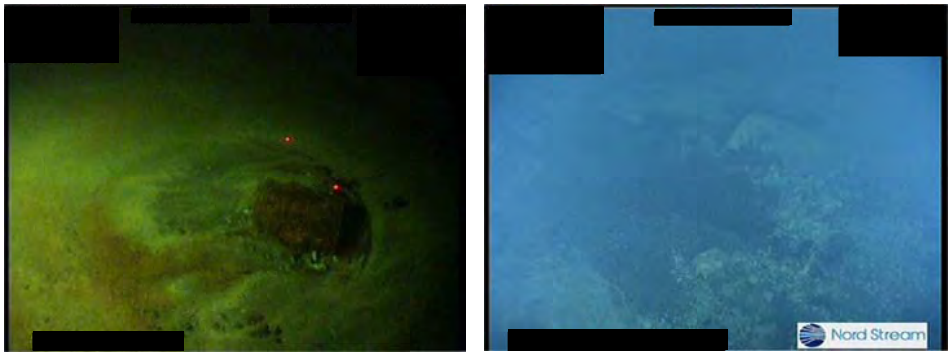
Before *After*

Figure A3.24c *Images of barrel R-11-26568; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



Before *After*

Figure A3.24d *Images of barrel RPS-11-3396; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*

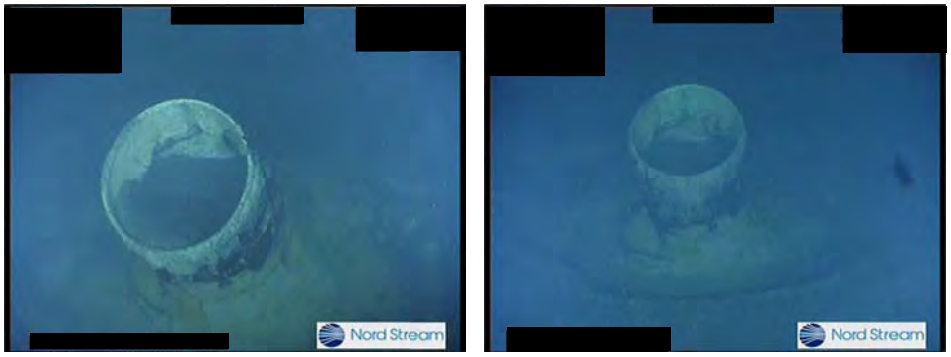


Before *After*

Figure A3.24e *Images of barrel R-11-26567; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*

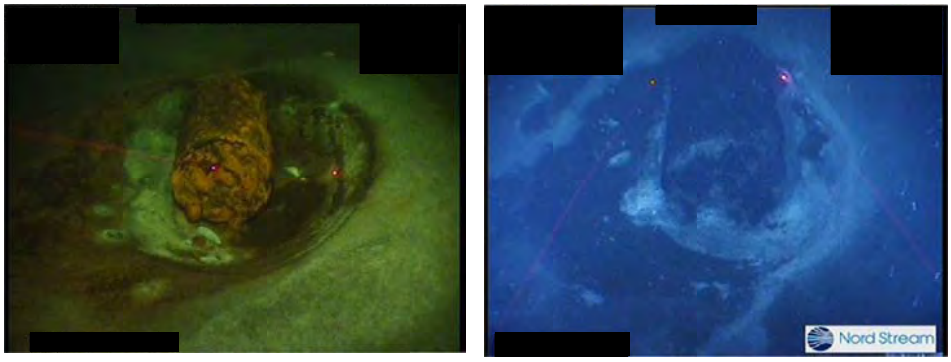
Before *After*

Figure A3.24f *Images of barrel RPS-11-1330; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



Before *After*

Figure A3.24g *Images of barrel RPS-11-42; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*

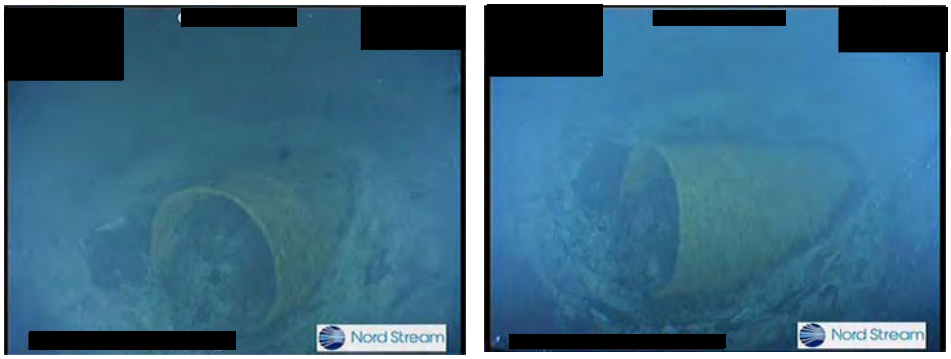


Before *After*

Figure A3.24h *Images of barrel R-11-26569A, which appeared to be same as barrel R-11-26569B.*

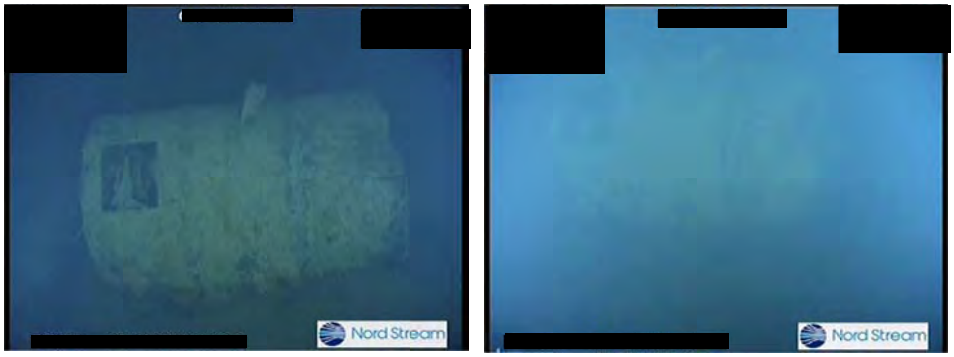
Before *After*

Figure A3.24i *Images of barrel RPS-11-3397; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



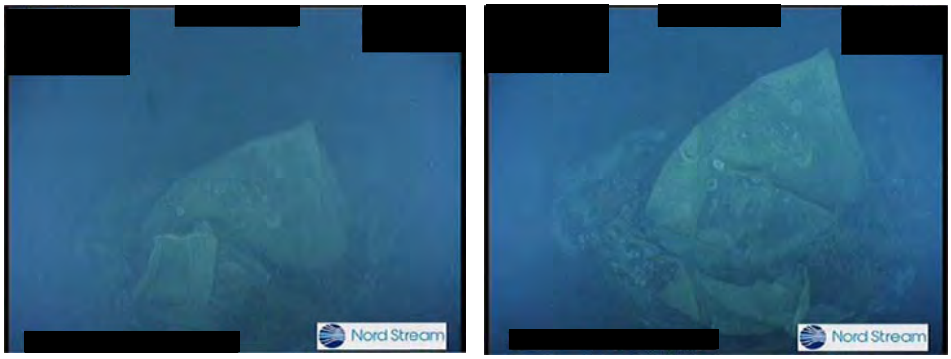
Before *After*

Figure A3.24j *Images of barrel R-11-26249; Due to equipment malfunction the co-ordinates as indicated on the 'before' image are incorrect; time and date are correct.*



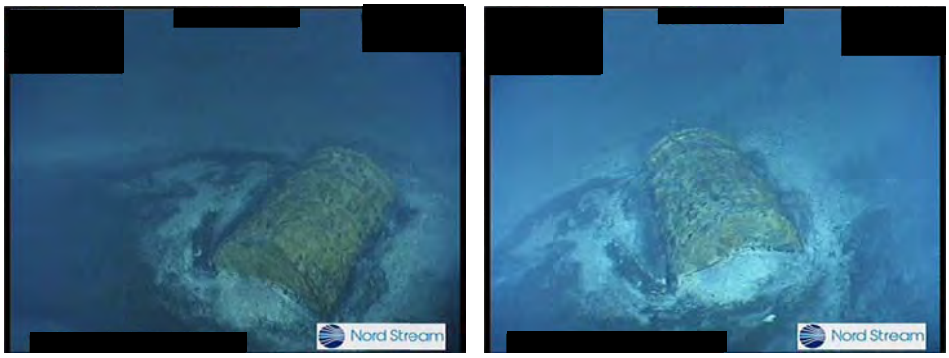
Before *After*

Figure A3.24k *Images of barrel RPS-11-25305.*



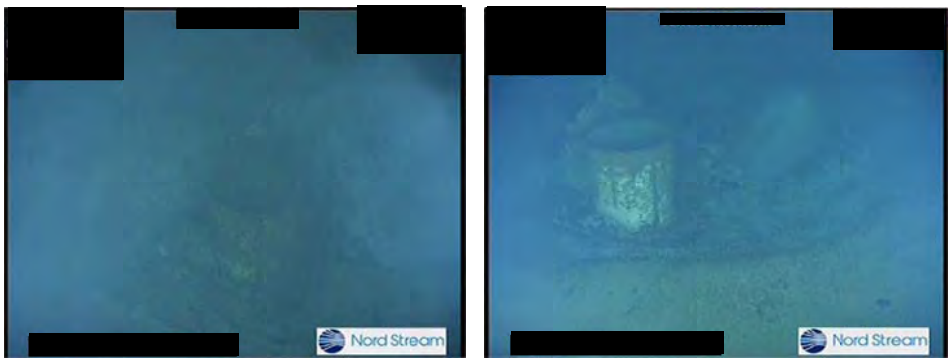
Before *After*

Figure A3.24l *Images of 'barrel' R-11-26112 appearing to be a plastic bag; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



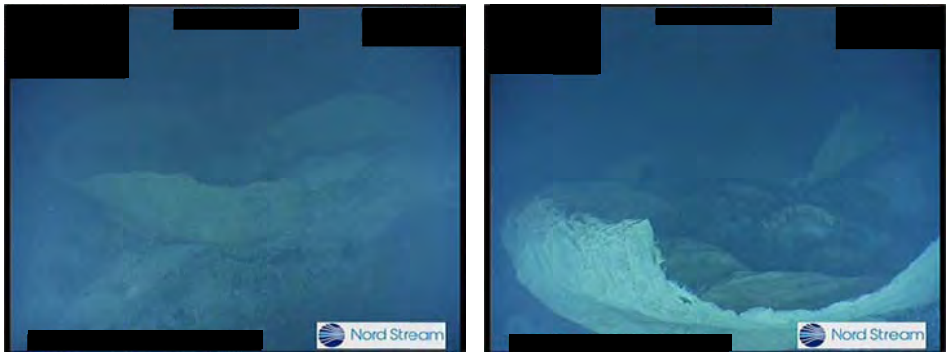
Before *After*

Figure A3.24m *Images of barrel RPS-11-3321; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



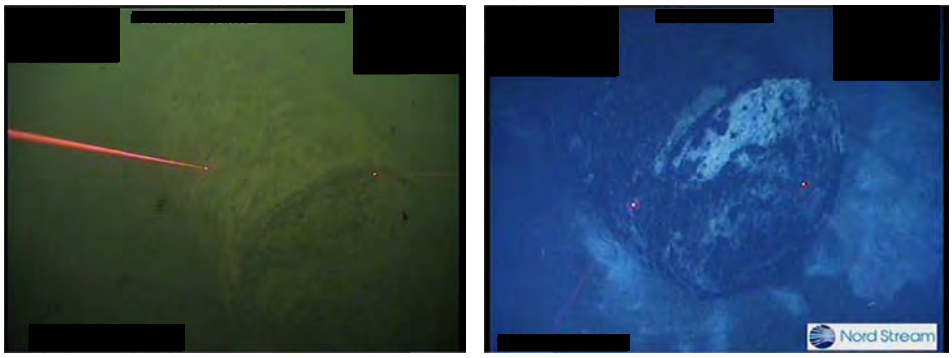
Before *After*

Figure A3.24n *Images of barrel R-11-25639; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



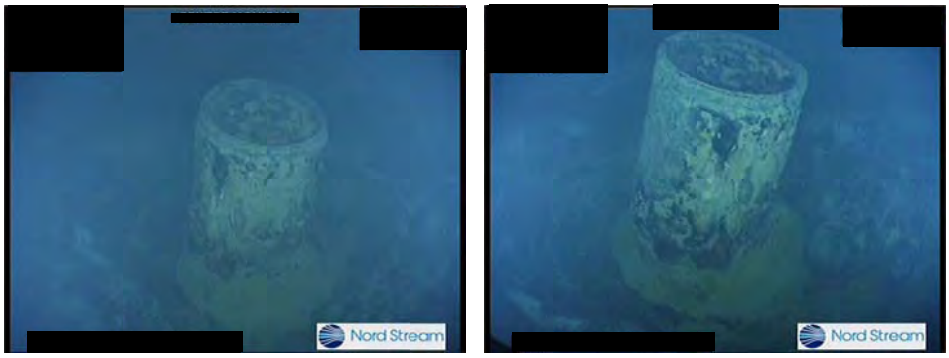
Before *After*

Figure A3.24o *Images of broken barrel or plastic bag R-11-26043; Due to equipment malfunction the co-ordinates as indicated on the 'before' image are incorrect; time and date are correct.*



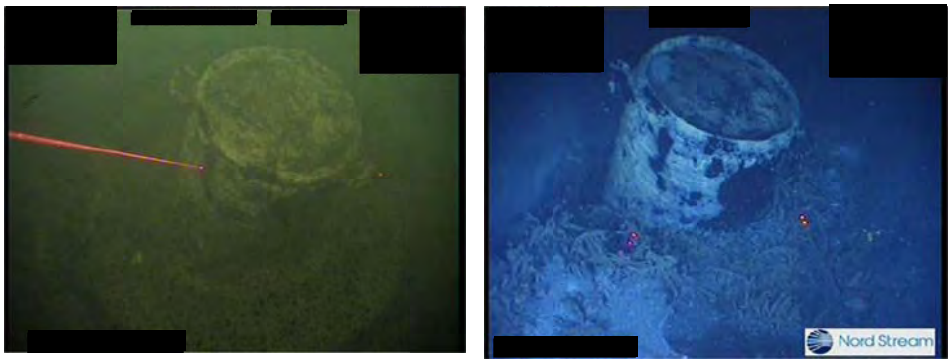
Before *After*

Figure A3.24p *Images of barrel RPS-11-2216.*



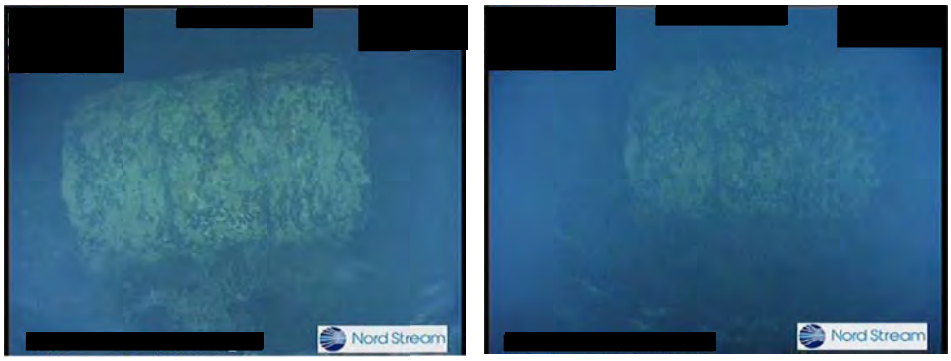
Before *After*

Figure A3.24q *Images of barrel RPS-11-241; Due to equipment malfunction the co-ordinates as indicated on the 'before' image are incorrect; time and date are correct.*



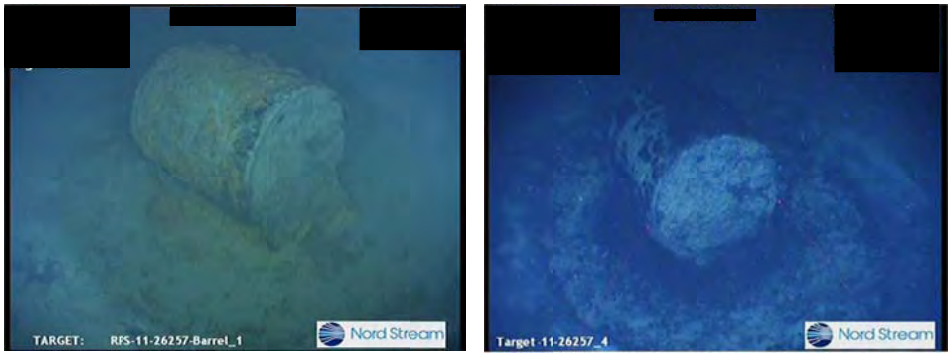
Before *After*

Figure A3.24r *Images of barrel RPS-11-41.*



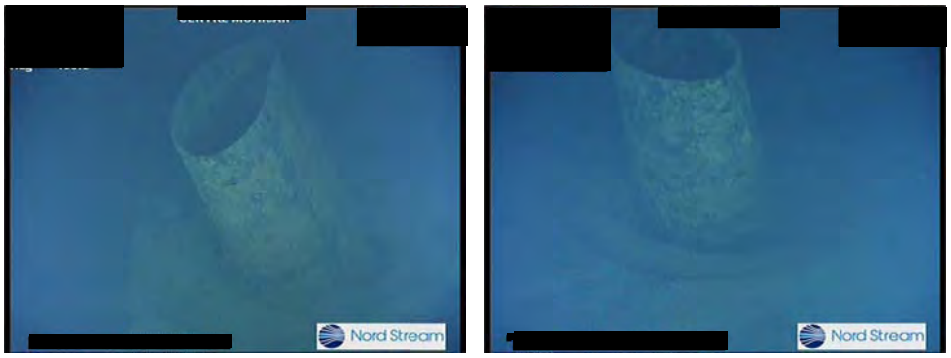
Before *After*

Figure A3.24s *Images of barrels RPS-11-25197, which appeared to be same as barrel RPS-11-2218.*



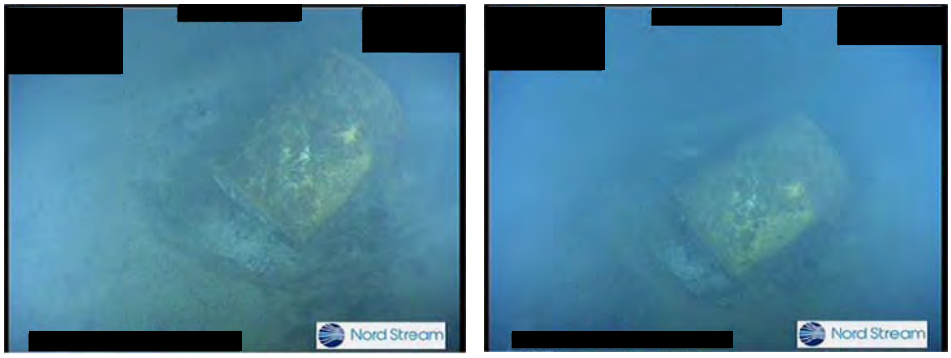
Before *After*

Figure A3.24t *Images of barrel RPS-11-26257.*



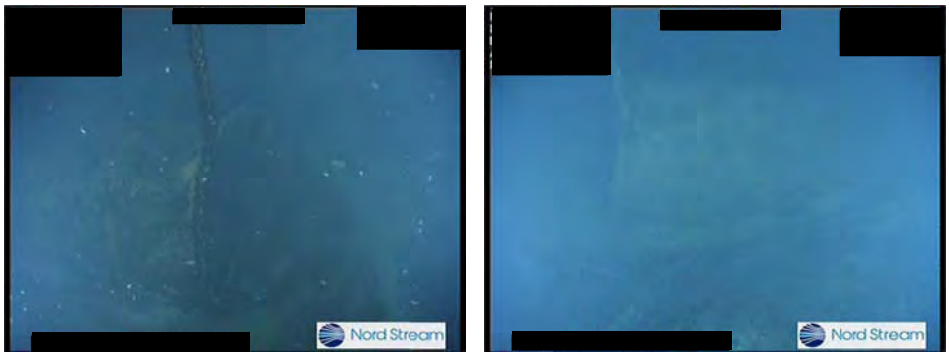
Before *After*

Figure A3.24u *Images of barrel R-11-300686, which appeared to be same as barrel RPS-11-2219.*



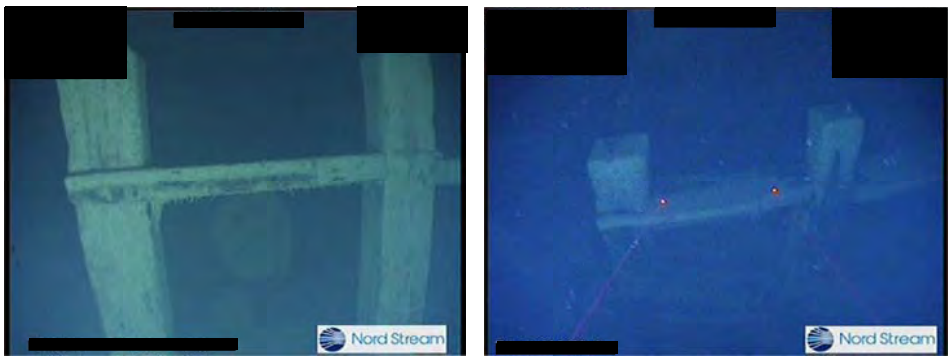
Before *After*

Figure A3.24v *Images of barrel R-11-26250; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



Before *After*

Figure A3.24w *Images of barrel R-11-26247; Due to equipment malfunction the co-ordinates as indicated on the 'after' image are incorrect; time and date are correct.*



Before *After*

Figure A3.24x *Images of wreck S-11-3138*

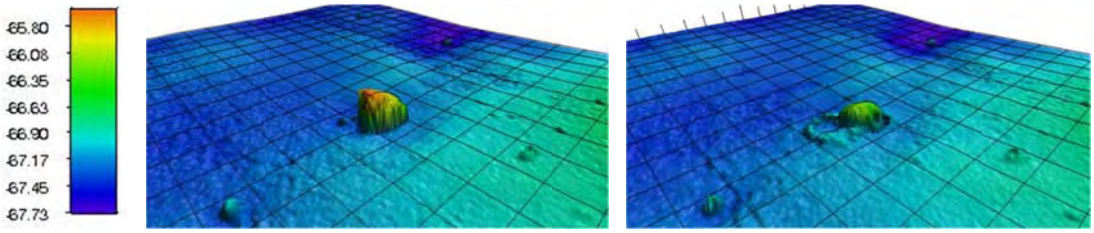
F25+F26 (R-12-008) **Sulphur**

General

Clearance of **F25+F26**, R-12-008, **Sulphur**; on 10 April 2010 at 10:15 UTC; see Figure A3.25 for images of the munitions, the seabed bathymetry and near barrel before and after the detonation. Details of the disposal of this munition are given in /25/.

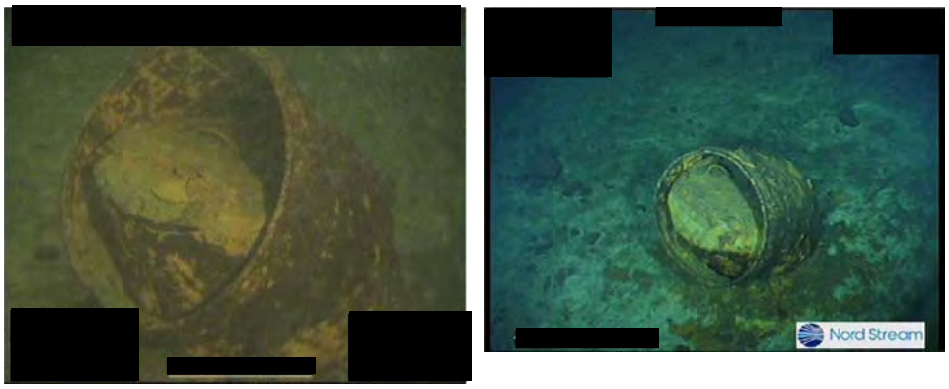
Before *After*

Figure A3.25a *Images of munitions before and after clearance. Note the plank of wood with inscription '24/2' that has been revealed after clearance standing against the rock.*



Before *After*

Figure A3.25b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.25c *Images of barrel R-12-380*

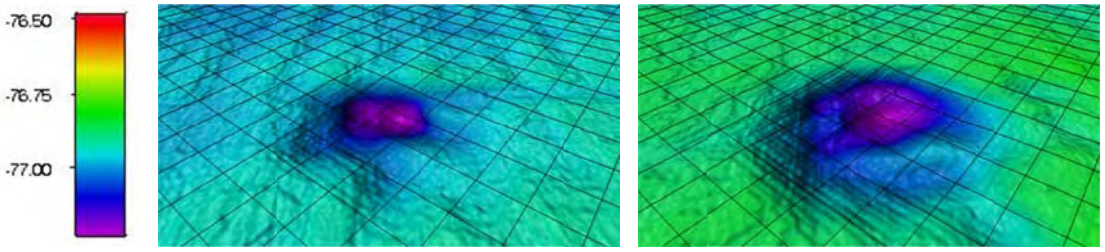
F27 (R-12-3463) **Xenon**

General

Clearance of **F27**, R-12-3463, **Xenon**; on 11 May 2010 at 14:00 UTC; see Figure A3.26 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /26/.

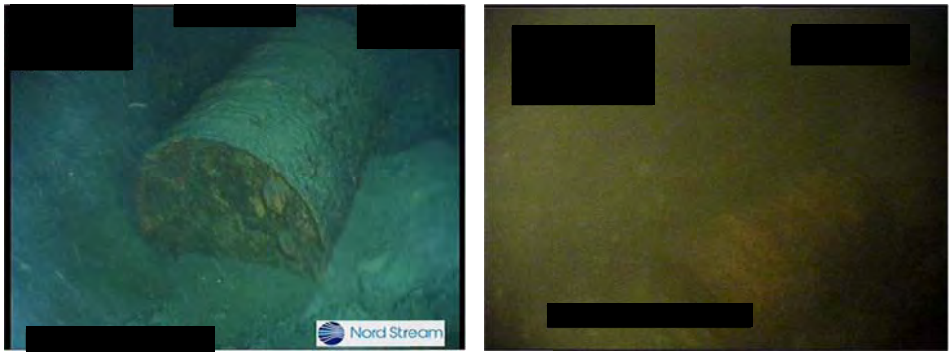
Before *After*

Figure A3.26a *Images of munitions before and after clearance.*



Before *After*

Figure A3.26b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



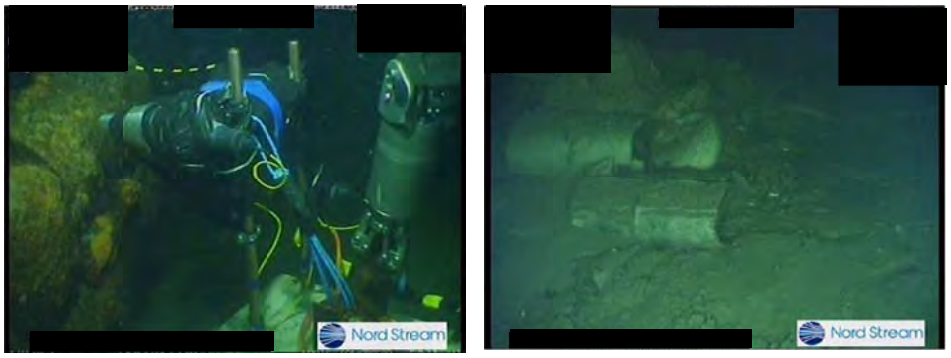
Before *After*

Figure A3.26c *Images of barrel R-12-130141.*

F33 (R-11-200030) **Aluminium**

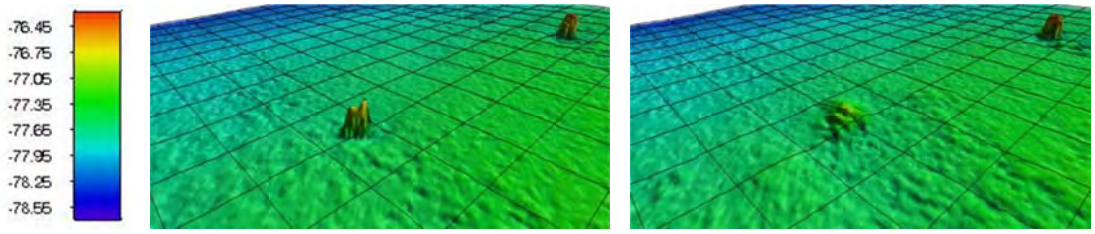
General

Clearance of **F33**, R-11-200030, **Aluminium**; on 12 April 2010 at 10:59 UTC; see Figure A3.27 for images of the munitions, the seabed bathymetry and near barrels before and after the detonation. Details of the disposal of this munition are given in /27/.



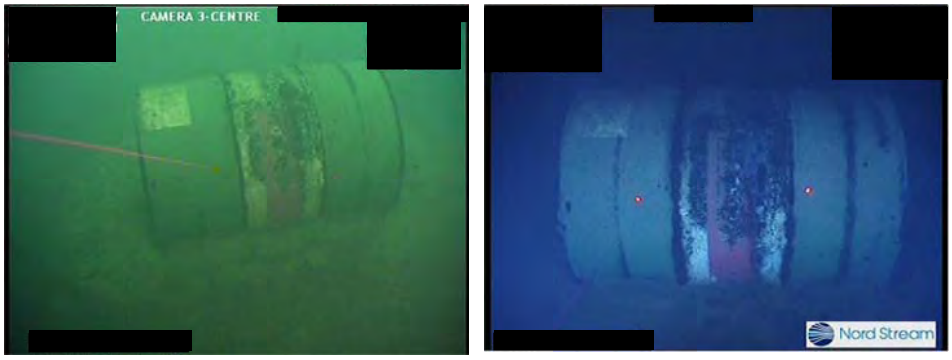
Before *After*

Figure A3.27a *Images of munitions before and after clearance.*



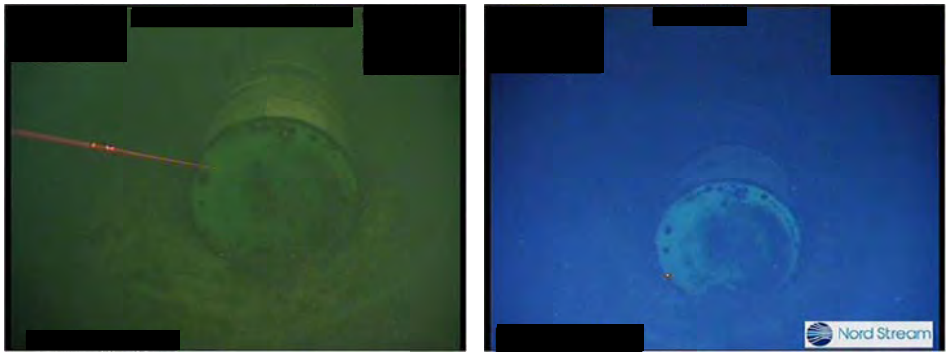
Before *After*

Figure A3.27b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.27c *Images of barrel R-11-26172.*



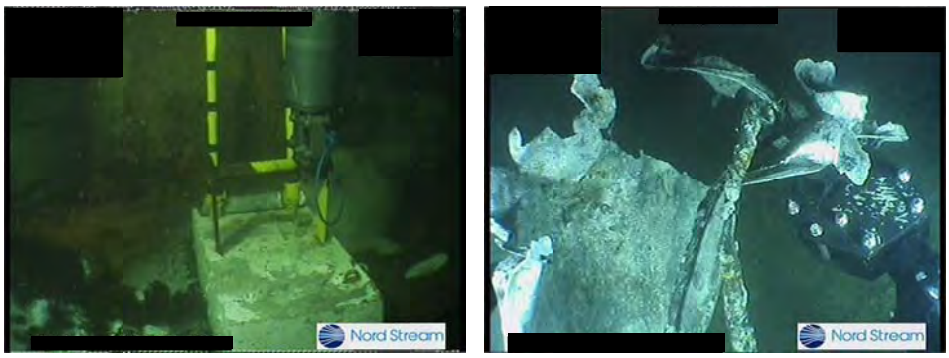
Before *After*

Figure A3.27d *Images of barrel R-11-3362.*

F34 (R-12-51010) **Lead**

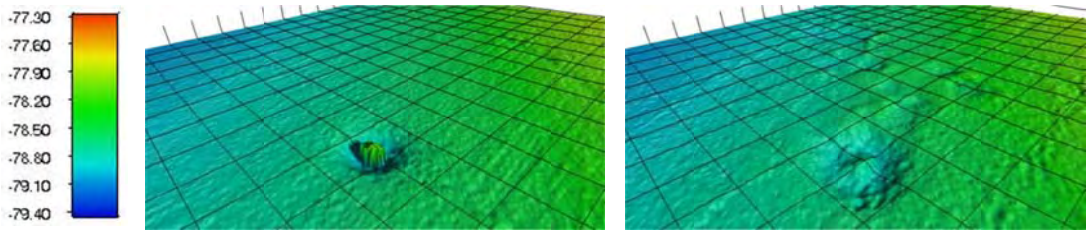
General

Clearance of **F34**, R-12-51010, **Lead**; on 11 April 2010 at 13:00 UTC; see Figure A3.28 for images of the munitions, the seabed bathymetry and near cable before and after the detonation. Details of the disposal of this munition are given in /28/.



Before *After*

Figure A3.28a *Images of munitions before and after clearance; the time on the image after clearance is not correct.*



Before *After*

Figure A3.28b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.28c *Images of cable UCCBF.*

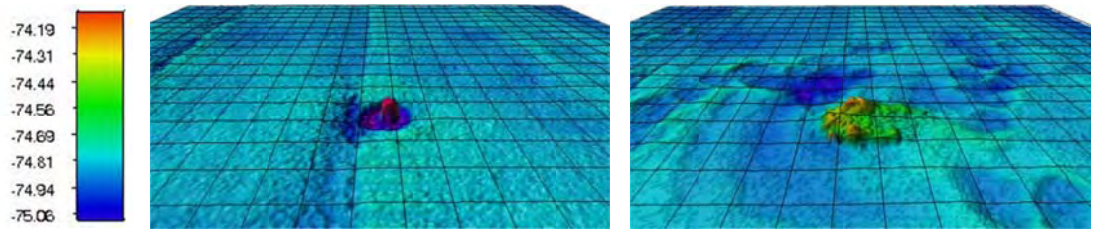
F35 (R-13-31989) **Osmium**

General

Clearance of **F35**, R-13-31989, **Osmium**; on 9 April 2010 at 16:00 UTC; see Figure A3.29 for images of the munitions, the seabed bathymetry and near barrel and wreck before and after the detonation. Details of the disposal of this munition are given in /29/.

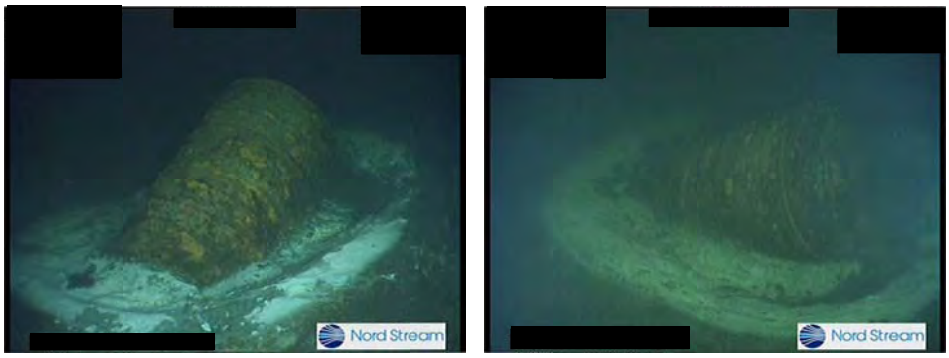
Before *After*

Figure A3.29a *Images of munitions before and after clearance.*



Before *After*

Figure A3.29b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

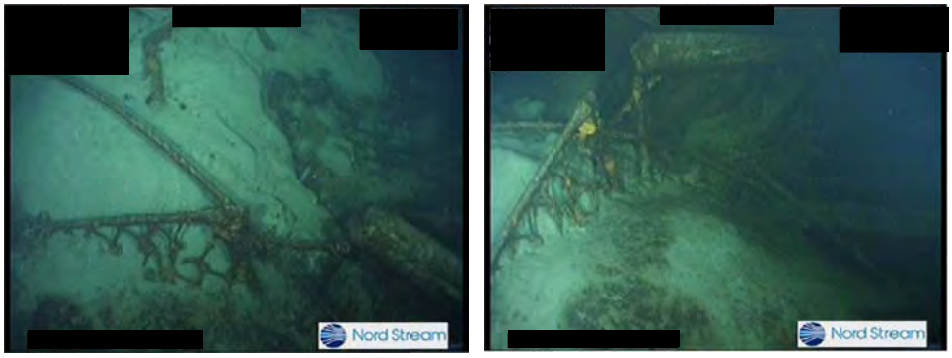


Before *After*

Figure A3.29c *Images of barrel R-13-33554.*

Before *After*

Figure A3.29d *Images of wreck S-13-32852.*



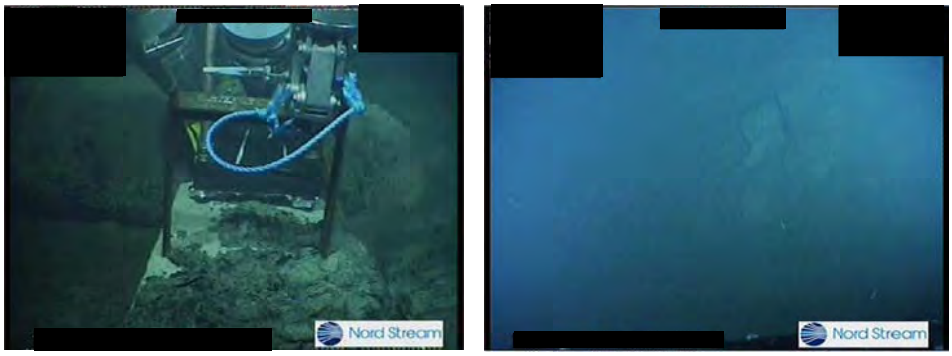
Before *After*

Figure A3.29e *Images of wreck S-13-32852.*

F36 (R-14-35290) **Iridium**

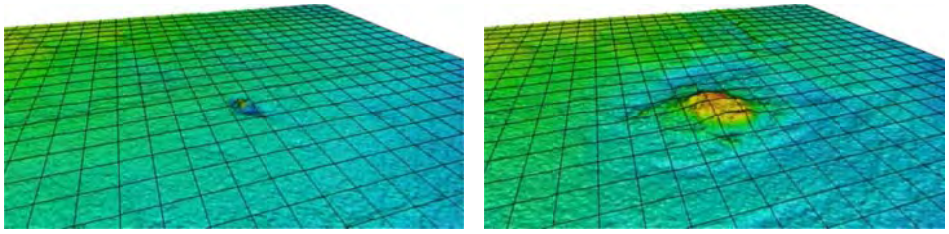
General

Clearance of **F36**, R-14-35290, **Iridium**; on 6 April 2010 at 09:00 UTC; see Figure A3.30 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /30/.



Before *After*

Figure A3.30a *Images of munitions before and after clearance.*



Before *After*

Figure A3.30b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

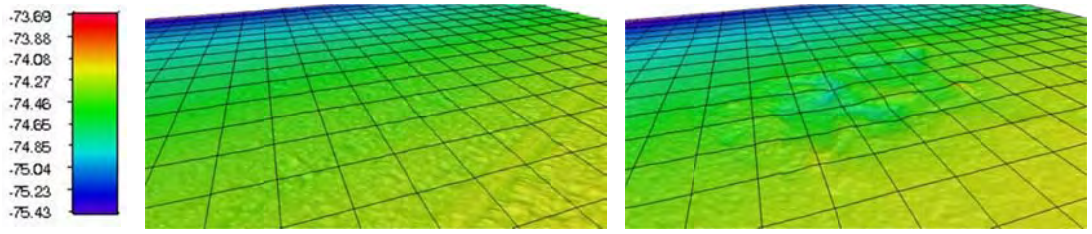
F37 (R-08-2767) **Rhodium**

General

Clearance of **F37**, R-08-2767, **Rhodium**; on 27 May 2010 at 12:00 UTC; see Figure A3.31 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /31/.

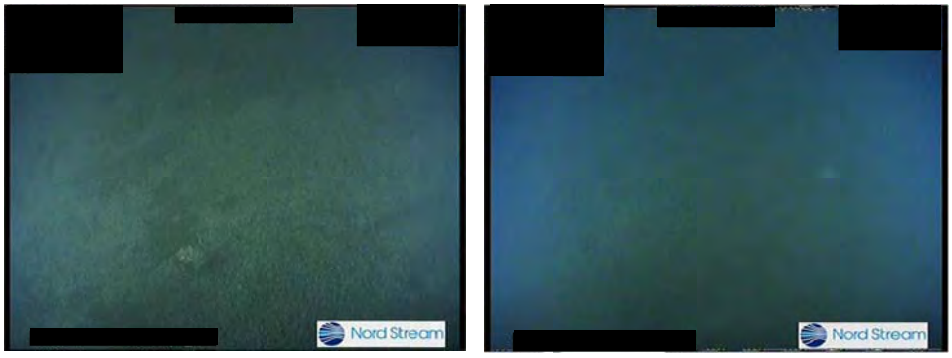
Before *After*

Figure A3.31a *Images of munitions before and after clearance.*



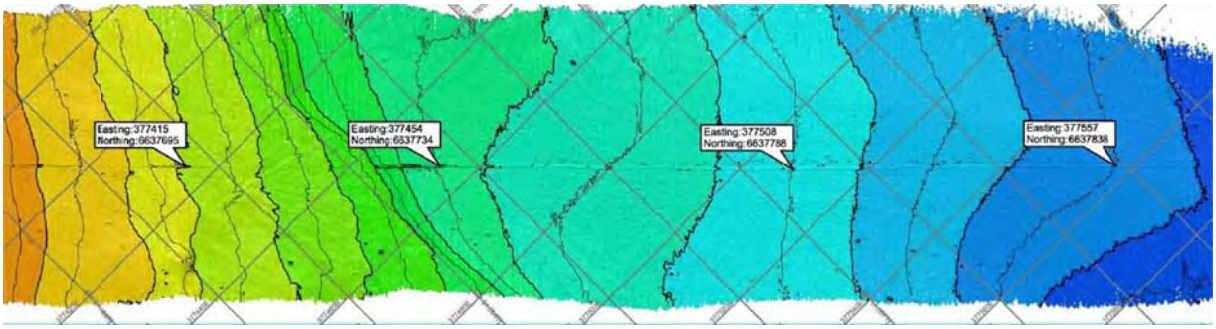
Before *After*

Figure A3.31b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

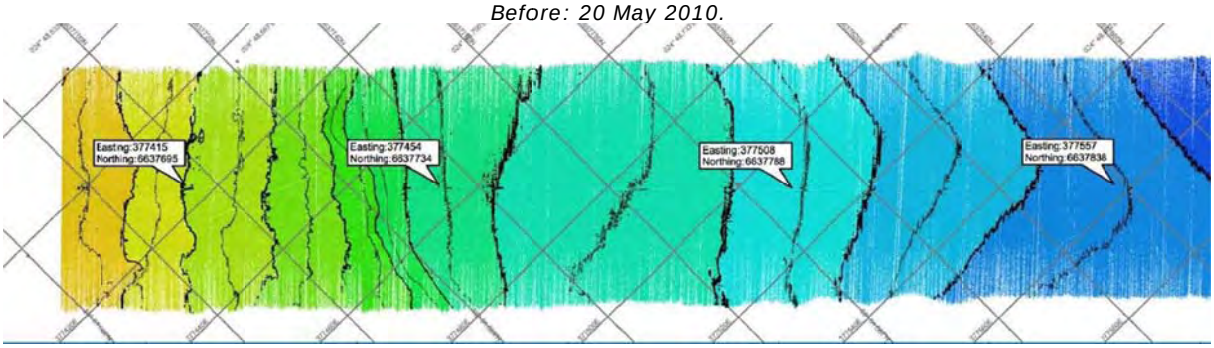


Before *After*

Figure A3.31c *Images of cable EE-SF2; these images have been taken before the disposal of any of the other FAB100 munitions (F38 –F38K).*

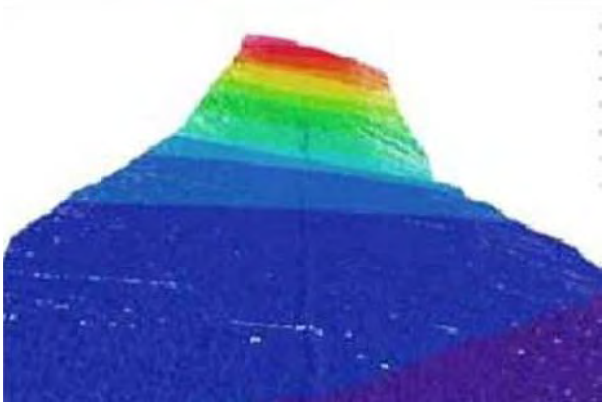


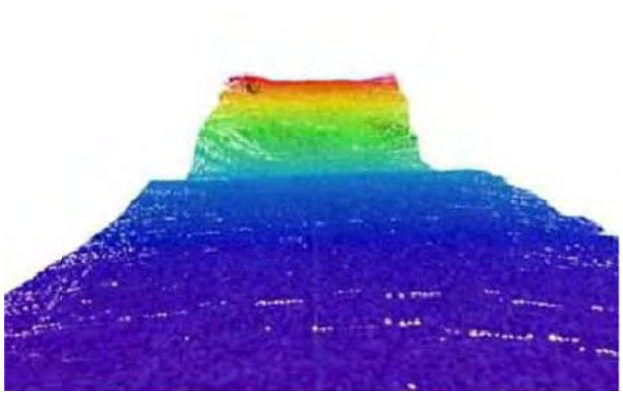
Before: 20 May 2010.



After: 11 June 2010.

Figure A3.31d *Images of ROV mounted MBES of cable Pangea Seg 3 in plan view; the MBES 'after' was performed after clearance of all FAB100 munitions (F38 – F38K).*





Before: 20 May 2010 *After: 11 June 2010*

Figure A3.31e *Images of ROV mounted MBES of cable Pangea Seg 3 in 3D view; the MBES 'after' was performed after clearance of all FAB100 munitions (F38 – F38K).*

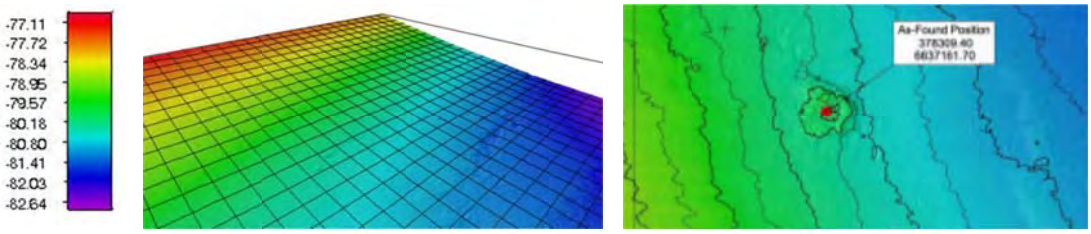
F38 (R-08-450077) **Gallium**

General

Clearance of **F38**, R-08-450077, **Gallium**; on 30 May 2010 at 09:00 UTC; see Figure A3.32 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /32/.

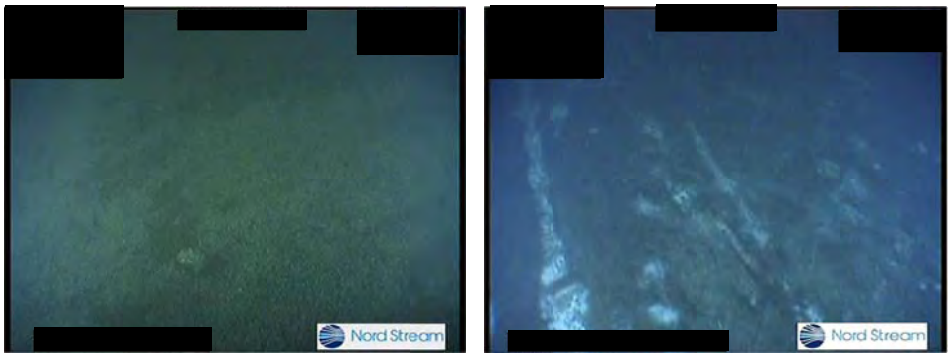
Before *After*

Figure A3.32a *Images of munitions before and after clearance; the left image shows the clamp with rope to the air bag just before lifting and re-locating the bomb.*



Before *After*

Figure A3.32b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.32c *Images of cable EE-SF2; the image 'after' was taken after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

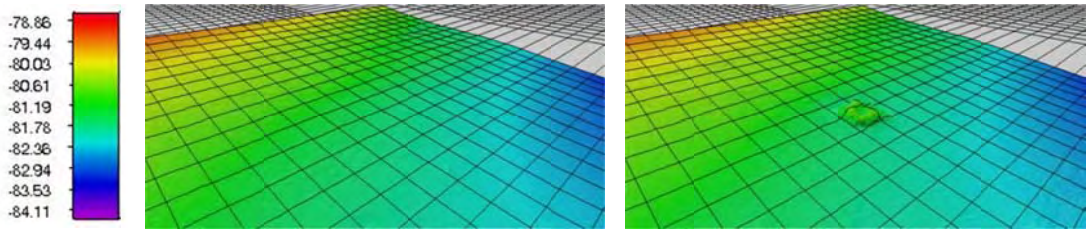
F38B (R-8-001-FAB) **Terbium**

General

Clearance of **F38B**, R-8-001-FAB, **Terbium**; 28 May 2010 at 18:00 UTC; see Figure A3.33 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /33/.

Before *After*

Figure A3.33a *Images of munitions before and after clearance.*



Before *After*

Figure A3.33b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.33c *Images of cable EE-SF2; the image 'after' was taken after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

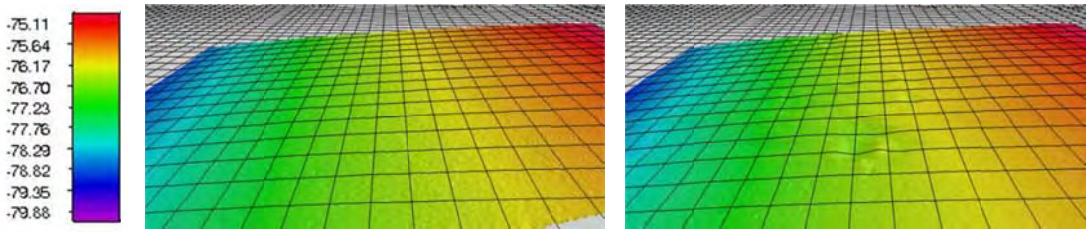
F38C (R-08-002-FAB) **Fluorine**

General

Clearance of **F38C**, R-08-002-FAB, **Fluorine**; 31 May 2010 at 16:30 UTC; see Figure A3.34 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /34/.

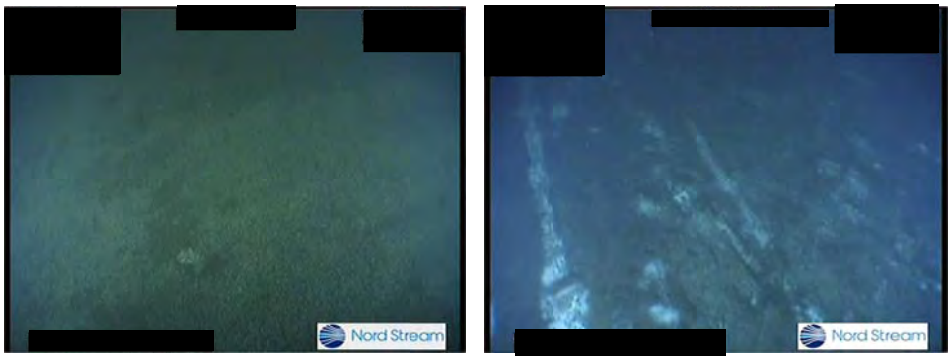
Before *After*

Figure A3.34a *Images of munitions before and after clearance.*



Before *After*

Figure A3.34b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.34c *Images of cable EE-SF2; the image 'after' was taken after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

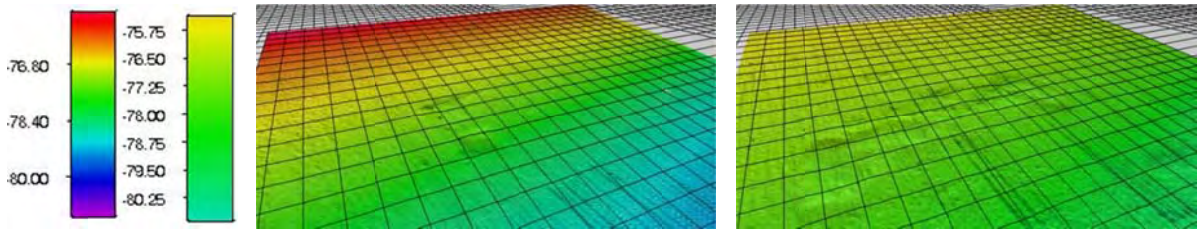
F38D (R-08-003-FAB) **Astatine**

General

Clearance of **F38D**, R-08-003-FAB, **Astatine**; 4 June 2010 at 05:00 UTC; see Figure A3.35 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /35/.

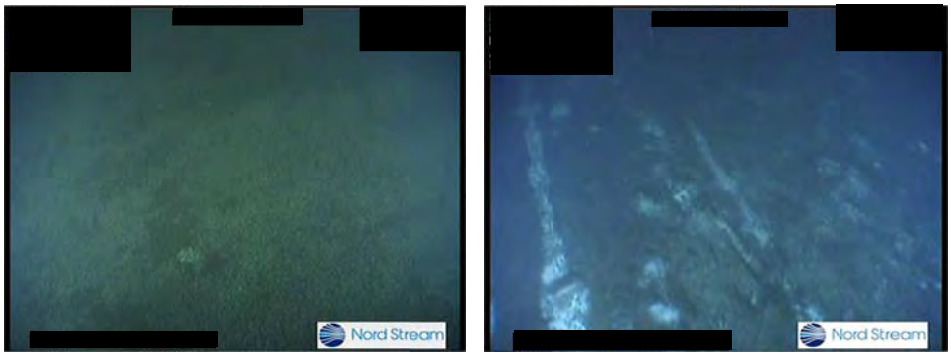
Before *After*

Figure A3.35a *Images of munitions before and after clearance.*



Before *After*

Figure A3.35b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



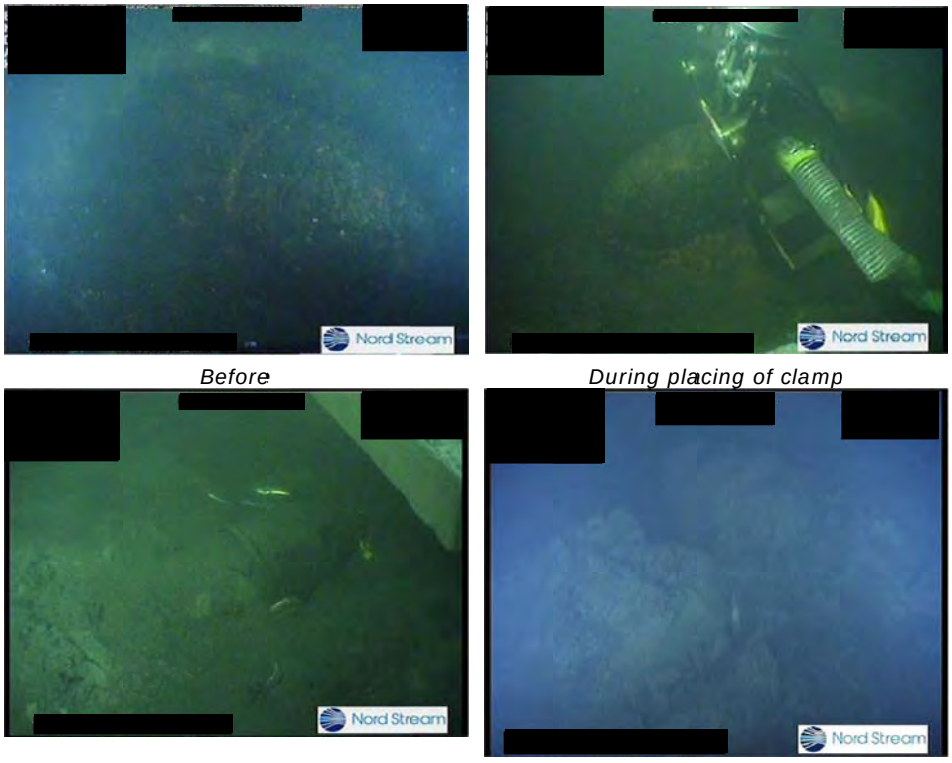
Before *After*

Figure A3.35c *Images of cable EE-SF2; the image 'after' was taken after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

F38E (R-8-004-FAB) **Nobelium**

General

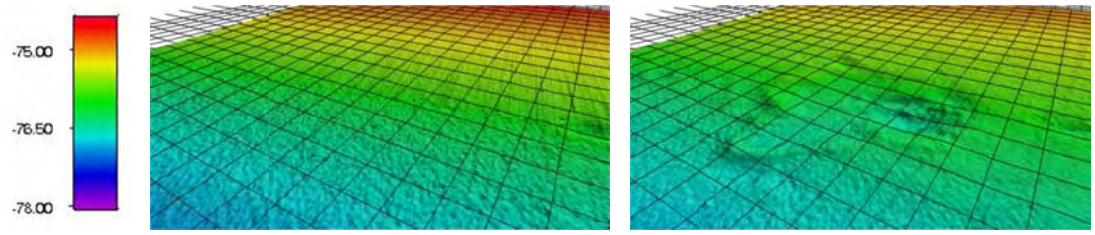
Clearance of **F38E**, R-8-004-FAB, **Nobelium**; 8 June 2010 at 12:00 UTC; see Figure A3.36 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /36/.



Before *During placing of clamp*

After 1st attempt, before 2nd *After*

Figure A3.36a *Images of munitions before and after final clearance.*



Before *After*

Figure A3.36b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

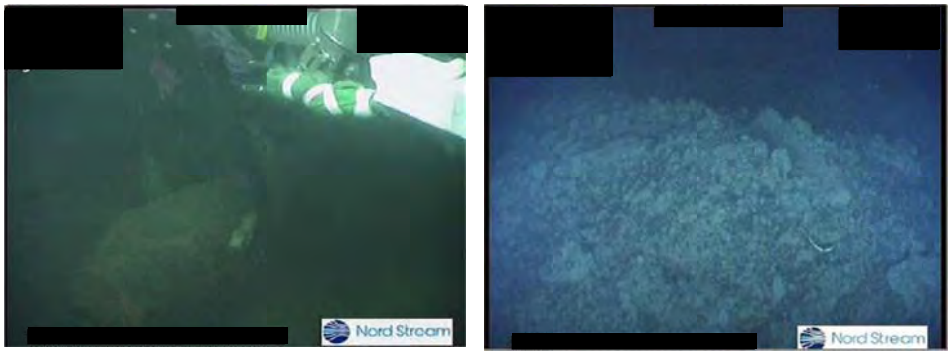
Before *After*

Figure A3.36c *Images of cable EE-SF2; the 'before' image is taken before 2nd and final disposal of this target (F38E) but after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

F38F (R-8-005-FAB) **Mendelevium**

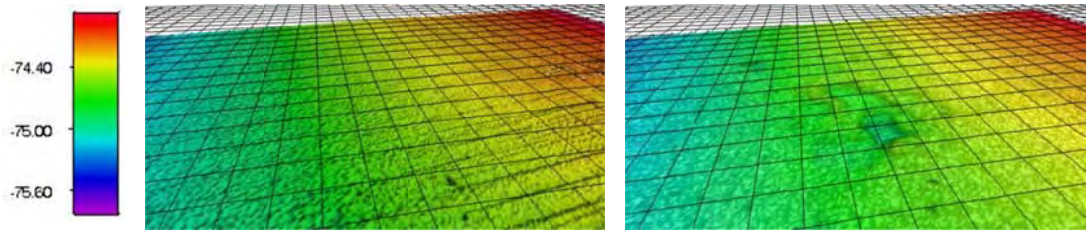
General

Clearance of **F38F**, R-8-003-FAB, **Mendelevium**; 7 June 2010 at 07:30 UTC; see Figure A3.37 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /37/.



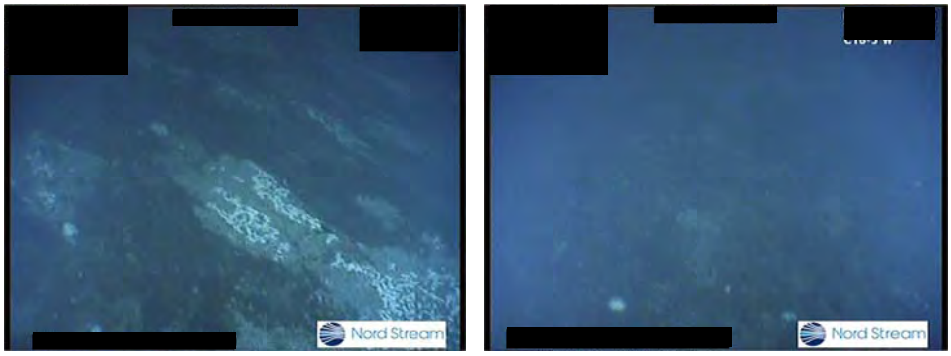
Before *After*

Figure A3.37a *Images of munitions before and after clearance.*



Before *After*

Figure A3.37b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.37c *Images of cable EE-SF2; the 'before' image is taken before 2nd and final disposal of this target (F38E) but after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E; the 'after' image is taken after disposal of three more: F38E, F38F and F38H, eight in total. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

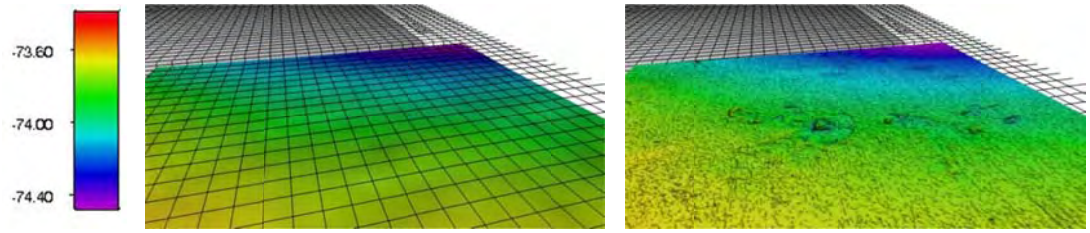
F38G (R-08-006-FAB) **Plutonium**

General

Clearance of **F38G**, R-08-006-FAB, **Plutonium**; 10 June 2010 at 10:30 UTC; see Figure A3.38 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /38/.

Before *After*

Figure A3.38a *Images of munitions before and after clearance.*



Before *After*

Figure A3.38b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale. Please note that the 'before" MBES was performed with a hull-mounted echosounder, resulting in an image with lower resolution compared with ROV-mounted echosounder as used for all other munitions clearance surveys. Based on the experience with crater volume calculations for the other FAB100 munitions, the crater volume was calculated.*

Before *After*

Figure A3.38c *Images of cable EE-SF2; the 'before' image was taken after disposal of 3 munitions (F37, F38 and F38B); the 'after' image was taken on 11 June 2010 after disposal of nine FAB100 munitions (F37 – F38G). Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

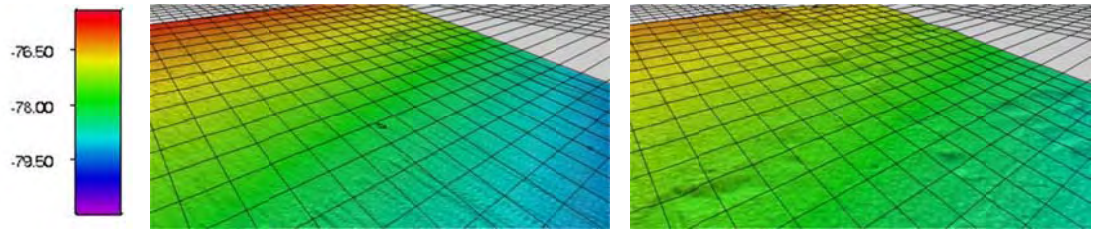
F38H (R-08-007-FAB) **Protactinium**

General

Clearance of **F38H**, R-08-007-FAB, **Protactinium**; 7 June 2010 at 18:00 UTC; see Figure A3.39 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /39/.

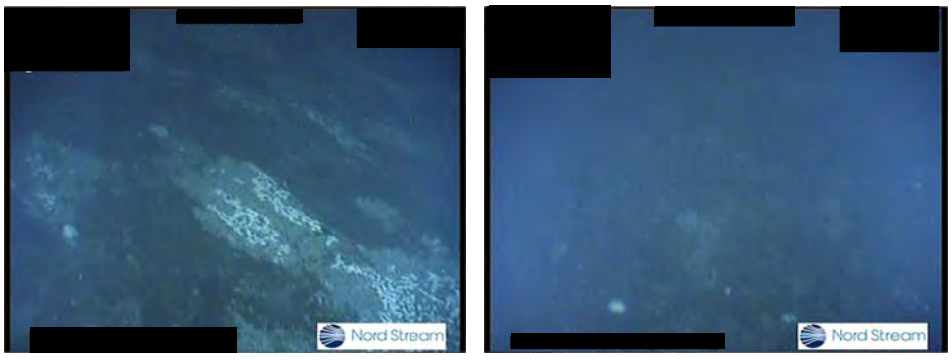
Before *After*

Figure A3.39a *Images of munitions before and after clearance.*



Before *After*

Figure A3.39b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



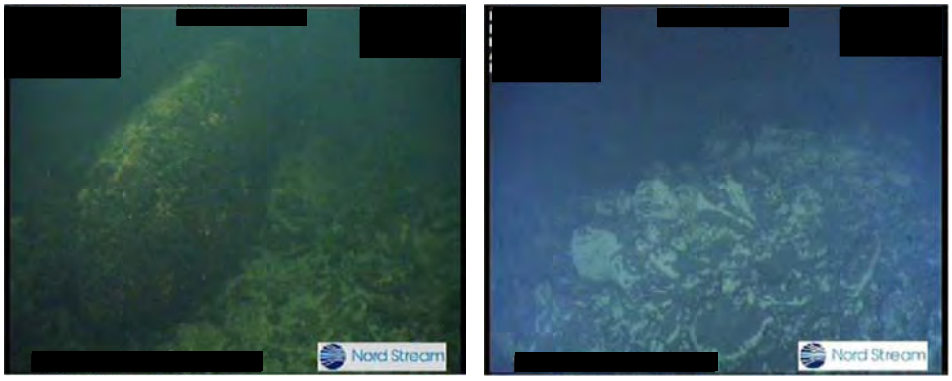
Before *After*

Figure A3.39c *Images of cable EE-SF2; the 'before' image is taken before 2nd and final disposal of this target (F38E) but after disposal of five FAB100 munitions (F37, F38, F38B, F38C, F38D) and 1st attempt F38E; the 'after' image is taken after disposal of F38G and F38H. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

F38J (R-08-009-FAB) **Tritium**

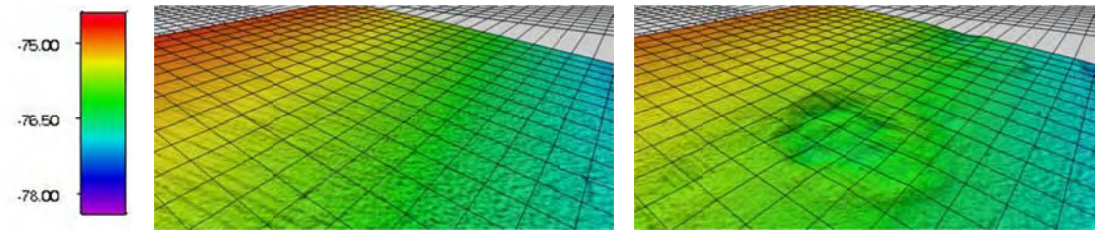
General

Clearance of **F38J**, R-08-009-FAB, **Tritium**; 11 June 2010 at 09:00 UTC; see Figure A3.40 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /40/.



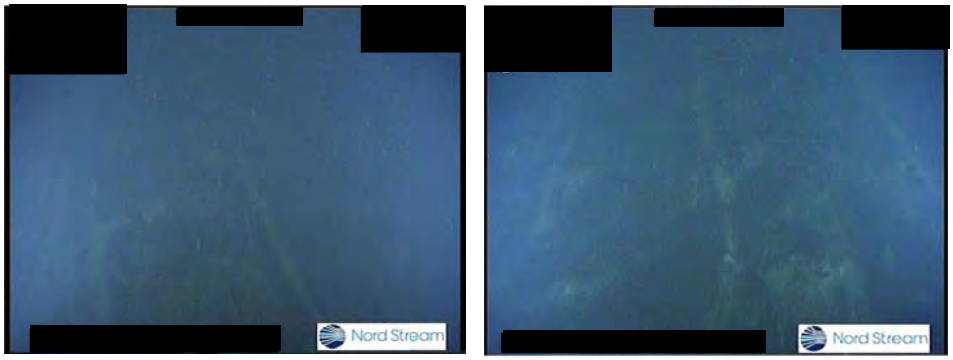
Before *After*

Figure A3.40a *Images of munitions before and after clearance; the coordinates of the 'before' image is erroneous due to limitations of the underwater hydro acoustic positioning reference system at the vessel stand-off distance.*



Before *After*

Figure A3.40b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.40c *Images of cable EE-SF2; the 'before' image was taken on 11 June 2010 after disposal of nine FAB100 munitions (F37 – F38G); the 'after' image was taken after disposal of all FAB100 munitions. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

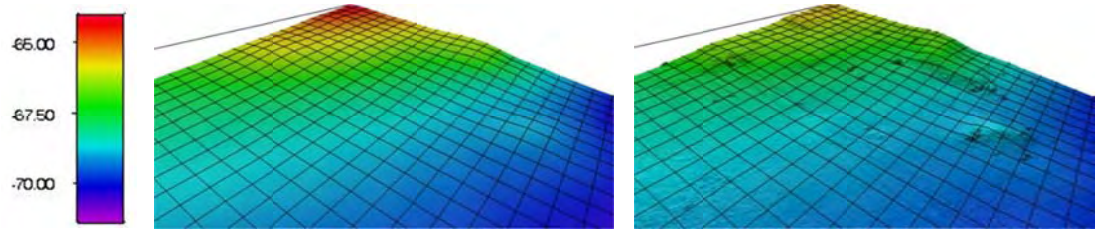
F38K (R-08-010-FAB) **Deuterium**

General

Clearance of **F38K**, R-08-010-FAB, **Deuterium**; 11 June 2010 at 19:00 UTC; see Figure A3.41 for images of the munitions, the seabed bathymetry and cable EE-SF2 before and after the detonation; images of the MBES survey of the Pangea Seg 3 cable are included in the Section on clearance of **F37** as Figures A3.31d+e. Details of the disposal of this munition are given in /41/.

Before *After*

Figure A3.41a *Images of munitions before and after clearance.*



Before *After*

Figure A3.41b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.41c *Images of cable EE-SF2; the 'before' image was taken on 11 June 2010 after disposal of nine FAB100 munitions (F37 – F38G); the 'after' image was taken after disposal of all FAB100 munitions. Detonation of this munition could potentially impact the cable. Concern was raised that each inspection by ROV could cause slight scour to the seabed and hence exposure of the cable. It was therefor decided not to repeat the inspection after each detonation but after a number of detonations.*

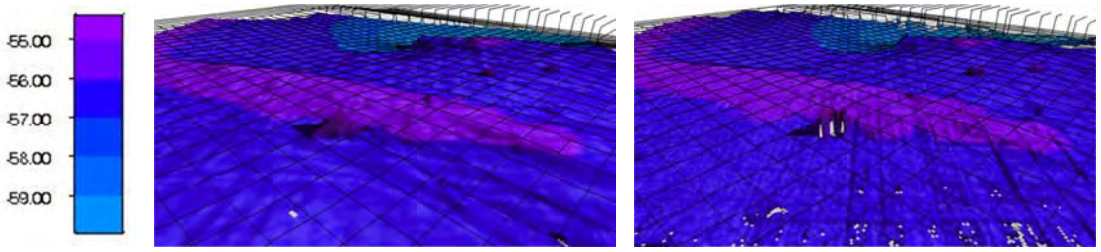
F39 (R-08-1000069) **Germanium**

General

Clearance of **F39**, R-08-1000069, **Germanium**; 10 May 2010 at 11:00 UTC; see Figure A3.42 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /42/.

Before *After*

Figure A3.42a *Images of munitions before and after final clearance attempt.*



Before *After*

Figure A3.42b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

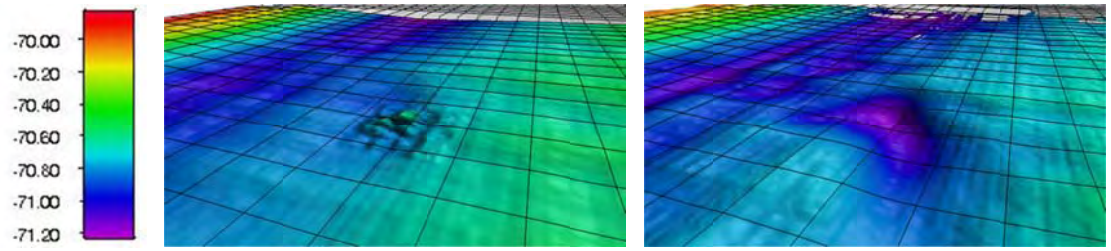
F40 (08-R-90) **Thallium**

General

Clearance of **F40**, 08-R-90, **Thallium**; 2 May 2010 at 18:00 UTC; see Figure A3.43 for images of the munitions, the seabed bathymetry and near barrel before and after the detonation. Details of the disposal of this munition are given in /43/.

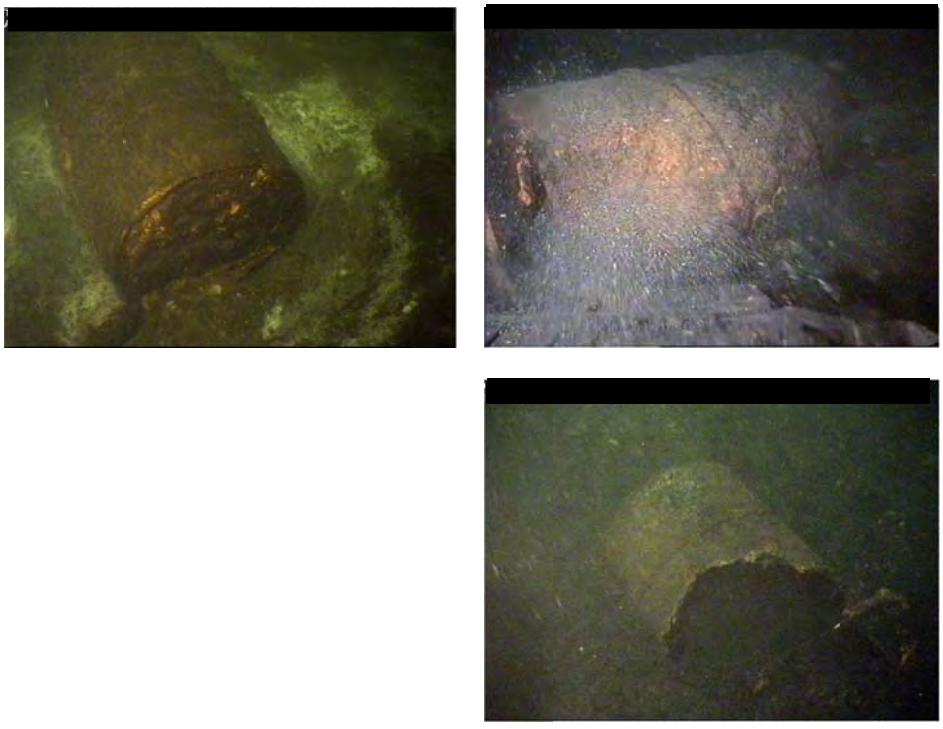
Before *After*

Figure A3.43a *Images of munitions before and after clearance.*



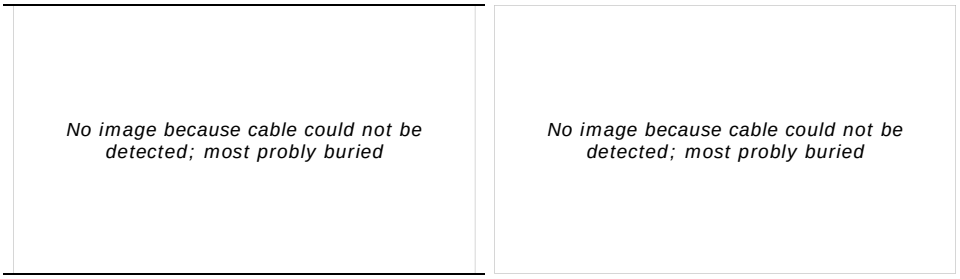
Before *After*

Figure A3.43b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.43c *Images of barrel R-09-327236. Barrel was hit by ROV during "after" video recording.*



Before *After*

Figure A3.43d *Images of cable FEC1.*

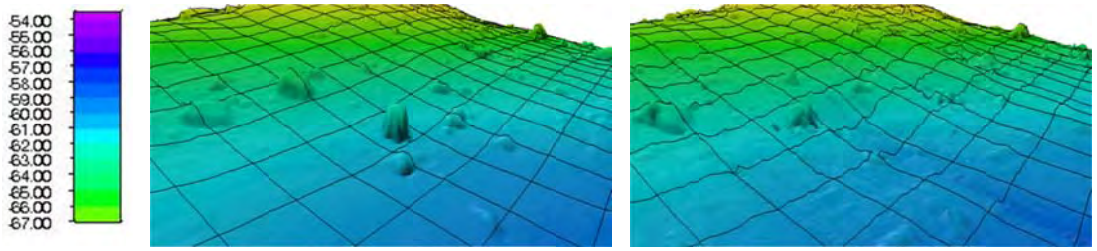
F41 (R-09-1000149) **Arsenic**

General

Clearance of **F41**, R-09-1000149, **Arsenic**; 27 April 2010 at 14:30 UTC; see Figure A3.44 for images of the munitions, the seabed bathymetry and near wrecks and torpedoes before and after the detonation. Details of the disposal of this munition are given in /44/.

Before *After*

Figure A3.44a *Images of munitions before and after clearance.*

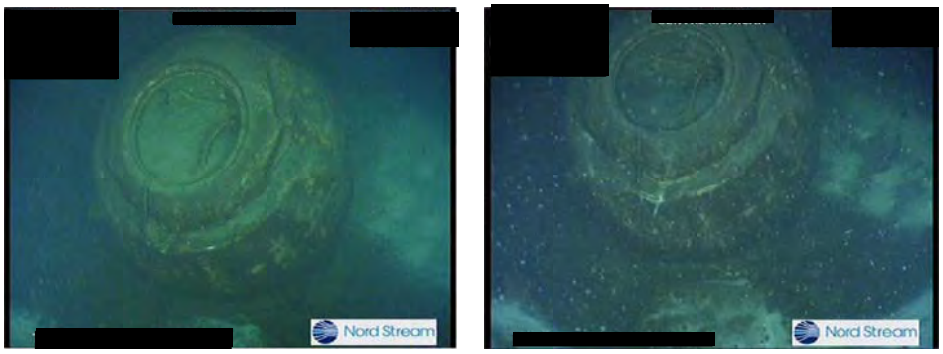


Before *After*

Figure A3.44b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

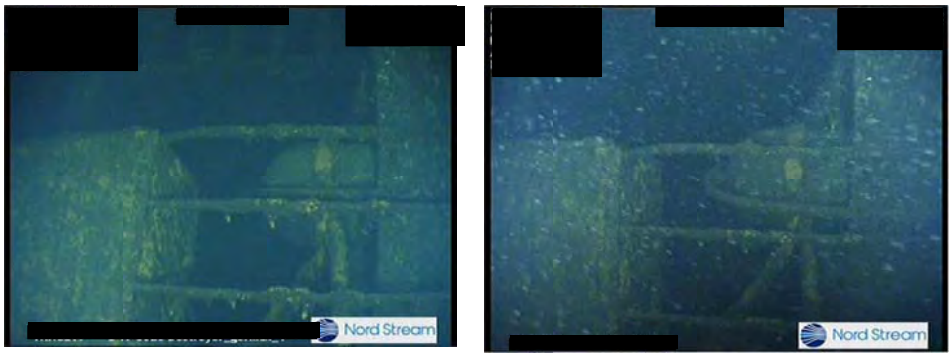
Before *After*

Figure A3.44c *Images of torpedoes R-09-49309; monitoring not required but performed as additional check.*



Before *After*

Figure A3.44d *Images of mines on deck of wreck R-09-10009*



Before *After*

Figure A3.44e *Images of wreck S-09-3025.*

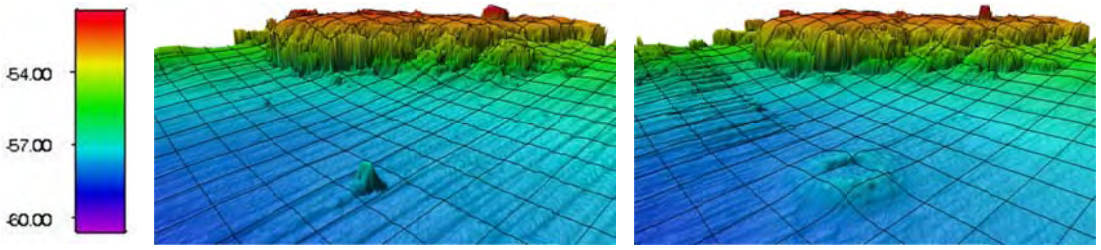
F42 (R-09-1000202) **Phosphorus**

General

Clearance of **F42**, R-09-1000202, **Phosphorus**; 17 April 2010 at 04:00 UTC; see Figure A3.45 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /45/.

Before *After*

Figure A3.45a *Images of munitions before and after clearance.*



Before *After*

Figure A3.45b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

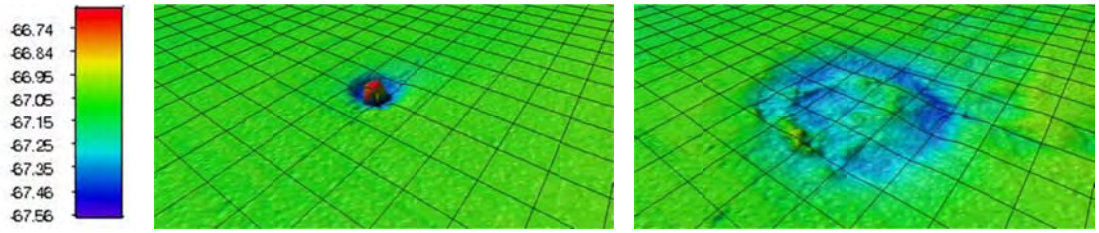
F43 (R-08-44066) **Polonium**

General

Clearance of **F43**, R-08-44066, **Polonium**; 21 May 2010 at 12:00 UTC; see Figure A3.46 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /46/.

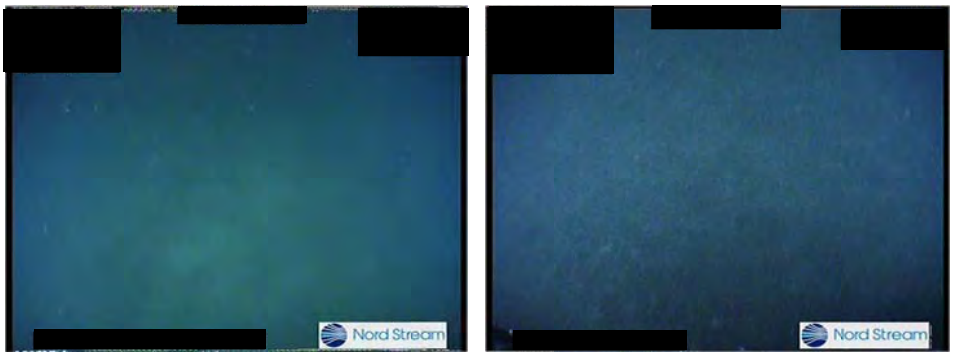
Before *After*

Figure A3.46a *Images of munitions before and after clearance.*



Before *After*

Figure A3.46b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*



Before *After*

Figure A3.46c *Images of UESF2 Cable.*

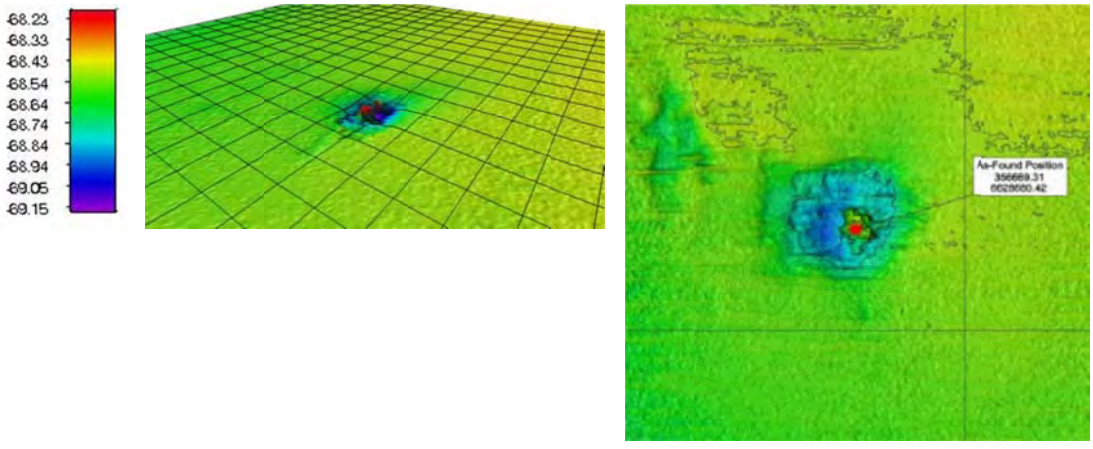
F44 (R-08-2000957) **Thorium**

General

Clearance of **F44**, R-08-2000957, **Thorium**; 25 May 2010 at 10:15 UTC; see Figure A3.47 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /47/.

Before *After*

Figure A3.47a *Images of munitions before and after clearance.*



Before *After*

Figure A3.47b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.47c *Images of cable UESF2.*

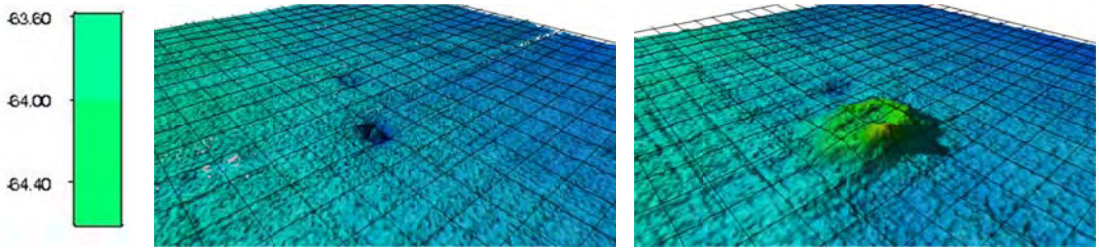
F45 (R-09-1116855) **Samarium**

General

Clearance of **F45**, R-09-1116855, **Samarium**; 14 May 2010 at 09:30 UTC; see Figure A3.48 for images of the munitions, the seabed bathymetry and near barrel and wreck before and after the detonation. Details of the disposal of this munition are given in /48/.

Before *After*

Figure A3.48a *Images of munitions before and after clearance.*



Before *After*

Figure A3.48b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

Before *After*

Figure A3.48c *Images of barrel R-09-48737*

Before *After*

Figure A3.48d *Images of wreck S-09-49489*

Before *After*

Figure A3.48e *Images of wreck S-09-49490*

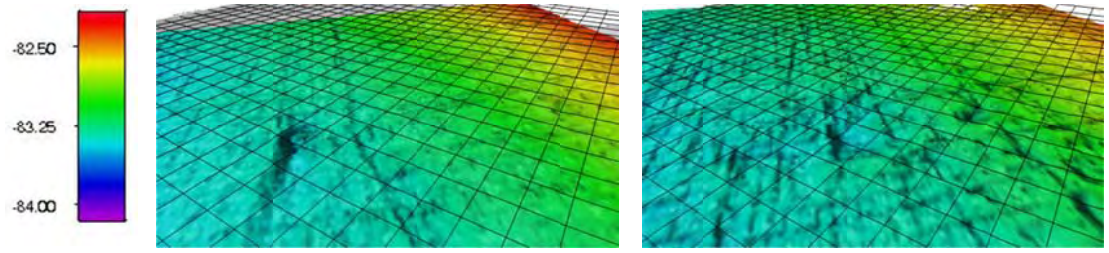
F46 (R-10-3227) **Hafnium**

General

Clearance of **F46**, R-10-3227, **Hafnium**; 12 May 2010 at 18:30 UTC; see Figure A3.49 for images of the munitions and the seabed bathymetry before and after the detonation. Details of the disposal of this munition are given in /49/.

Before *After*

Figure A3.49a *Images of munitions before and after clearance.*

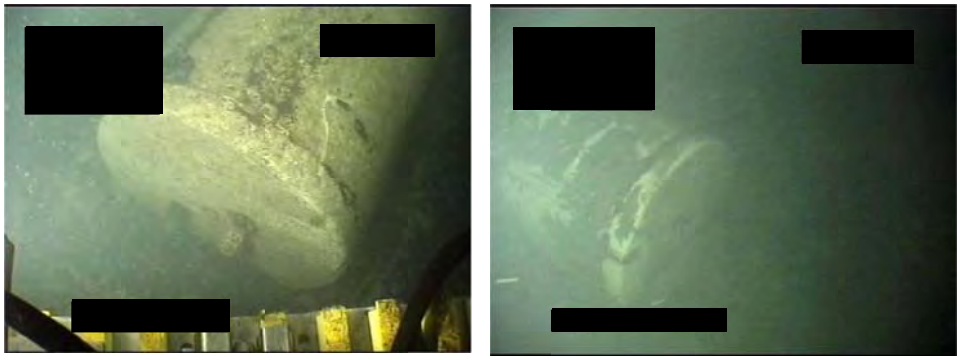


Before *After*

Figure A3.49b *Images of seabed bathymetry before and after clearance. Grid: 2*2 m; same vertical and horizontal scale.*

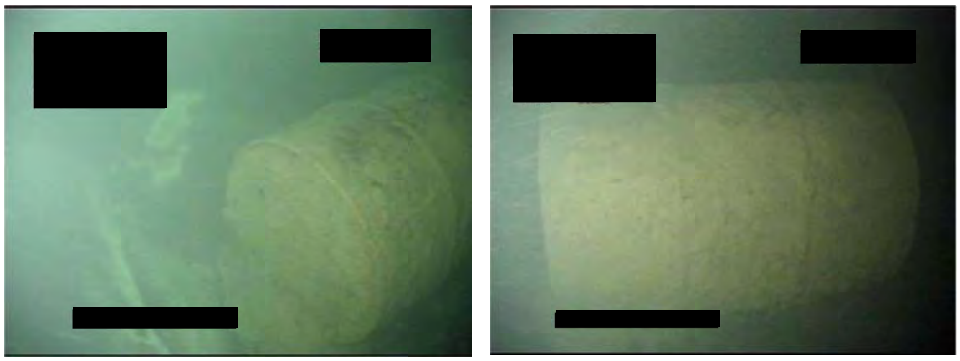
Before *After*

Figure A3.49c *Images of barrel R-10-52996.*



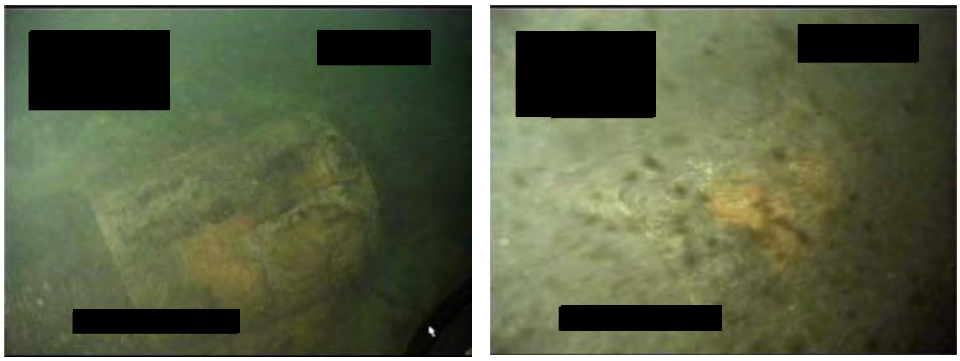
Before *After*

Figure A3.49d *Images of barrel R-10-53214.*



Before *After*

Figure A3.49e *Images of barrel R-10-53215.*



Before *After*

Figure A3.49f *Images of barrel R-10-54053.*

F47 (R-07-3400791)

General Removed by 'lift and shift' of **F47**, R-07-3400791; 15 October 2010 at 20:40 UTC; see Figure A3.50 for images of the munitions and the seabed bathymetry before and after the relocation. Details of the disposal of this munition are given in /53/.

Before *During move……* *After*

Figure A3.50 *Images of munitions before, during and after removal by 'lift and shift' operation.*

F48 (R-08-3400066)

General Removed by 'lift and shift' of **F48**, R-08-3400066; 16 October 2010 at 07:12 UTC; see Figure A3.51 for images of the munitions and the seabed bathymetry before and after the relocation. Details of the disposal of this munition are given in /53/.

Before *During move……* *After*

Figure A3.51 *Images of munitions before, during and after removal by 'lift and shift' operation.*

F49 (R-09-3401125)

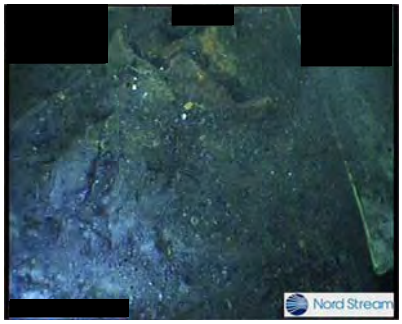
General

Removed by 'lift and shift' of **F49**, R-09-3401125; 16 October 2010 at 15:08 UTC; see Figure A3.52 for images of the munitions and the seabed bathymetry before and after the relocation. Details of the disposal of this munition are given in /53/.

Before

During move……(part 1)

Recovering and move of fuse and charge…… (part 2)



Further move……(part 3)

After (at final position)

Figure A3.52 *Images of munitions before, during and after removal by 'lift and shift' operation.*

Annex 4 Water quality, sediment and benthos monitoring

This Annex

This Annex contains the report presenting the results of the monitoring of water quality, sediment, benthos and currents related to munitions clearance in the Finnish EEZ in April – June 2010. The previous version of this report (version A of 10 September 2010) was included as Annex 6.2 in the main report 'Final monitoring results on munition by munition basis', revision A of 19 September 2010 /97/. The version included in this Addendum is the Final version that includes the results of the laboratory tests on sediment and benthos samples that were not yet available in September 2010 /59/.

Nord Stream
The new gas supply route for Europe

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Document Title

WATER QUALITY, SEDIMENT AND BENTHOS MONITORING DURING NORD STREAM OPERATIONS IN THE GULF OF FINLAND, AMMUNITION CLEARANCE OPERATIONS

Company Representative : Tiina Salonen							
Reference :	Document-No.						Rev.
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Table of contents

1. Introduction

This report includes the results of automatic vessel operated monitoring around four ammunition clearance sites: VOM1 (F27, Xenon), VOM2 (F22, Potassium), VOM3 (F17, Nickel) and VOM4 (F44, Thorium) shown on the Figure 1. Vessel operated monitoring included vertical profiling of turbidity spreading at the ammunition clearance site along two transects together with traditional water sampling. Water depth at sites VOM1, VOM3 and VOM4 is around 70 metres and all three sites have low oxygen concentration in deeper layers. However, oxygen concentration was above zero during vessel operated sampling. Site VOM2 is shallower, with a water depth of around 60 metres and oxygen level is good.

In the Finnish waters sediment samples from VOM1, VOM2 and VOM3 / SED3 stations and benthos samples from VOM3/BENT3 station were collected before and after the disposal. In the Estonian EEZ sediment and benthos samples were taken from the station SED3/BENT3 (Est) that relates to the station VOM3. The sampling locations are shown in Figure 1. These results are also included into this report.

Conclusions of ammunition clearance impacts based on gathered monitoring results are presented in the end of the report (Ch 4).

Monitoring work in the Finnish waters was carried out according to the “Monitoring Programme for Munitions Clearance Finland” (Doc. No: G-PE-PER-REP-000-EMPFINMU-G) and “Monitoring Programme for Munitions Clearance in Phase 2 Finland” (Doc No: G-PE-PER-REP-000-EMPFIMU2-B). In the Estonian waters monitoring work was performed according to the “Transboundary Monitoring Programme Finland” (Doc. No. G-PE-PER-REP-000-TRAMOFI-A).

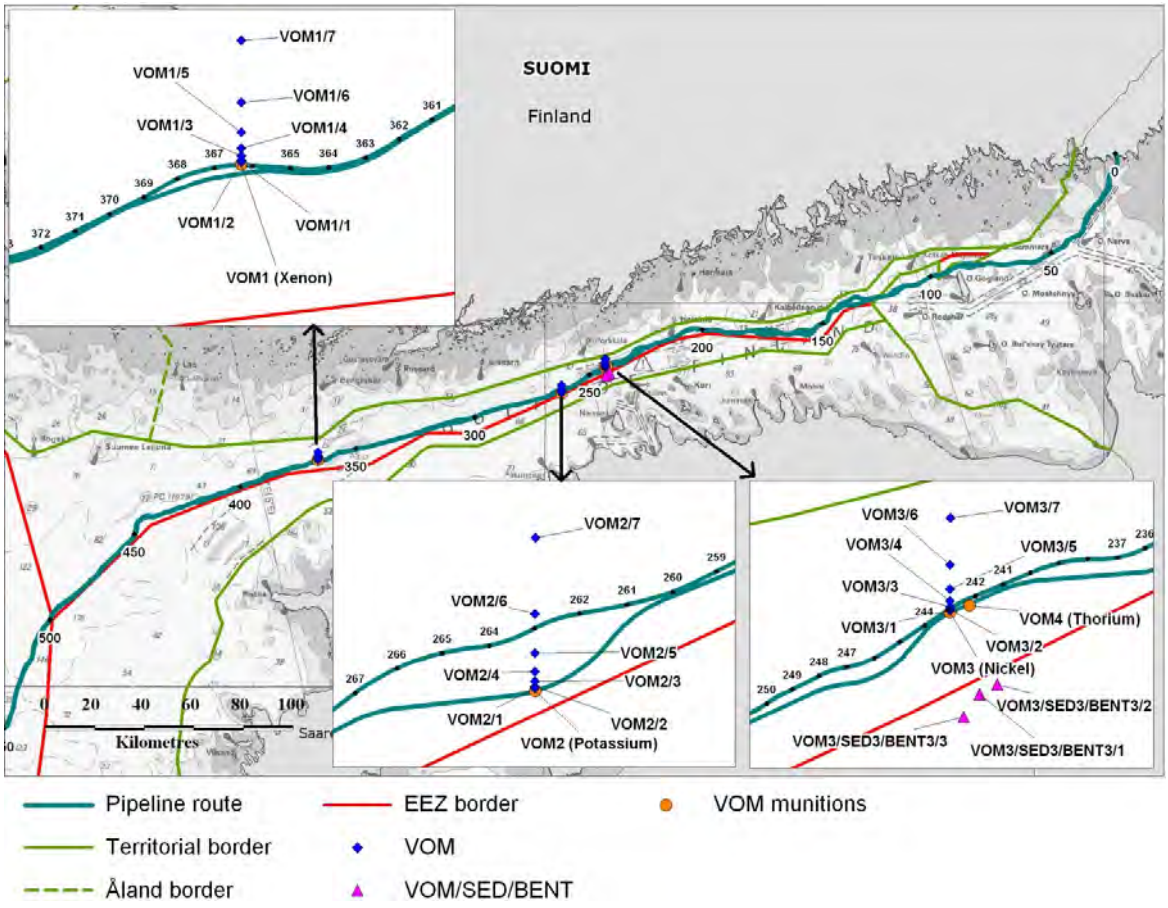


Figure 1. Locations of the ammunition clearance monitoring sites: VOM1 - VOM4. (Map Ramboll Finland Oy & Luode Consulting Oy). Purple dots show sediment and benthos monitoring locations in Estonian EEZ.

Summary of main conclusions

Based on the collected datasets from four monitored stations, the ammunition clearance work did not cause significant turbidity spreading into surrounding water masses. Metal and nutrient levels did not increase based on the results obtained from water samples taken before and after the disposal. Some variations were seen on benthos samples, but in general the number of species and individuals were low. Results from sediment samples did not show any general increase in metal, dioxin or nutrient values. Larger variation was only seen in organotin values at the station SED3 both in Finnish and Estonian EEZs, which were generally higher in the samples taken during post-sampling. The samplings areas at SED 3 stations in the Finnish and Estonian EEZ are crossed by several shipping lanes and the probable origin of TBT are the antifouling paints of vessels.

Recorded parameters on each station are listed in Table 1.

Table 1. Recorded parameters on each station.

Station and KP	Station id and Position	Parameters	Monitoring depth	Monitoring date
VOM1 ~ KP 366		Vessel operated monitoring: turbidity, salinity and temperature Water samples: As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg and suspended matter, turbidity and nutrients	Vessel operated monitoring: all depths Water samples: every ten metres + 1 meter above bottom and 1 meter below surface	22.4.2010 and 11.5.2010
	Sediment samples: VOM1/1: 59°25,76´N, 22°22,65´E VOM1/2: 59°25,79´N, 22°22,65´E VOM1/3: 59°25,84´N 22°22,65´E VOM1/4: 59°25,95´N, 22°22,65´E VOM1/5: 59°26,17´N, 22°22,65´E VOM1/6: 59°26,60´N, 22°22,65´E VOM1/7: 59°27,46´N, 22°22,65´E	Sediment: Dioxins, organic tin compounds, As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg, Organic matter and nutrients	Sediment: 0-2 cm all locations; 2-10 cm locations 1 and 2	pre 19.11.2009 post 6.9.2010
VOM2 ~ KP 264		Vessel operated monitoring: turbidity, salinity and temperature Water samples: As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg and suspended matter, turbidity and nutrients	Vessel operated monitoring: all depths Water samples: every ten metres + 1 meter above bottom and 1 meter below surface	20.4.2010
	Sediment samples: VOM2/1: 59°40,42´N, 24°07,15´E VOM2/2: 59°40,44´N, 24°07,15´E VOM2/3: 59°40,50´N 24°07,15´E VOM2/4: 59°40,61´N, 24°07,15´E VOM2/5: 59°40,82´N, 24°07,15´E VOM2/6: 59°41,25´N, 24°07,15´E VOM2/7: 59°42,11´N, 24°07,15´E	Sediment: Dioxins, organic tin compounds, As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg, Organic matter and nutrients	Sediment: 0-2 cm all locations; 2-10 cm locations 1 and 2	pre 11.11.2009 post 6.9.2010
VOM3 / SED3 / BENT3 ~ KP 243		Vessel operated monitoring: turbidity, salinity and temperature Water samples: As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg and suspended matter, turbidity and nutrients	Vessel operated monitoring: all depths Water samples: every ten metres + 1 meter above bottom and 1 meter below surface	20.5.2010
	Sediment and Benthos samples: VOM3/SED3/BENT3/1: 59°46,06´N, 24°25,81´E VOM3/SED3/BENT3/2: 59°46,08´N, 24°25,81´E VOM3/SED3/BENT3/3: 59°46,14´N 24°25,81´E VOM3/SED3/BENT3/4: 59°46,24´N, 24°25,81´E VOM3/SED3/BENT3/5: 59°46,46´N, 24°25,81´E VOM3/SED3/BENT3/6: 59°46,89´N, 24°25,81´E VOM3/SED3/BENT3/7: 59°47,75´N, 24°25,81´E	Sediment: Dioxins, organic tin compounds, As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg, Organic matter and nutrients, water quality were analysed also from water sample taken from VOM3/1 during pre and post sampling Benthos: Abundance of species and individuals, oxygen concentration	Sediment: 0-2 cm all locations; 2-10 cm locations 1 and 2 Benthos: 3 replicates from all locations	pre 5.5.2010 post 3.8.2010
SED3 / BENT3 (EST) (~3 km	Sediment and Benthos samples: VOM3/SED3/BENT3(Est)/1: 59°44,55´N, 24°26,89´E VOM3/SED3/BENT3(Est)/2:	Sediment: Dioxins, organic tin compounds, As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg, Organic matter and nutrients	Sediment: 0-2 cm all locations	pre 12.5.2010 post 12.7.2010

south from VOM3)	59°44,72´N, 24°27,53´E VOM3/SED3/BENT3(Est)/3: 59°44,13´N, 24°26,31´E	Benthos: Abundance of species and individuals, oxygen concentration	Benthos: 3 replicates from all locations	
VOM4 ~ KP 242		Vessel operated monitoring: turbidity, salinity and temperature Water samples: As, Co, Cr, Ni, Zn, Cu, Pb, Cd, Hg and suspended matter, turbidity and nutrients	Vessel operated monitoring: all depths Water samples: every ten metres + 1 meter above bottom and 1 meter below surface	25.5.2010

2. Material and Methods during ammunition clearance monitoring

2.1 Sediment and Benthos sampling before and after ammunition clearance

Sediment sampling was carried out with Limnos and GEMAX type samplers (Fig 2), which were lowered with a hydraulic winch to the sea floor. The sediment samples were sliced into sub-samples, stored in containers, labelled and stored in cold until transport to laboratory. Background samples were collected from two sites during the year 2009 (VOM1, VOM2) and from two sites during the year 2010 (VOM3/SED3 and VOM3/SED3(EST) in Estonian EEZ). Background samples were collected in order to see the natural level of different substances before the actual ammunitions clearance work started. Post-detonation sampling at all sites was carried out after the completion of the clearance works in the summer 2010. This means that some seasonal variations will exist on datasets. Reason for the long time period between the sampling campaigns at VOM1 and VOM2 stations is that munitions at these sites were originally planned to be cleared in autumn 2009. However, the clearance had to be postponed until spring 2010 because of the slow start in ammunition clearance operation in November 2009 due to lessons learned and early start of winter in December 2009..

In addition to sediment sampling a quantitative Van Veen grab sample of the seabed was taken from VOM3/BENT3 and VOM3/BENT3(EST) stations for the analysis of macrozoobenthos (Fig 2). Sampling was performed before and after the munitions clearance in 2010.

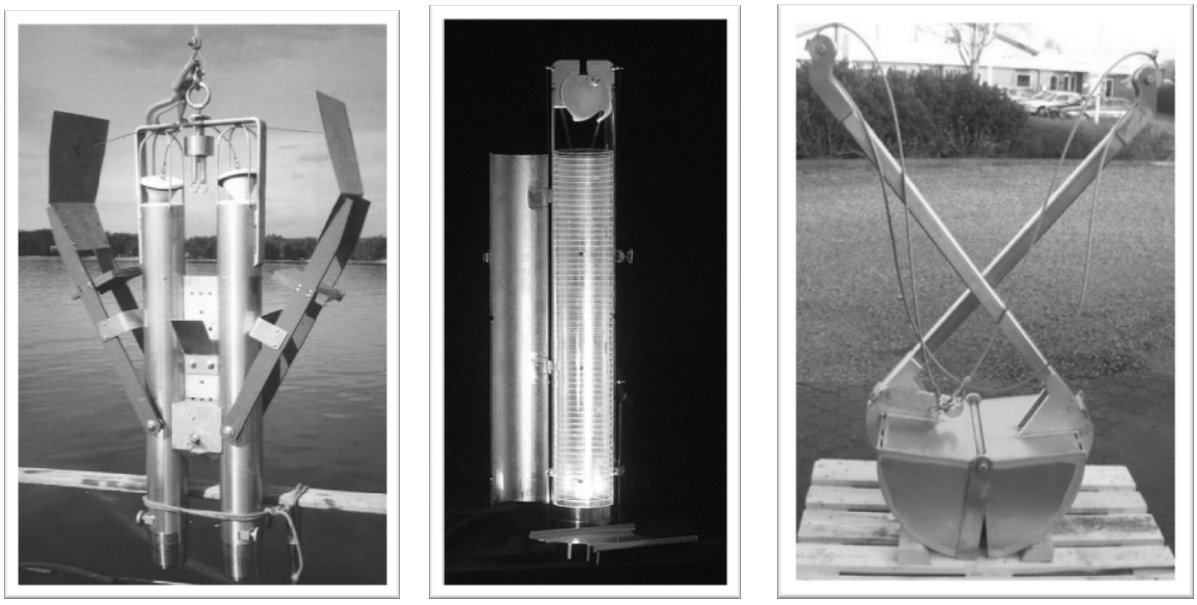


Figure 2. GEMAX sediment sampler (left), Limnos sediment sampler with 1cm vertical rings for high resolution sampling (middle) and Van Veen benthos sampler (right).

In the Finnish waters sediment and benthos samples were collected along a sampling line reaching 3200 metres north from the munition to be demolished. The distances of the sampling locations from the mine to be cleared were 50, 100, 200, 400, 800, 1600 and 3200 metres (Fig 4). Sediment samples were collected from the uppermost 0 – 2 cm section in all locations. In addition 2 – 10 cm sections were analysed from the two closest locations (50 and 100 metres).

Sampling at the VOM3/SED3/BENT3 (Est) station contained three sampling locations and they were located in the Estonian EEZ close to VOM3 site in the Finnish waters. Sediment samples were taken from the uppermost 0 – 2 cm sections at all Estonian locations, based on monitoring program.

For benthos analysis three separate replicates were taken from each sampling location. Samples were sieved onboard through 1.0 and 0.5 mm sieves, preserved in 70-% methanol and stored in

plastic containers. The macrozoobenthos in the samples were identified and counted. The numbers of individuals and the biomass were calculated per square metre. The total biomasses of the samples were determined as wet weight with 0.01g accuracy. The lengths of the *Macoma baltica* shells were measured and divided into groups of <4 mm, 4-10 mm and >10 mm long shells. The identification was performed by Lauri Paasivirta / Kala- ja vesitutkimus Oy. Each sample was kept and analyzed separately. Oxygen concentration, temperature and salinity measurements were carried out in the water column just above the bottom at each sampling site.

2.2 Sediment data normalisation

Concentrations of harmful substances in sediment samples were normalised according to the Instructions for Dredging and Depositing Dredged Materials by the Ministry of the Environment (2004)[1].

Equation 1 was used to normalise the concentration of metals (*As, Cd, Cr, Cu, Hg, Ni, Pb, Zn*),

Equation 1:

$$C\ normalised = C\ \times \frac{a + (b\ \times 25) + (c\ \times\ 10)}{a + (b\ \times clay) + (c\ \times organic\ matter)}$$

where: *C normalised* = concentration of substance in the standard sediment
C = measured concentration of the substance before normalisation
clay = measured percentage of clay (<2 µm) of dry weight
organic matter = measured percentage of organic matter of dry weight
a, b and c = substance specific normalisation factors

Constants *a, b* and *c* are defined in the Instructions for Dredging and Depositing Dredged Materials by the Ministry of the Environment (2004) for different metals excluding Cobalt. Therefore the cobalt concentration was not normalised.

Harmful organic substances (organotins and dioxin and furan) were normalised using the equation 2.

Equation 2:

$$C\ normalized = C\ \times \frac{10}{organic\ matter}$$

where: *C normalised* = concentration of substance in the standard sediment
C = measured concentration of substance before normalisation
organic matter = measured percentage of organic matter of dry weight

2.3 Real-time turbidity monitoring with automatic instruments during ammunition clearance

Automatic real time monitoring at all monitoring locations was carried out with a self-logging YSI-6600 series Deep Water sonde (Fig 3). Instrument records turbidity and depth with one second time interval from surface to bottom. In addition instrument collects information on salinity and temperature values.

[1] As normalised these concentrations are comparable with each other, since actual concentrations are converted to concentrations in the standard sediment. Standard sediment consists of organic matter (10 % of dry weight) and clay (grain size <2 µm, 25 % of dry weight) (Ministry of the Environment, 2004).

Ranges, resolution and accuracy of the YSI sonde are listed in the Attachment 1. Position information was collected with a GPS.

Figure 3. YSI multiparameter sonde.

In all stations the natural background turbidity was measured typically 0.5-2 hours before the ammunition clearance started. Monitoring after the detonation was performed along two transects running in SW-NE and SE-NW directions over the clearance sites. Transects were oriented so that the ammunition to be cleared was located in the middle point of these transects (Fig 4). Length of transects varied from 900 to 1200 metres. Monitoring was performed in evenly spaced grid at every 100-200 metres depending on weather and wave conditions. Monitoring was repeated two times on both lines in all four sites. The first round started immediately after it was safe to enter the clearance area (10-30 minutes after disposal) and the second round was carried out after the first round was completed. Monitoring was completed typically within 3-4 hours after the disposal (see Table 2).

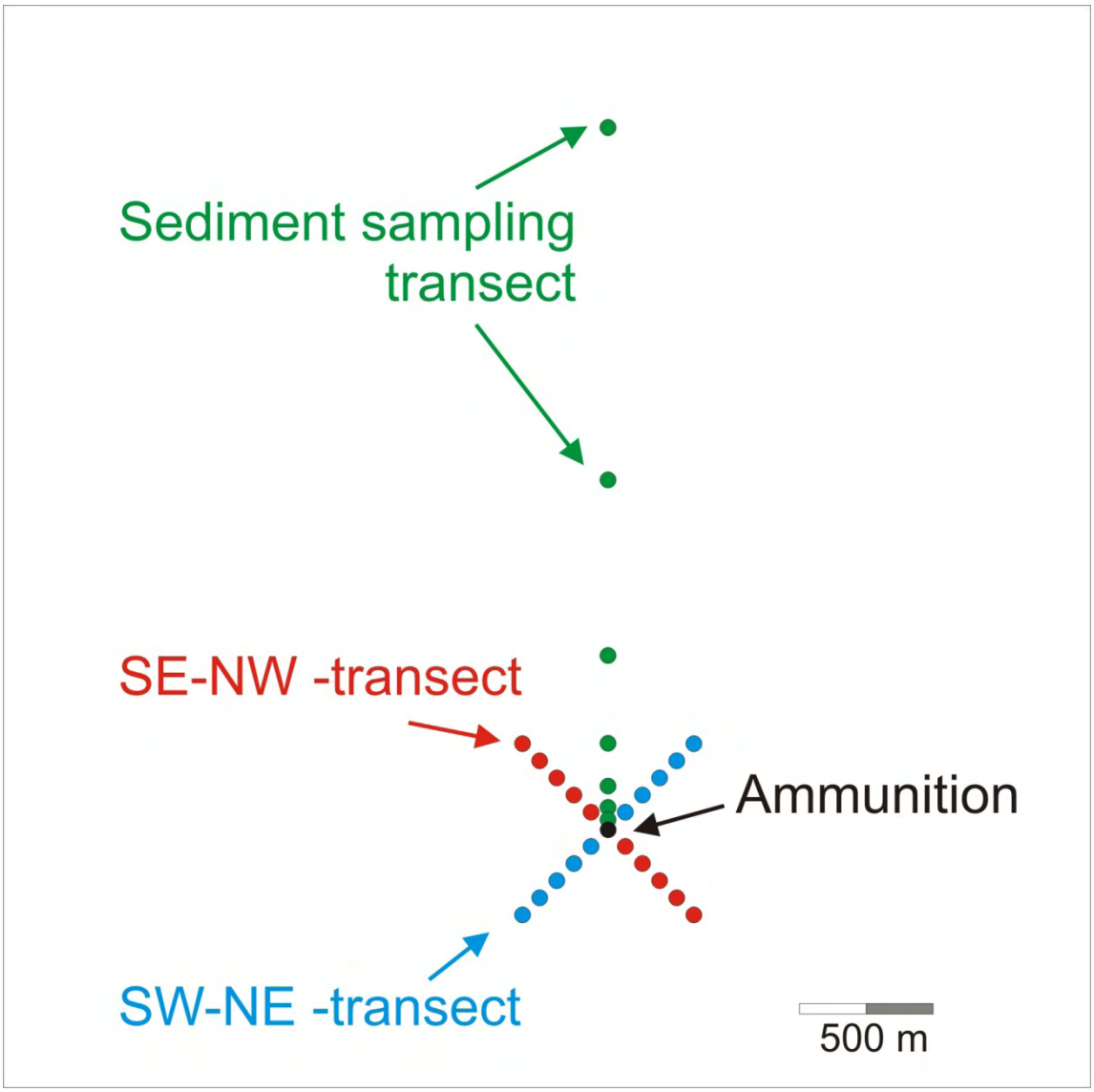


Figure 4. Orientation of transects during sediment sampling and vertical profiling. The black dot represents the location of ammunition and red and blue dots represent two transects in Southeast-Northwest and Southwest-Northeast directions. Sediment sampling sites are marked with green dots. Water sample was taken as close to the detonation site (black dot) as possible. Benthos samples were taken from the same locations as sediment samples at VOM3 / SED3 / BENT3 and VOM3 / SED3 / BENT3 (Est).

2.4 Water sampling during ammunition clearance

To complement automatic monitoring a set of water samples was taken on each site after the detonation. Samples were taken every 10 metres throughout the water column and 1 meter above the bottom and 1 meter below the surface with a 3.5 litre Limnos water sampler (Fig 5). Sampling was performed during the first round of vessel operated monitoring (typically ~60 minutes after the detonation) and as close to the detonation site as possible (~50 metres).

Background samples were collected 1-5 hours before the detonation from 3-4 depths. Background sampling was performed at ~1000 metres away from detonation site due to safety precautions.

All water samples were stored in bottles, labelled and kept cold until transportation to the laboratory.

Figure 5. Limnos water sampler

Timings of disposals and associated real-time turbidity monitoring and water sampling at all stations are listed in the following Table 2 together with water depth and quantity of used charges (Information source: Bactec International Ltd.).

Table 2. Summary of disposals and water quality monitoring at the monitored clearance sites

Target / monitoring station	Date of Disposal	Water depth (m)	Bottom type	Time of Disposal (UTC)	Disposal Vessel and Monitoring Vessel	Charge weights NEQ (kg)[1]		Result of Disposal	Luode monitoring times (UTC)
						Donor	Munition (estim.)		
R-12-3463 (Xenon, F27) VOM1	22nd April 2010	78	very soft clay	12:14	M/V Edda Freya R/V Palmen	9.8	300	No high order detonation. Poor visibility during as left survey. Later re-survey showed mine disrupted but charge case intact	Background 7:40-8:45 Post detonation 12:35-16:50 Water sampling 13:00-14:00
R-12-3463 (Xenon, F27) VOM1	11th May 2010	78	very soft clay	14:00	M/V Noordhoek Singapore R/V Palmen	11.5	300	Complete destruction of charge case in a high order explosion	Background 8:25-9:25 Post detonation 14:25-17:35 Water sampling 14:25-15:25
R-09-192 (Potassium, F22) VOM2	20th April 2010	61	silt and fine sand	09:30	M/V Edda Freya R/V Palmen	9.0	115	Complete destruction of target in a high order explosion	Background 7:10-8:10 Post detonation 9:40-13:25 Water sampling 10:05-10:45
R-08-2805 (Nickel, F17) VOM3	20th May 2010	71	very soft clay	10:01	M/V Edda Freya R/V Palmen	16.1	340	Total disruption of mine and charge case	Background 9:05-9:45 Post detonation 10:15-13:55 Water sampling 10:35-11:10
R-08-2000957 (Thorium, F44) VOM4	25th May 2010	70	sand / soft clay	10:16	M/V Edda Freya R/V Palmen	16.6	300	Total disruption of mine and charge case	Background 8:40-9:35 Post detonation 10:25-13:55 Water sampling 12:05-12:35

1 Net explosive quantity

3. Results and Discussion

Transect images for turbidity monitoring, laboratory results of the water and sediment sample analysis as well as the benthos analysis results are presented separately for all monitoring sites in the following chapters 3.1-3.4.

Sections 3.1.1-3.4.1 present the site specific turbidity transect datasets. The dataset per day consists of four result figures of vessel operated monitoring. The first two figures show results from the first measurement round along both transects and the third and fourth figure presents results from the second monitoring round along both transects. Background turbidity is subtracted from result images. The used turbidity scale from 0 to 50 NTU[2] is typical to water quality monitoring of construction projects in Finland.

The analysis results for the water samples taken during vessel operated turbidity monitoring are shown for each site in sections 3.1.2-3.4.2.

Data from sediment sampling are presented in sections 3.1.3-3.3.3 in the site specific chapters. It should be noted that there is no sediment data from site VOM4. This station was added into monitoring program upon request from the supervising authorities while ammunition clearance work was already going on in the same region. The station was added because the charge weight of the related munition at VOM4 appeared to be larger than originally estimated. The monitoring obligation included only vessel operated turbidity monitoring and water sampling.

Benthos data for samples collected from station VOM3 / BENT3 in Finnish EEZ and VOM3 / BENT3 (Est) in Estonian EEZ are shown in section 3.3.3.

[2] NTU=Nephelometric turbidity unit

3.1 VOM1 station

3.1.1 Real-time turbidity monitoring with automatic instrument

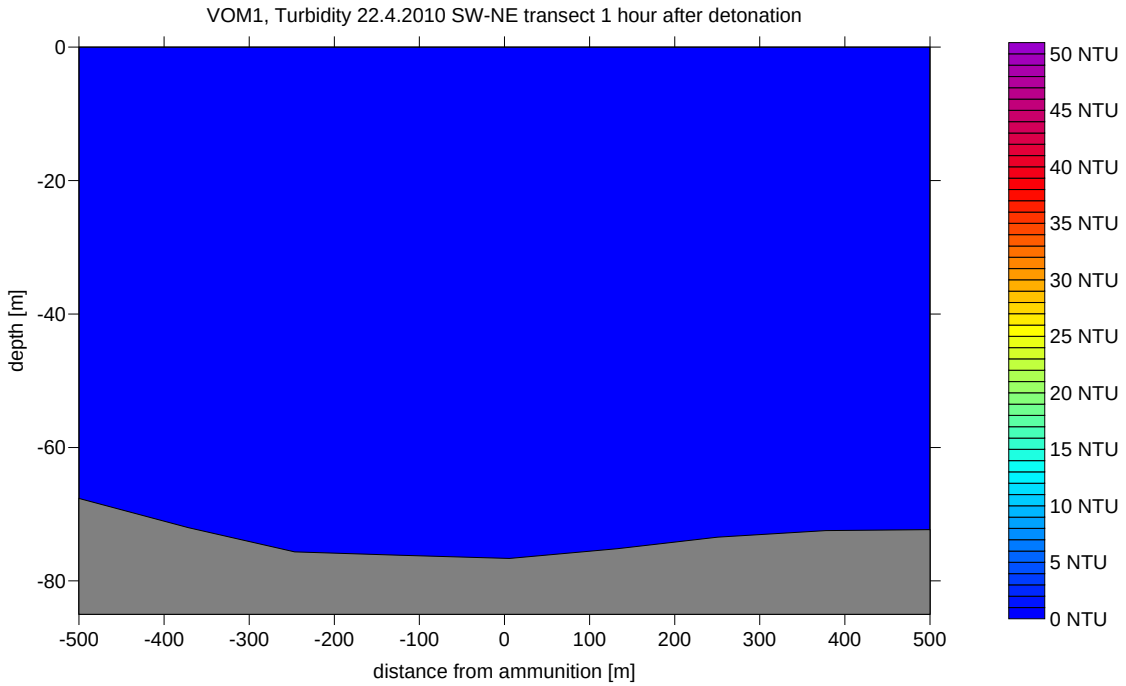


Figure 6. VOM1, vessel operated monitoring, first round, SW-NE, 22nd April 2010.

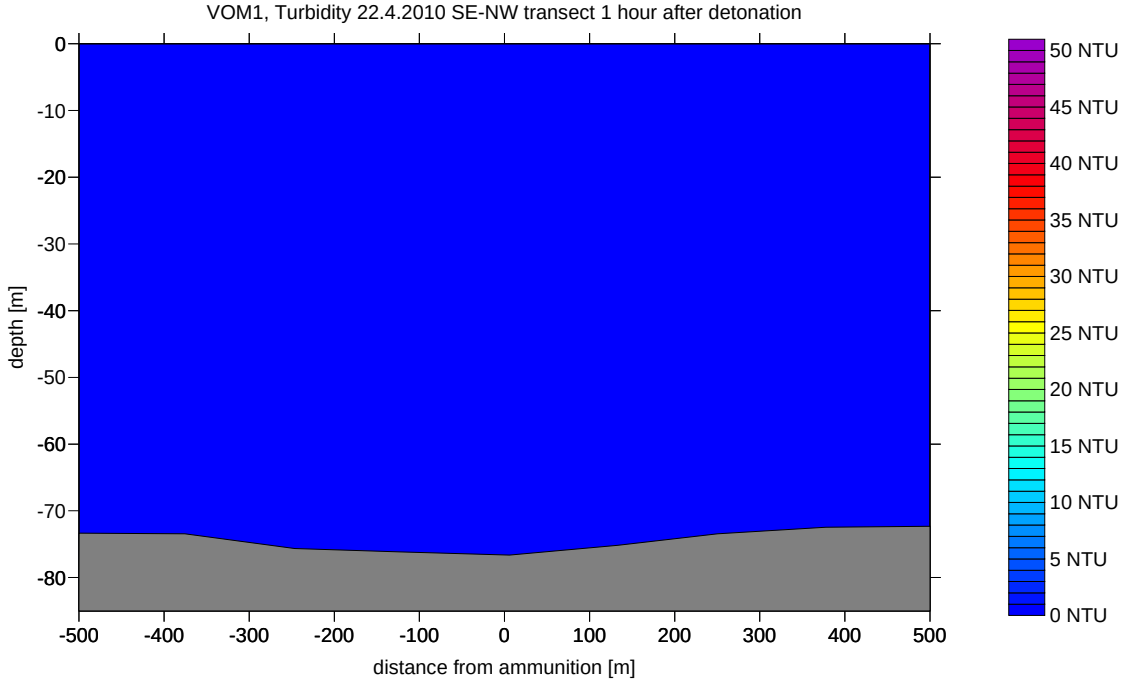


Figure 7. VOM1, vessel operated monitoring, first round, SE-NW, 22nd April 2010.

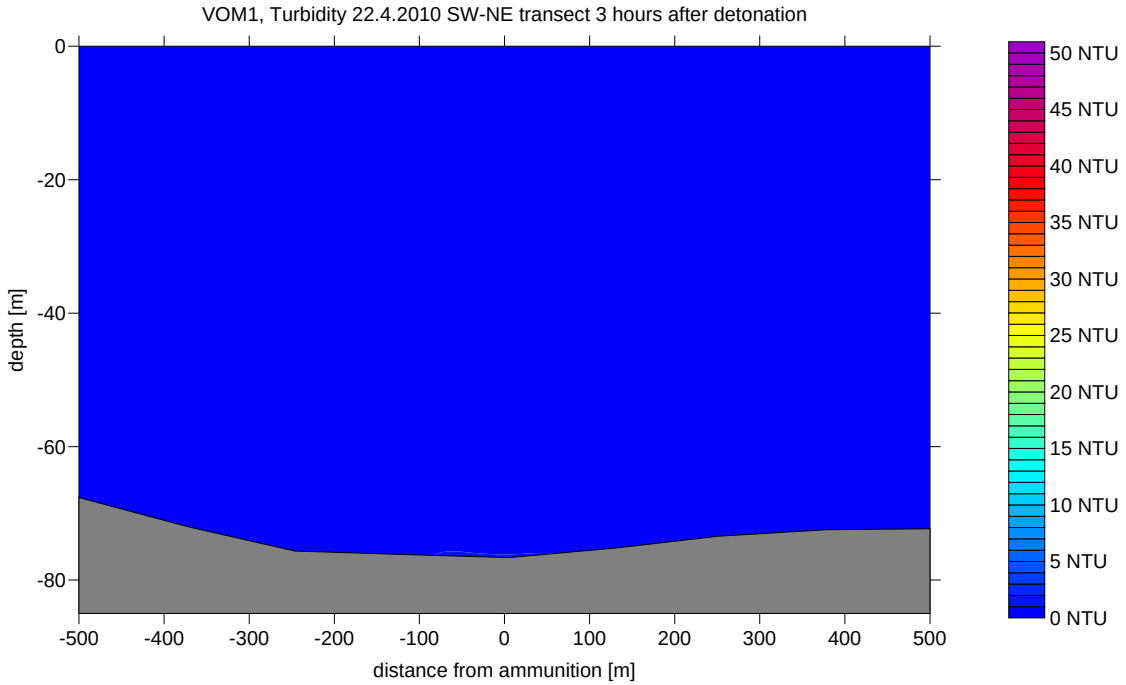


Figure 8. VOM1, vessel operated monitoring, second round, SW-NE, 22nd April 2010.

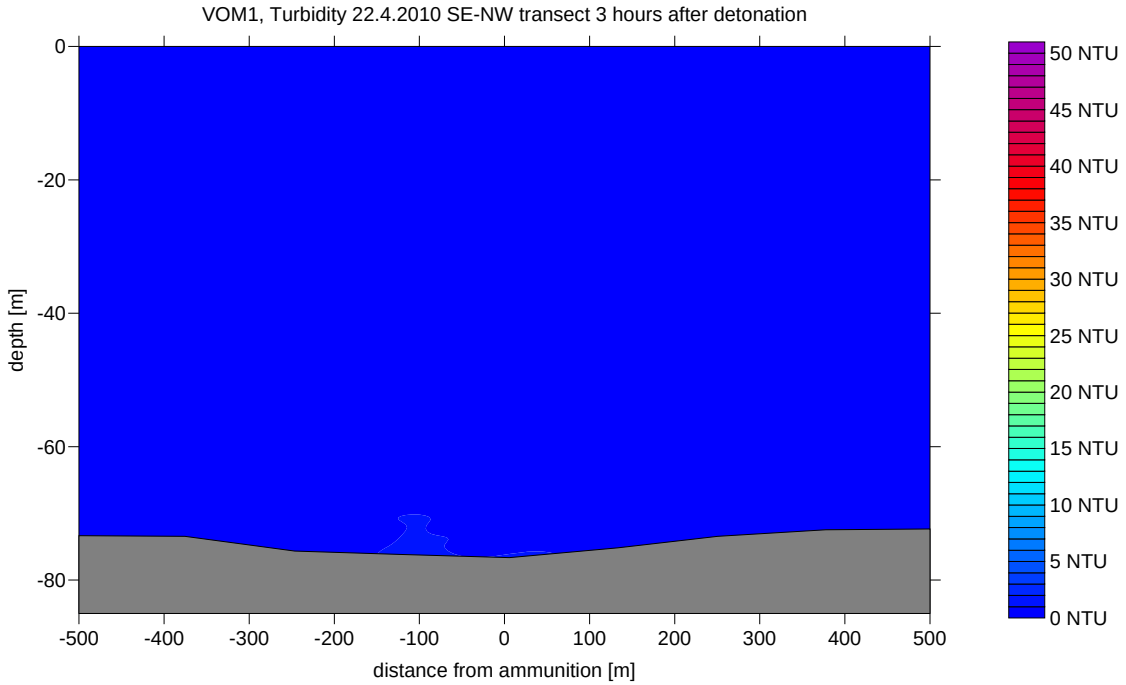


Figure 9. VOM1, vessel operated monitoring, second round, SE-NW, 22nd April 2010.

Monitoring at VOM1 was repeated on 11th of May due to only partial disposal on the 22nd of April 2010.

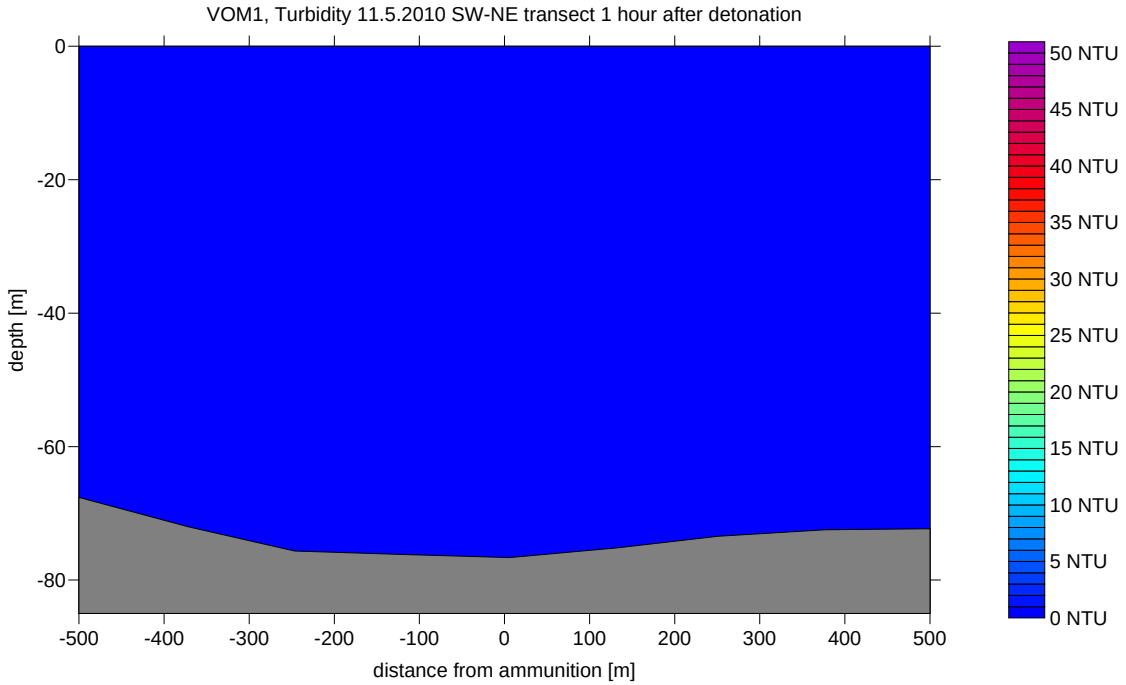


Figure 10. VOM1, vessel operated monitoring, first round, SW-NE, 11th May 2010.

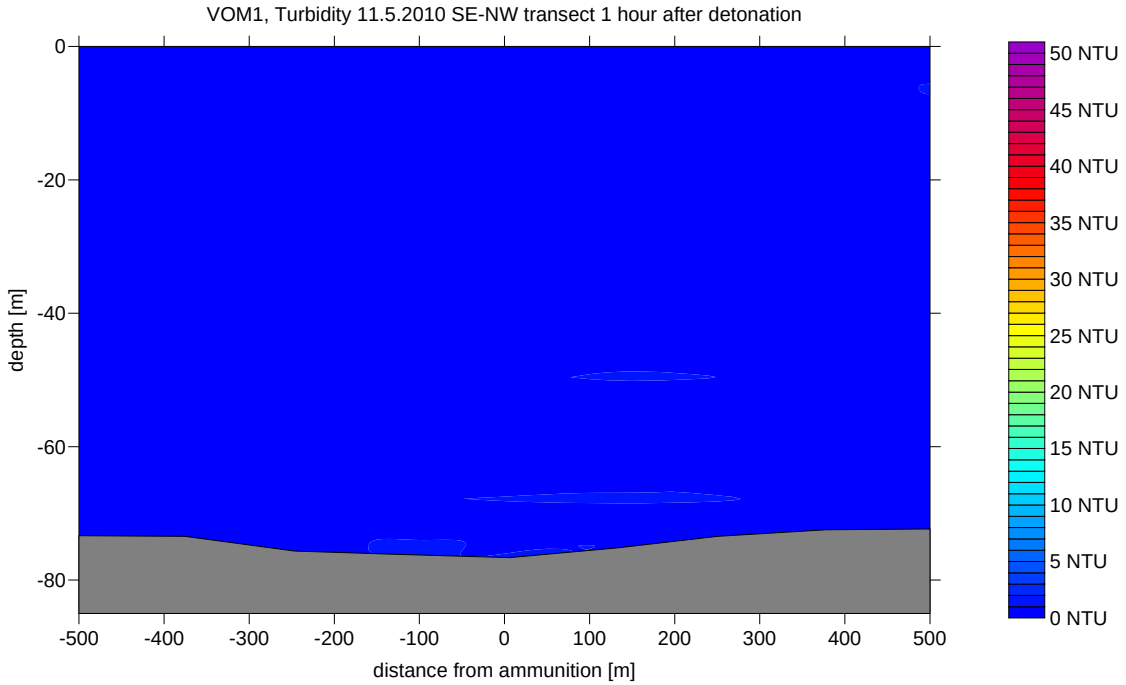


Figure 11. VOM1, vessel operated monitoring, first round, SE-NW, 11th May 2010.

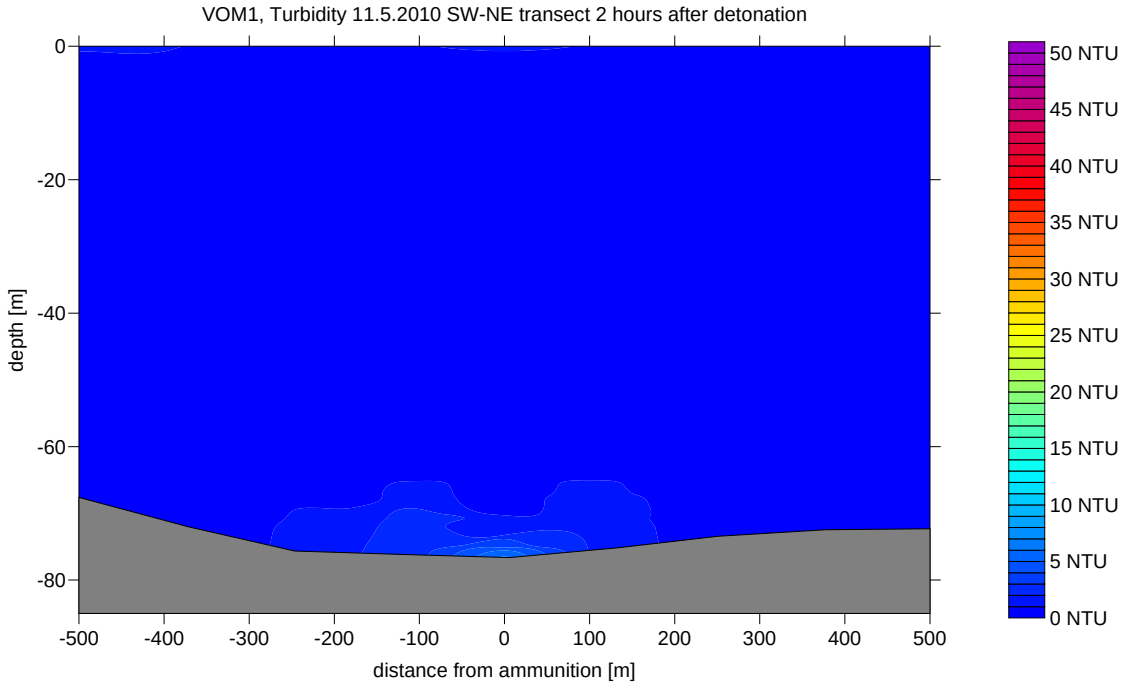


Figure 12. VOM1, vessel operated monitoring, second round, SW-NE, 11th May 2010. Re-scaled figure with higher resolution is shown as an example in Attachment 2.

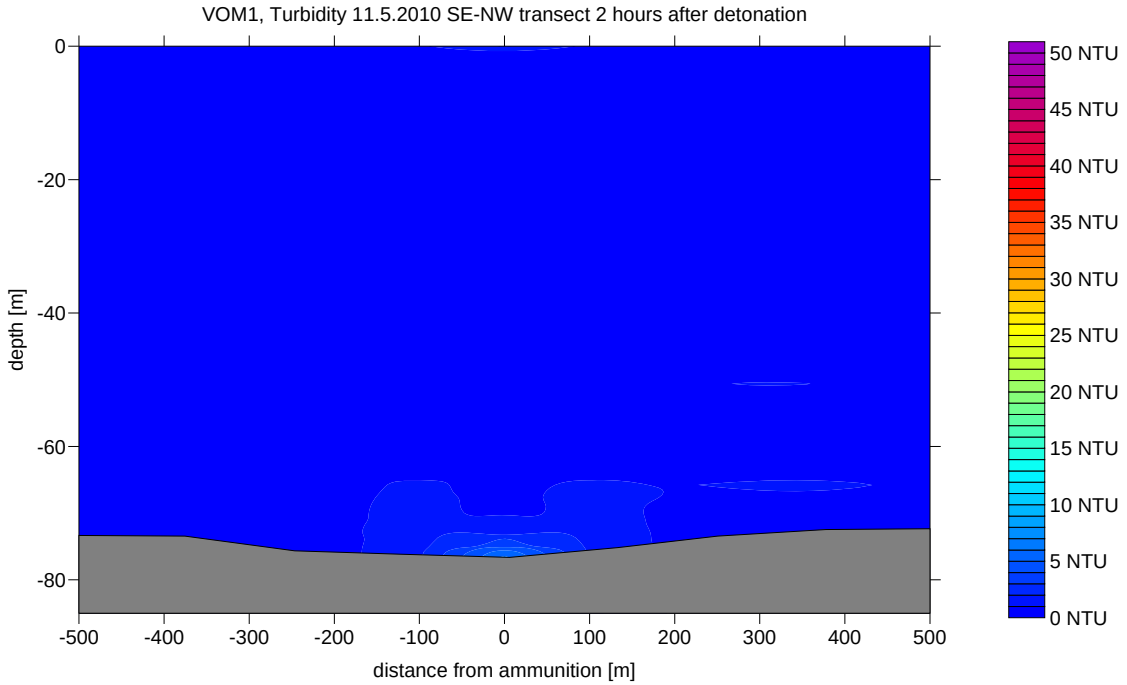


Figure 13. VOM1, vessel operated monitoring, second round, SE-NW, 11th May 2010. Re-scaled figure with higher resolution is shown as an example in Attachment 2.

3.1.2 Water sampling

Table 3. Laboratory results of the water samples taken during the vessel operated monitoring from VOM1 on 22.4.2010. Laboratory: Kokemäenjoen vesistön vesiensuojeluyhdistys ry.

Date	Site, sample depth	Cr	Cu	Hg	Co	Zn	Ni	Pb	Cd	As	Turbidity	Solid matter	dissolved oxygen	tot,N	NO3-N	NO2-N	NO23-N	NH4-N,M	tot,P	po4-p
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	FNU	mg/l	mg/l	µg/l	µg/l N	µg/l N	µg/l	µg/l	µg/l	µg/l
22.4.2010	1m background	<0,05	<0,05	<0,002	0,14	1,4	0,42	<0,05	<0,01	0,85	0,76	1	14,6	300	<5	<2,5	<5	N/A	17	5
22.4.2010	30m background	<0,05	<0,05	<0,002	0,15	1,4	0,43	<0,05	<0,01	0,93	0,43	0,6	13,1	340	63	3,4	66	17	22	19
22.4.2010	50m background	<0,05	<0,05	<0,002	0,16	1,5	0,46	<0,05	<0,01	0,94	0,45	<0,5	10,3	310	96	2,7	98	10	28	23
22.4.2010	70m background	<0,05	<0,05	<0,002	0,19	1,9	0,46	<0,05	<0,01	1	0,55	1,1	7,7	340	11	88	99	<7	79	71
22.4.2010	1m	<0,05	<0,05	<0,002	0,14	1,5	0,38	<0,05	<0,01	0,9	0,54	1,1	14,4	310	<5	<2,5	<5	59	21	5
22.4.2010	10m	<0,05	<0,05	0,002	0,14	1,3	0,38	<0,05	<0,01	0,89	0,94	0,7	14,4	300	<5	<2,5	<5	34	21	5
22.4.2010	20m	<0,05	<0,05	0,004	0,14	1,3	0,38	<0,05	<0,01	0,88	0,3	0,6	14,1	280	<5	<2,5	<5	16	15	4
22.4.2010	30m	<0,05	<0,05	0,002	0,15	1,4	0,36	<0,05	<0,01	0,93	0,36	<0,5	13,1	310	58	2,5	61	10	23	17
22.4.2010	40m	<0,05	<0,05	<0,002	0,14	1,5	0,38	<0,05	<0,01	0,95	1,1	<0,5	12,2	310	65	2,6	67	14	24	19
22.4.2010	50m	<0,05	<0,05	<0,002	0,15	1,5	0,36	<0,05	<0,01	0,94	0,98	0,6	11,5	330	68	2,8	70	10	29	23
22.4.2010	60m	<0,05	<0,05	<0,002	0,15	1,6	0,4	<0,05	<0,01	0,96	1,5	0,5	10,1	310	70	2,8	73	9	32	27
22.4.2010	70m	<0,05	<0,05	<0,002	0,17	1,8	0,4	<0,05	<0,01	1	0,53	0,6	4,8	320	86	3,1	89	<7	74	64
22.4.2010	75m	<0,05	<0,05	<0,002	0,2	1,9	0,41	<0,05	<0,01	1,1	1,6	1	1,5	320	64	<2,5	66	N/A	110	100

N/A = not available
Turbidity units: Formazin Nephelometric Unit (FNU) is used for laboratory analyses while field instrument uses Nephelometric Turbidity Units (NTU). Values are typically comparable 1:1 for values <100 NTU/FNU.

Table 4. Laboratory results of the water samples taken during the vessel operated monitoring from VOM1 on 11.5.2010. Laboratory: Kokemäenjoen vesistön vesiensuojeluyhdistys ry.

Date	Site, sample depth	Cr	Cu	Hg	Co	Zn	Ni	Pb	Cd	As	Turbidity	Solid matter	dissolved oxygen	tot,N	NO3-N	NO2-N	NO23-N	NH4-N,M	tot,P	po4-p
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	FNU	mg/l	mg/l	µg/l	µg/l N	µg/l N	µg/l	µg/l	µg/l	µg/l
11.5.2010	1m background	<0,05	1	<0,002	0,15	1,4	0,49	<0,05	<0,01	0,89	1,3	1,4	13,4	320	<5	<2,5	<5	59	25	<3
11.5.2010	30m background	<0,05	1,9	<0,002	0,15	1,2	0,46	<0,05	0,05	0,88	0,63	<1	13,2	260	<5	<2,5	<5	15	17	6
11.5.2010	50m background	<0,05	0,86	<0,002	0,17	1,8	0,57	<0,05	<0,01	0,93	0,44	<1	11,4	290	69	<2,5	71	<7	27	24
11.5.2010	70m background	<0,05	0,8	<0,002	0,2	1,6	0,6	<0,05	<0,01	1,1	1,1	1,4	6,0	310	75	<2,5	77	<7	66	65
11.5.2010	1m	0,61	2	0,003	0,14	1,1	0,41	<0,05	<0,01	0,89	0,47	1	13,4	330	<5	<2,5	<5	50	22	<3
11.5.2010	10m	<0,05	0,53	0,002	0,14	1,1	0,4	<0,05	<0,01	0,85	0,45	<1	13,2	250	<5	<2,5	<5	20	16	5
11.5.2010	20m	<0,05	1,5	<0,002	0,14	1,1	1	<0,05	<0,01	0,88	0,55	<1	13,1	250	<5	<2,5	<5	14	17	6
11.5.2010	30m	<0,05	0,99	<0,002	0,15	1,2	0,7	<0,05	<0,01	0,88	0,32	<1	13,1	260	<5	<2,5	<5	15	15	7
11.5.2010	40m	<0,05	0,9	0,003	0,15	1,3	0,42	<0,05	<0,01	0,9	0,3	<1	12,0	320	64	<2,5	66	<7	27	19
11.5.2010	50m	<0,05	1,1	<0,002	0,16	1,3	0,44	<0,05	<0,01	0,98	0,57	<1	10,9	320	68	<2,5	70	<7	27	21
11.5.2010	60m	<0,05	0,69	0,003	0,16	1,8	0,44	<0,05	<0,01	0,97	0,39	<1	10,5	290	71	<2,5	73	<7	32	25
11.5.2010	70m	<0,05	1,2	<0,002	0,18	1,6	0,47	<0,05	<0,01	1,1	0,54	<1	5,5	310	82	<2,5	84	<7	69	64
11.5.2010	78m	<0,05	2,6	0,002	0,22	1,7	0,44	<0,05	<0,01	1,2	1,3	<1	3,2	310	42	<2,5	44	24	100	97
11.5.2010	1m extra point	0,12	1	<0,002	0,15	1,5	0,43	<0,05	<0,01	0,89	1,5	1,8	13,1	270	<5	<2,5	<5	24	19	5

Turbidity units: Formazin Nephelometric Unit (FNU) is used for laboratory analyses while field instrument uses Nephelometric Turbidity Units (NTU). Values are typically comparable 1:1 for values <100 NTU / FNU.

3.1.3 Sediment sampling

Table 5. Laboratory results of the sediment samples taken during pre- and post clearance monitoring from VOM1. Laboratory: Eurofins Scientific Finland Oy.

VOM1	**sample(cm below surface)**	**1A (0-2 cm)**		**1B (2-10 cm)**		**2A (0-2 cm)**		**2B (2-10 cm)**		**3A (0-2 cm)**		**4A (0-2 cm)**		**5A (0-2 cm)**		**6A (0-2 cm)**		**7A (0-2 cm)**	
	distance [m]	**50**		**50**		**100**		**100**		**200**		**400**		**800**		**1600**		**3200**	
	depth [m] latitude longitude	**78 59°25,76'N 22°22,65´E**		**78 59°25,76'N 22°22,65´E**		**76 59°25,79'N 22°22,65´E**		**76 59°25,79'N 22°22,65´E**		**74 59°25,84'N 22°22,65´E**		**72 59°25,95'N 22°22,65´E**		**71 59°26,17'N 22°22,65´E**		**70 59°26,60'N 22°22,65´E**		**65 59°27,46'N 22°22,65´E**	
Parameter	**Unit**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Metals																			
Arsenic, As	mg/kg dw	10	6	8,2	9,4	8,8	8,4	11	12	8	5,8	6,6	8,3	7,3	6,7	5,7	5,8	8,6	5,6
Cadmium, Cd	mg/kg dw	0,43	0,53	0,81	0,42	0,5	0,56	0,56	0,67	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40
Chromium, Cr	mg/kg dw	63	22	60	64	56	50	71	63	57	23	82	58	59	54	52	50	68	25
Cobalt, Co	mg/kg dw	15	9,6	15	14	14	13	16	15	13	9,5	19	15	14	12	12	10	15	9,1
Copper, Cu	mg/kg dw	34	30	33	33	32	30	36	36	31	30	41	33	34	29	29	25	37	30
Mercury, Hg	mg/kg dw	<0,10	0,12	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10
Nickel, Ni	mg/kg dw	42	23	38	37	38	34	40	37	40	23	48	35	38	32	32	28	43	21
Lead, Pb	mg/kg dw	28	23	36	39	24	25	40	44	24	22	20	22	31	29	40	26	26	17
Zinc, Zn	mg/kg dw	140	94	150	140	130	110	160	150	130	89	150	120	140	120	120	100	140	75
Auxiliary parameters																			
Fraction < 2000 µm	% dw	61,1	79,9	52,7	71,2	50,9	78,2	54,7	73,3	51,9	73,5	64,3	72,9	54,1	82,8	64,2	79,8	53,4	76,6
Fraction < 63 µm	% dw	59,1	79,2	52,3	70,8	48,4	77,8	54,1	72,8	51,2	72,2	56,7	59,1	52,2	80,3	45,8	62,7	45,5	71,5
Fraction < 45 µm	% dw	59,1	78,6	52,3	70,8	48,3	77,8	54	72,5	51,1	71,9	55,8	56,7	52,1	79,9	43,7	60,8	44,5	70,9
Fraction < 16 µm	% dw	58,6	75,3	51,6	69,3	47,8	75,2	53,9	70,3	51	69,4	55,6	55,9	51,6	74,7	42,4	56,2	44,3	68,5
Fraction < 2 µm	% dw	43,1	51,9	45,7	51,4	40,9	52,6	44,7	47,8	40,8	47,7	48,6	44,2	42,4	52,3	34,3	37,5	38,7	50,6
Organic matter	% dw	7,3	9,1	5	3,7	8,3	9,4	5,7	5,5	9,1	9,6	0,7	2,4	6,9	6,4	5,2	5,1	6,4	5,1
Residual of ignition	% dw	89,7	87,2	91,8	92,7	88,8	86,9	91,1	91,1	88,1	87	95,9	94,5	90,1	90	92,4	92,3	90,9	91,3
Dry matter	g/kg dw	206	129	238	252	168	133	244	239	167	129	381	245	195	168	263	215	212	295
Dry matter concentration	%	16,6	12,6	23,8	25,8	16,8	13	24,4	23,9	17,3	13	31,9	27,3	18,9	16,3	26,3	20,99	19,5	20,64
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl. LOQ	ng/kg dw	4,97	4,41	10,7	9,69	4,37	4,61	13,7	12,3	5,26	4,33	0,125	0,363	5,66	4,85	14,1	3,68	3,23	2,31
I-TEQ (NATO/CCMS) excl. LOQ	ng/kg dw	5,02	4,44	10,1	9,03	4,42	4,66	12,8	11,5	5,29	4,36	0,141	0,384	5,72	4,9	13,1	3,68	3,28	2,31

Organotins																		
Monobutyltin, MBT	µg/kg dw	2	<3,8	<0,9	<4,0	2,8	<0,9	<1,7	<3,3	2,7	<6,8	<1,0	<2,5	<2,1	<5,6	<2,1	<3,3	<2,2	1
Dibutyltin, DBT	µg/kg dw	<1	<5,0	<1,4	<3,1	<1,0	<0,6	<1,1	<0,8	<0,9	<1,5	<1,0	<0,8	<1,0	<3,5	<1,1	<3,2	<1,1	<0,9
Tributyltin, TBT	µg/kg dw	2,9	16,5	2,2	9,7	3,6	2,1	3,2	8,1	3,2	14,8	<1,2	3	<1,8	7,7	<2,4	6,7	<2,0	1,9
Tetrabutyltin, TTBT	µg/kg dw	<1	<2,3	<0,9	<1,3	<1,0	<0,3	<1,0	<1,5	<0,9	<2,8	<1,0	<1,9	<1	<2,5	<0,9	<2,3	<0,9	<0,6
Mono-octyltin, MOT	µg/kg dw	<1	<2,2	<0,9	<1,3	<1,0	<0,3	<1,0	<1,5	<0,9	<2,8	<1,0	<1,8	<1	13,5	<0,9	<2,4	<0,9	<0,6
Dioctylintin, DOT	µg/kg dw	<1	<4,4	<0,9	<1,5	<1,0	<0,3	<1,0	<0,9	<0,9	<2,7	<1,0	<1,5	<1	9	<0,9	<1,1	<0,9	<0,4
Tricyclohexyltin, TCHT	µg/kg dw	<1	<6,9	<0,9	<1,8	<1,0	<0,3	<1,0	<1,2	<0,9	<2,7	<1,0	<1,9	<1	<1,5	<0,9	<1,0	<0,9	<0,4
Triphenyltin, TPhT	µg/kg dw	<1	<26,6	<0,9	<8,2	<1,0	<1,5	<1,0	<3,1	<0,9	<12,6	<1,0	<6,0	<1	<2,7	<0,9	<8,3	<0,9	<1,4
Nutrients																			
Nitrogen, sludge	g/kg dw	4,4	5,5	3,1	3,4	4,9	5,8	0,7	3,8	5,2	5,7	1,2	2,6	4,3	4,7	3,1	3,6	4	2,1
Total phosporus	g/kg dw	0,9	1	0,85	0,85	0,92	1	0,84	0,91	0,92	1,1	1,1	0,88	0,98	1,1	1,1	0,86	0,89	0,97
Phosphatephosporus	mg/g ww	N/A	<0,0001	N/A	<0,0001	N/A	<0,0001	N/A	0,0001	N/A	0,0003	N/A	0,0007	N/A	0,0004	N/A	0,0004	N/A	0,0008
Nitritenitrogen	mg/g ww	N/A	0,0002	N/A	0,0001	N/A	0,0002	N/A	0,0001	N/A	0,0002	N/A	0,0001	N/A	0,0001	N/A	0,0001	N/A	0,0001
Nitratenitrogen	mg/g ww	N/A	0,0001	N/A	<0,0001	N/A	0,0002	N/A	0,0002	N/A	0,0002	N/A	0,0004	N/A	0,0003	N/A	0,0005	N/A	0,0003
Ammonium nitrogen	mg/g ww	N/A	0,006	N/A	0,004	N/A	0,003	N/A	0,005	N/A	0,005	N/A	0	N/A	0,003	N/A	0,001	N/A	0,002
NORMALISED CONCENTRATIONS																			
Metals																			
Arsenic, As Level 1: 15 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	8,2	4,4	6,7	7,4	7,4	6,1	9,1	9,6	6,6	4,4	5,4	7,2	6,1	5,0	5,4	5,2	7,5	4,4
Cadmium, Cd Level 1: 0,5 mg/kg dw Level 2: 2,5 mg/kg dw	mg/kg dw	0,4	0,4	0,8	0,4	0,5	0,5	0,5	0,6	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40
Chromium, Cr Level 1: 65 mg/kg dw Level 2: 270 mg/kg dw	mg/kg dw	46,3	14,3	42,4	41,9	42,5	32,2	50,9	43,3	43,3	15,8	55,7	41,9	43,8	34,9	43,8	40,0	53,4	16,5
Copper, Cu Level 1: 50 mg/kg dw Level 2: 90 mg/kg dw	mg/kg dw	27,1	20,9	26,2	24,7	25,9	20,7	28,6	27,6	24,8	21,9	32,5	27,7	27,5	20,8	27,0	22,2	31,7	22,3
Mercury, Hg Level 1: 0,1 mg/kg dw Level 2: 1,0 mg/kg dw	mg/kg dw	<0,10	0,1	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10
Nickel, Ni Level 1: 45 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	27,7	13,0	23,9	21,1	26,1	19,0	25,6	22,4	27,6	14,0	28,7	22,6	25,4	18,0	25,3	20,6	30,9	12,1
Lead, Pb Level 1: 40 mg/kg dw Level 2: 200 mg/kg dw	mg/kg dw	23,7	17,6	30,4	31,5	20,6	19,0	33,9	36,2	20,4	17,4	16,9	19,4	26,5	22,7	38,0	23,9	23,2	13,7
Zinc, Zn Level 1: 170 mg/kg dw Level 2: 500 mg/kg dw	mg/kg dw	103,0	60,0	107,9	93,4	98,3	69,4	116,3	104,1	97,8	60,0	105,6	90,2	104,5	77,6	104,5	82,3	111,6	50,1
Organotins																			
Monobutyltin, MBT	µg/kg dw	2,7	<3,8	<0,9	<4,0	3,4	<0,9	<1,7	<3,3	3,0	<6,8	<1,0	<2,5	<2,1	<5,6	<2,1	<3,3	<2,2	2,0
Dibutyltin, DBT	µg/kg dw	<1	<5,0	<1,4	<3,1	<1,0	<0,6	<1,1	<0,8	<0,9	<1,5	<1,0	<0,8	<1,0	<3,5	<1,1	<3,2	<1,1	<0,9

Tributyltin, TBT Level 1: 3 µg/kg dw Level 2: 200 µg/kg dw	µg/kg dw	4,0	18,1	4,4	26,2	4,3	2,2	5,6	14,7	3,5	15,4	<1,2	12,5	<1,8	12,0	<2,4	13,1	<2,0	3,7
Tetrabutyltin, TTBT	µg/kg dw	<1	<2,3	<0,9	<1,3	<1,0	<0,3	<1,0	<1,5	<0,9	<2,8	<1,0	<1,9	<1	<2,5	<0,9	<2,3	<0,9	<0,6
Mono-octyltin, MOT	µg/kg dw	<1	<2,2	<0,9	<1,3	<1,0	<0,3	<1,0	<1,5	<0,9	<2,8	<1,0	<1,8	<1	21,1	<0,9	<2,4	<0,9	<0,6
Dioctylintin, DOT	µg/kg dw	<1	<4,4	<0,9	<1,5	<1,0	<0,3	<1,0	<0,9	<0,9	<2,7	<1,0	<1,5	<1	14,1	<0,9	<1,1	<0,9	<0,4
Tricyclohexyltin, TCHT	µg/kg dw	<1	<6,9	<0,9	<1,8	<1,0	<0,3	<1,0	<1,2	<0,9	<2,7	<1,0	<1,9	<1	<1,5	<0,9	<1,0	<0,9	<0,4
Triphenyltin, TPhT	µg/kg dw	<1	<26,6	<0,9	<8,2	<1,0	<1,5	<1,0	<3,1	<0,9	<12,6	<1,0	<6,0	<1	<2,7	<0,9	<8,3	<0,9	<1,4
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6,8	4,8	21,4	26,2	5,3	4,9	24,0	22,4	5,8	4,5	0,6	1,5	8,2	7,6	27,1	7,2	5,0	4,5
I-TEQ (NATO/CCMS) excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6,9	4,9	20,2	24,4	5,3	5,0	22,5	20,9	5,8	4,5	0,7	1,6	8,3	7,7	25,2	7,2	5,1	4,5

dw = dry weight
ww = wet weight
N/A = not available
Level 1 = slightly contaminated mass and Level 2 = contaminated mass, classification based on Dredging manual

Vessel operated monitoring showed low turbidity values on both detonation days at VOM1. During the second round of monitoring, that was performed on the 11th of May 2010, some elevated values were seen in bottom close waters up to 10-15 metres above the seabed in the area having a radius of approximately 250 metres centred at the munition. Values remained below 10 NTU, which is typically considered as a threshold value for visible turbidity. (See Attachment 2).

Water sampling showed that the lowest 10 metre water layer had lower oxygen concentration than upper water mass. Other parameters showed values typical for the Gulf of Finland and prevailing season.

Sediment samples did not show any general increase in metal or dioxin values. Heavy metal and dioxin levels in the samples taken after ammunition clearance operations were of the same order of magnitude or slightly lower than in the samples taken before ammunition clearance operations. Normalised dioxin values were slightly above Level 1 at three sampling locations prior to clearance and at two locations after the clearance. The only rise in contaminant values was seen on TBT levels, which increased a little between pre and post sampling (See Attachment 3). Five of nine TBT samples showed normalised concentrations that exceeded the Level 1 in the pre sampling phase while all nine samples were above the Level 1 in the post sampling phase. However, all samples were still clearly below the Level 2. Nitrogen level in sediment showed also a small increase.

3.2 VOM2 station

3.2.1 Real-time turbidity monitoring with automatic instrument

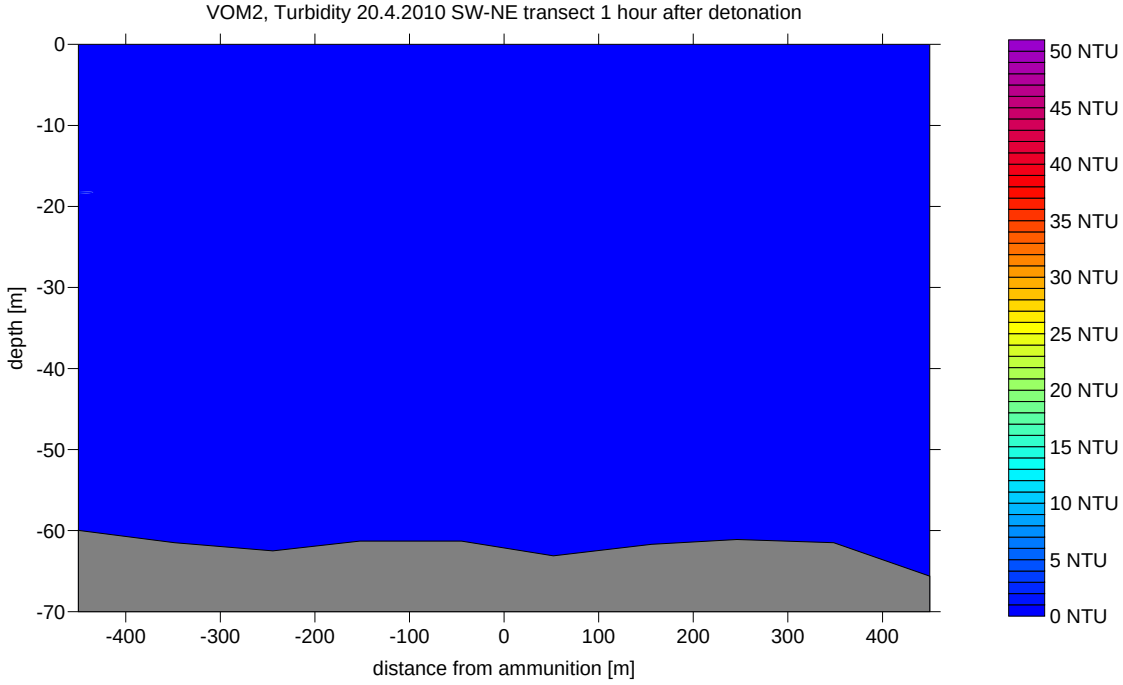


Figure 14. VOM2, vessel operated monitoring, first round, SW-NE, 20th April 2010.

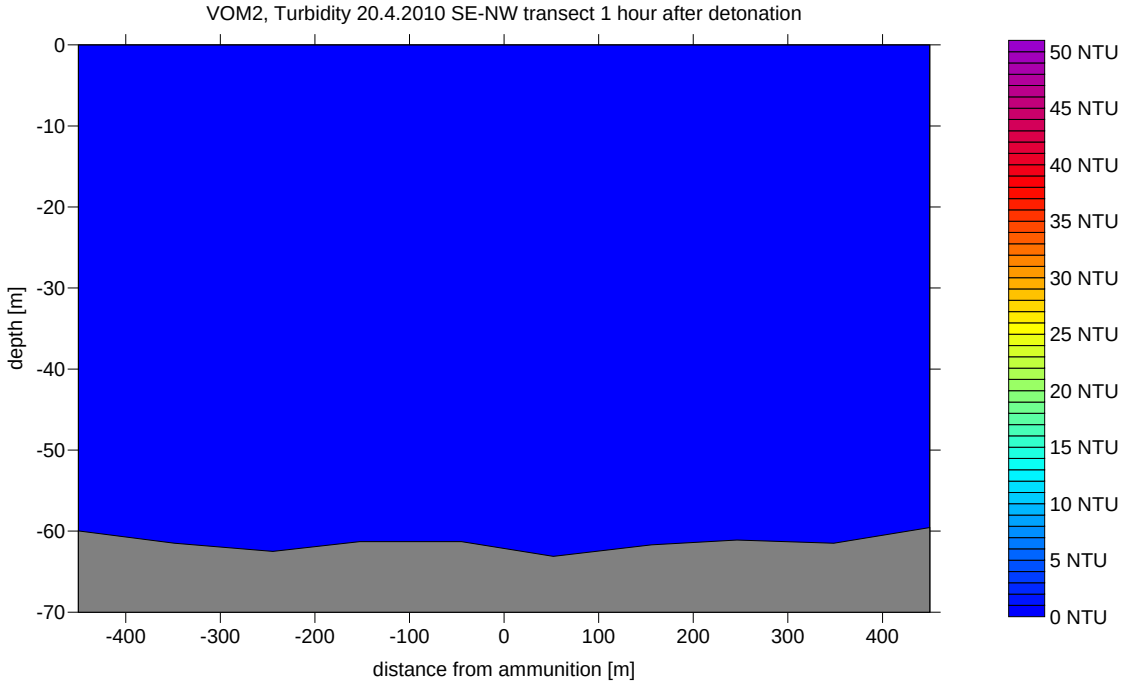


Figure 15. VOM2, vessel operated monitoring, first round, SE-NW, 20th April 2010.

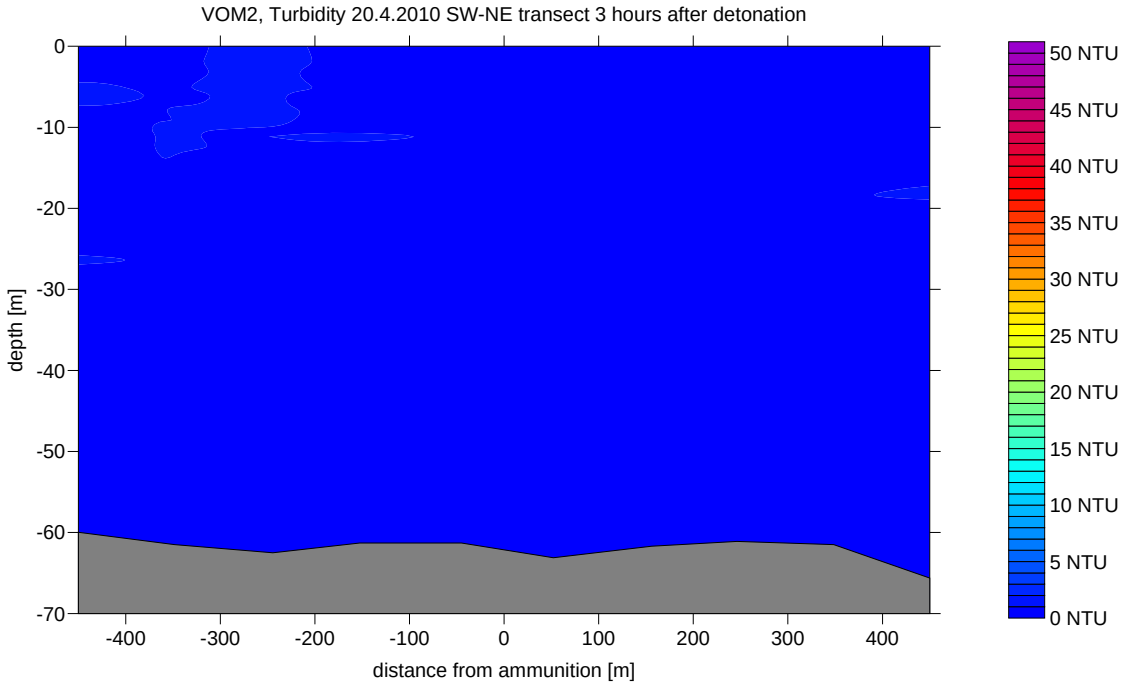


Figure 16. VOM2, vessel operated monitoring, second round, SW-NE, 20th April 2010.

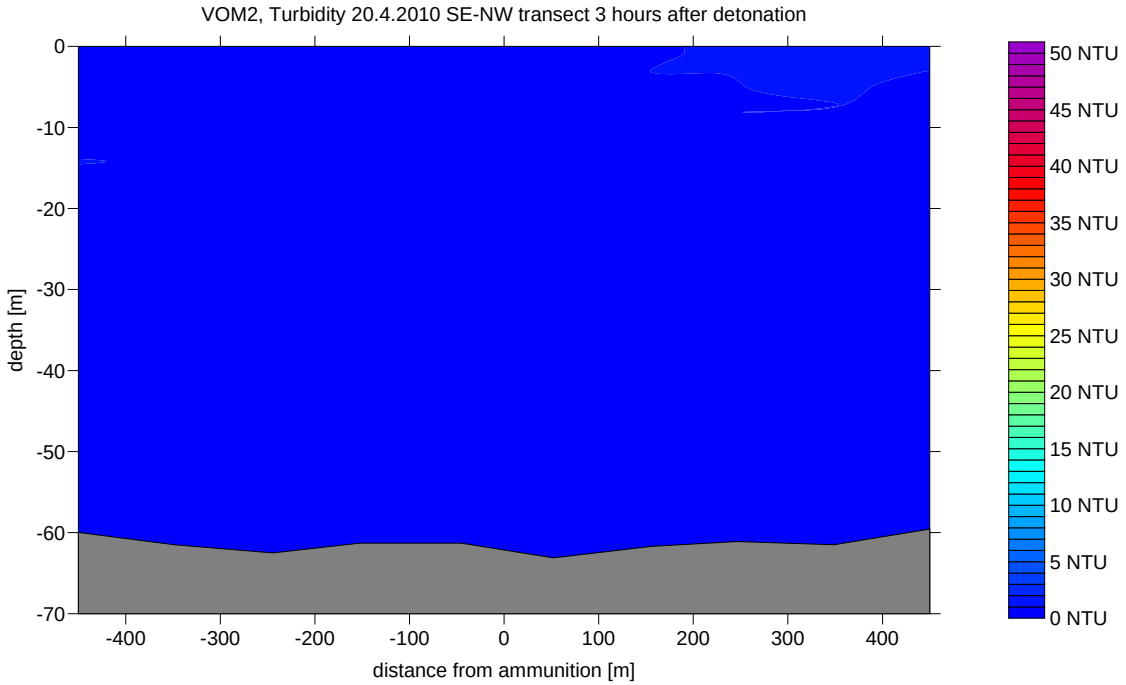


Figure 17. VOM2, vessel operated monitoring, second round, SE-NW, 20th April 2010.

3.2.2 Water sampling

Table 6. Laboratory results of the water samples taken during the vessel operated monitoring from VOM2 on 20.4.2010. Laboratory: Kokemäenjoen vesistön vesiensuojeluyhdistys ry.

Date	Site, sample depth	Cr	Cu	Hg	Co	Zn	Ni	Pb	Cd	As	Turbidity	Solid matter	dissolved oxygen	tot,N	NO3-N	NO2-N	NO23-N	NH4-N,M	tot,P	po4-p
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	FNU	mg/l	mg/l	µg/l	µg/l N	µg/l N	µg/l	µg/l	µg/l	µg/l
20.4.2010	1m background	<0,05	0,33	<0,002	0,24	1,9	0,82	0,09	0,01	0,89	0,83	2,1	13,0	350	7,5	9,2	<2,5	20	37	9
20.4.2010	20m background	<0,05	0,25	0,005	0,24	1,5	0,65	<0,05	0,01	0,89	0,8	1,7	13,9	290	<5	<5	<2,5	17	23	9
20.4.2010	40m background	0,85	0,09	0,005	0,26	6,7	0,88	<0,05	0,01	0,97	0,45	4,1	11,5	330	96	97	<2,5	30	36	31
20.4.2010	60m background	1,9	<0,05	0,002	0,28	13	1,1	<0,05	0,01	1	0,52	0,7	8,5	320	94	93	<2,5	59	47	43
20.4.2010	1m	0,35	<0,05	0,003	0,27	4,2	0,66	<0,05	0,01	1	0,63	0,7	14,0	310	95	94	<2,5	51	48	45
20.4.2010	10m	<0,05	<0,05	0,002	0,23	1,6	0,6	<0,05	0,01	1,1	0,33	0,5	13,4	320	85	85	<2,5	62	33	28
20.4.2010	20m	<0,05	<0,05	0,002	0,2	1,5	0,55	<0,05	<0,01	0,92	0,27	3,9	13,5	320	79	82	2,5	35	31	23
20.4.2010	30m	<0,05	<0,05	0,002	0,18	1,4	0,54	<0,05	0,01	0,89	0,37	4,2	13,3	280	8	9,5	<2,5	25	22	10
20.4.2010	40m	2,5	<0,05	<0,002	0,18	13	0,99	<0,05	0,01	0,85	0,51	1,5	12,5	290	18	19	<2,5	38	24	11
20.4.2010	50m	0,24	<0,05	0,003	0,16	2,8	0,63	<0,05	<0,01	0,85	0,88	4,8	10,9	340	<5	<5	<2,5	11	33	8
20.4.2010	60m	5,9	0,06	0,003	0,17	27	1,7	<0,05	<0,01	0,86	0,79	2,2	8,2	330	<5	<5	<2,5	15	33	10

Turbidity units: Formazin Nephelometric Unit (FNU) is used for laboratory analyses while field instrument uses Nephelometric Turbidity Units (NTU). Values are typically comparable 1:1 for values <100 NTU/FNU.

3.2.3 Sediment sampling

Table 7. Laboratory results of the sediment samples taken during pre- and post clearance monitoring from VOM2. Laboratory: Eurofins Scientific Finland Oy.

VOM2	sample(cm below surface)	1A (0-2 cm)		1B (2-10 cm)		2A (0-2 cm)		2B (2-10 cm)		3A (0-2 cm)		4A (0-2 cm)		5A (0-2 cm)		6A (0-2 cm)		7A (0-2 cm)	
	distance [m]	50		50		100		100		200		400		800		1600		3200	
	depth [m] latitude longitude	62 59°40,42'N 24°07,15´E		62 59°40,42'N 24°07,15´E		62 59°40,44'N 24°07,15´E		62 59°40,44'N 24°07,15´E		61 59°40,50'N 24°07,15´E		61 59°40,61'N 24°07,15´E		56 59°40,82'N 24°07,15´E		58 59°41,25'N 24°07,15´E		63 59°42,11'N 24°07,15´E	
Parameter	Unit	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Metals																			
Arsenic, As	mg/kg dw	5	<5,0	9,2	7,6	<5,0	<5,0	9	7,6	5,9	<5,0	<5,0	<5,0	10	29	<5,0	46	5,1	6,2
Cadmium, Cd	mg/kg dw	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	0,44
Chromium, Cr	mg/kg dw	33	10	73	25	31	11	65	23	27	9,8	27	9,8	83	26	25	32	29	38
Cobalt, Co	mg/kg dw	7,2	<5,0	17	12	7,2	<5,0	16	9,8	11	<5,0	7,1	<5,0	20	21	6,7	15	8,1	9,2
Copper, Cu	mg/kg dw	18	13	30	24	17	15	31	24	18	12	18	13	39	33	13	17	21	23
Mercury, Hg	mg/kg dw	0,11	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10
Nickel, Ni	mg/kg dw	18	9,3	43	23	17	9,5	41	20	20	8,9	17	8,7	46	31	16	23	20	24
Lead, Pb	mg/kg dw	16	13	16	15	17	15	16	15	16	11	14	14	17	18	<10	14	19	22
Zinc, Zn	mg/kg dw	68	42	110	62	70	50	100	58	66	39	64	42	130	87	48	72	79	89
Auxiliary parameters																			
Fraction < 2000 µm	% dw	78,8	89	57,4	82,4	79,4	87,1	58,7	87,2	81,4	89,7	84,7	89,7	76,1	62,9	88,6	99,4	76,5	80,9
Fraction < 63 µm	% dw	38,8	47,6	49,7	80,5	42,9	44,5	47,2	81,3	36,9	40,8	43	42	68,3	61	30,2	43,2	36,1	57,7
Fraction < 45 µm	% dw	29,7	39,8	48	79,1	34	39,9	44,9	79,2	27,9	34,5	34,4	37,1	67,9	60,4	28,1	41,2	31,3	55,4
Fraction < 16 µm	% dw	26,3	29,1	47,8	78,2	27	32,8	44,7	76,8	25,2	24,2	29,4	31,4	66,9	58,5	27,2	35,1	29,2	49,9
Fraction < 2 µm	% dw	18,7	28,2	46,3	56,4	16,2	18,1	42	53,2	17,6	14,5	19,2	21,5	52,2	47,8	20,4	23,8	20,4	35,5
Organic matter	% dw	4	2,8	5,1	2,7	3,6	3,4	3,2	2	2,6	2,6	3,3	3,2	<0,50	0,9	1	1,8	4,8	7
Residual of ignition	% dw	94,7	95,2	91,6	93,4	95,3	95,3	93,8	94,3	96,2	96,4	95,4	95,3	96,9	95,8	97,6	96,5	93,7	90,5
Dry matter	g/kg dw	375	360	371	354	360	352	399	378	436	422	398	351	496	506	565	514	302	182
Dry matter concentration	%	39,8	36,5	35,8	36,5	38,5	33,2	40	38,2	41,7	42,2	39,3	32,8	50	49,1	57,9	51,8	30,3	16,9
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl, LOQ	ng/kg dw	1,8	2,03	0,0006	0,078	2,12	2,39	0,068	0,679	0,306	0,402	2	1,59	0,068	0,029	0,102	0,093	2,65	4,84
I-TEQ (NATO/CCMS) excl, LOQ	ng/kg dw	1,83	2,03	0,006	0,078	2,16	2,44	0,075	0,705	0,339	0,429	2,06	1,63	0,075	0,029	0,114	0,093	2,71	4,94

Organotins																		
Monobutyltin, MBT	µg/kg dw	8,1	4,6	<2,7	<0,8	9	5,3	<1,2	<1,2	8,2	3,7	9,7	9,4	2,1	<1,5	3,8	2,9	10,7	6,4
Dibutyltin, DBT	µg/kg dw	6,6	9,9	<1,6	<1,9	7,3	6,3	<1,2	<0,9	9,9	4,2	8	13	1,8	<2,3	2,6	3,4	7,5	9,1
Tributyltin, TBT	µg/kg dw	21	33,4	<2,1	<3,6	22	22,2	<1,4	<4,7	34,5	14,1	40,9	119	6,8	<2,4	7,5	9,7	47,3	26,9
Tetrabutyltin, TTBT	µg/kg dw	1,5	1,3	<1,1	<1,7	<1,0	<1,7	<1,2	<0,8	<1	<0,9	<1,2	2,1	<1	<0,9	1,6	<1	<1,1	<4,7
Mono-octyltin, MOT	µg/kg dw	<1,7	<1,4	<2,1	<1,5	<2,0	<1,7	<1,9	<0,7	<1,6	<0,9	<1,9	<2,0	<1,5	<0,7	1,3	<0,9	<2,2	<3,9
Dioctylintin, DOT	µg/kg dw	<0,8	<0,6	<1,1	<0,7	<1,0	<0,9	<1,2	<0,5	<1	<0,7	<2,4	<0,8	<1	<0,4	<0,6	<1,1	<1,1	<2,6
Tricyclohexyltin, TCHT	µg/kg dw	<2,1	<0,8	<2,7	<0,8	<2,5	<0,7	<2,4	<0,6	<2,0	<0,5	<1,2	<1,2	<2,3	<0,4	4,3	<0,4	<2,8	<3,3
Triphenyltin, TPhT	µg/kg dw	<0,8	40,6	<1,1	<1,7	<1,0	<1,6	<1,2	<0,8	<1	<0,4	N/A	<0,7	<1	<0,5	<0,6	<0,6	7,7	<2,3
Nutrients																			
Nitrogen, sludge	g/kg dw	1,9	2	2,5	2,4	2,2	2,2	1,7	2,3	1,7	1,9	2	1,9	0,6	0,8	1,1	1	2,8	4,4
Total phosporus	g/kg dw	0,64	0,8	0,66	0,73	0,66	0,81	0,65	0,72	0,64	0,82	0,64	0,71	2	3,1	0,74	0,84	0,68	0,85
Phosphatephosporus	mg/g ww	N/A	0,0009	N/A	0,0006	N/A	0,0009	N/A	0,0006	N/A	0,0008	N/A	0,001	N/A	0,003	N/A	0,001	N/A	<0,0001
Nitritenitrogen	mg/g ww	N/A	0,0001	N/A	0,0002	N/A	0,0001	N/A	0,0002	N/A	0,0001	N/A	0,00008	N/A	0,0002	N/A	0,0002	N/A	0,0002
Nitratenitrogen	mg/g ww	N/A	0,0005	N/A	0,0003	N/A	0,0006	N/A	0,0002	N/A	0,0004	N/A	0,0004	N/A	0,0006	N/A	0,0003	N/A	0,0002
Ammonium nitrogen	mg/g ww	N/A	0,001	N/A	0,001	N/A	0,0009	N/A	0,001	N/A	0,001	N/A	0,001	N/A	0,0007	N/A	0,0007	N/A	0,006
NORMALISED CONCENTRATIONS																			
Metals																			
Arsenic, As Level 1: 15 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	6,0	<5,0	7,5	5,7	<5,0	<5,0	7,9	<5,0	7,4	<5,0	<5,0	<5,0	7,9	24,4	<5,0	52,9	5,9	5,6
Cadmium, Cd Level 1: 0,5 mg/kg dw Level 2: 2,5 mg/kg dw	mg/kg dw	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	<0,40	0,4
Chromium, Cr Level 1: 65 mg/kg dw Level 2: 270 mg/kg dw	mg/kg dw	13,8	9,4	51,2	15,4	37,6	12,8	48,5	14,7	31,7	12,4	30,5	10,5	53,8	17,9	27,5	32,8	31,9	31,4
Copper, Cu Level 1: 50 mg/kg dw Level 2: 90 mg/kg dw	mg/kg dw	35,1	13,9	23,6	17,1	22,8	19,4	26,5	18,0	23,9	17,1	22,7	15,7	29,5	26,9	16,5	20,2	25,1	20,4
Mercury, Hg Level 1: 0,1 mg/kg dw Level 2: 1,0 mg/kg dw	mg/kg dw	0,2	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10
Nickel, Ni Level 1: 45 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	1,6	8,5	26,7	12,1	22,7	11,8	27,6	11,1	25,4	12,7	20,4	9,7	25,9	18,8	18,4	23,8	23,0	18,5
Lead, Pb Level 1: 40 mg/kg dw Level 2: 200 mg/kg dw	mg/kg dw	24,9	13,6	13,4	11,7	20,7	17,8	14,3	12,1	19,4	13,9	16,4	15,9	13,9	15,5	<10	15,7	21,5	20,2
Zinc, Zn Level 1: 170 mg/kg dw Level 2: 500 mg/kg dw	mg/kg dw	154,3	42,4	78,4	38,9	94,2	64,0	77,4	38,2	86,6	56,1	79,6	49,3	86,8	62,5	44,3	81,2	93,4	74,6
Organotins																			
Monobutyltin, MBT	µg/kg dw	20,3	16,4	<2,7	<0,8	25,0	15,6	<1,2	<1,2	31,5	14,2	29,4	29,4	10,5	<1,5	19,0	14,5	22,3	9,1
Dibutyltin, DBT	µg/kg dw	16,5	35,4	<1,6	<1,9	20,3	18,5	<1,2	<0,9	38,1	16,2	24,2	40,6	9,0	<2,3	13,0	17,0	15,6	13,0

Tributyltin, TBT Level 1: 3 µg/kg dw Level 2: 200 µg/kg dw	µg/kg dw	52,5	119,3	<2,1	<3,6	61,1	65,3	<1,4	<4,7	132,7	54,2	123,9	371,9	34,0	<2,4	37,5	48,5	98,5	38,4
Tetrabutyltin, TTBT	µg/kg dw	3,8	4,6	<1,1	<1,7	<1,0	<1,7	<1,2	<0,8	<1	<0,9	<1,2	6,6	<1	<0,9	8,0	<1	<1,1	<4,7
Mono-octyltin, MOT	µg/kg dw	<1,7	<1,4	<2,1	<1,5	<2,0	<1,7	<1,9	<0,7	<1,6	<0,9	<1,9	<2,0	<1,5	<0,7	6,5	<0,9	<2,2	<3,9
Dioctylintin, DOT	µg/kg dw	<0,8	<0,6	<1,1	<0,7	<1,0	<0,9	<1,2	<0,5	<1	<0,7	<2,4	<0,8	<1	<0,4	<0,6	<1,1	<1,1	<2,6
Tricyclohexyltin, TCHT	µg/kg dw	<2,1	<0,8	<2,7	<0,8	<2,5	<0,7	<2,4	<0,6	<2,0	<0,5	<1,2	<1,2	<2,3	<0,4	21,5	<0,4	<2,8	<3,3
Triphenyltin, TPhT	µg/kg dw	<0,8	145,0	<1,1	<1,7	<1,0	<1,6	<1,2	<0,8	<1	<0,4	N/A	<0,7	<1	<0,5	<0,6	<0,6	16,0	<2,3
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	4,5	7,3	0,0	0,3	5,9	7,0	0,2	3,4	1,2	1,5	6,1	5,0	0,3	0,3	0,5	0,5	5,5	6,9
I-TEQ (NATO/CCMS) excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	4,6	7,3	0,0	0,3	6,0	7,2	0,2	3,5	1,3	1,7	6,2	5,1	0,4	0,3	0,6	0,5	5,6	7,1

dw = dry weight
ww = wet weight
N/A = not available
Level 1 = slightly contaminated mass and Level 2 = contaminated mass, classification based on Dredging manual

Vessel operated monitoring showed low turbidity values at VOM2.

Water sampling showed that the oxygen concentration was good in the whole water mass. Other parameters showed values typical for the Gulf of Finland and prevailing season. Two elevated chromium values were seen on samples taken at 40 and 65 metres depth.

Sediment samples did not show any general increase in metal, dioxin or organotin values. Heavy metal levels were of the same order of magnitude or slightly lower in the sampling performed after ammunition clearance operations (See Attachment 4). Normalised dioxin concentration in all samples taken before and after the clearance operations was below the Level 1. One normalised TBT concentration was above Level 2.

3.3 VOM3 station

3.3.1 Real-time turbidity monitoring with automatic instrument

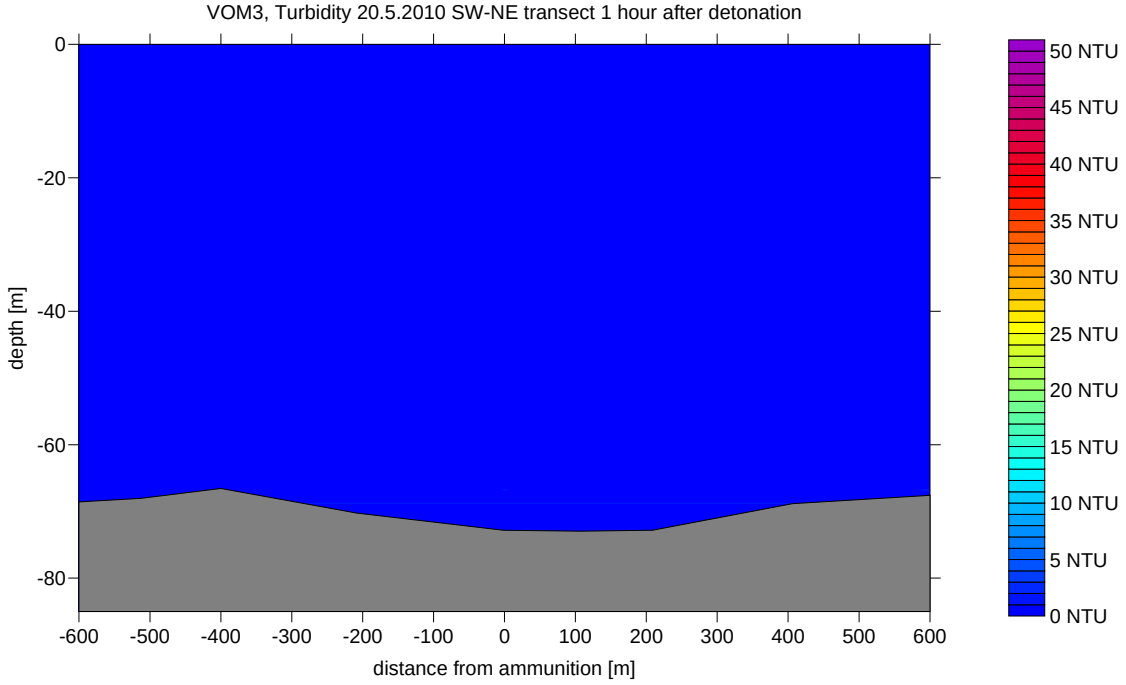


Figure 18. VOM3, vessel operated monitoring, first round, SW-NE, 20th May 2010.

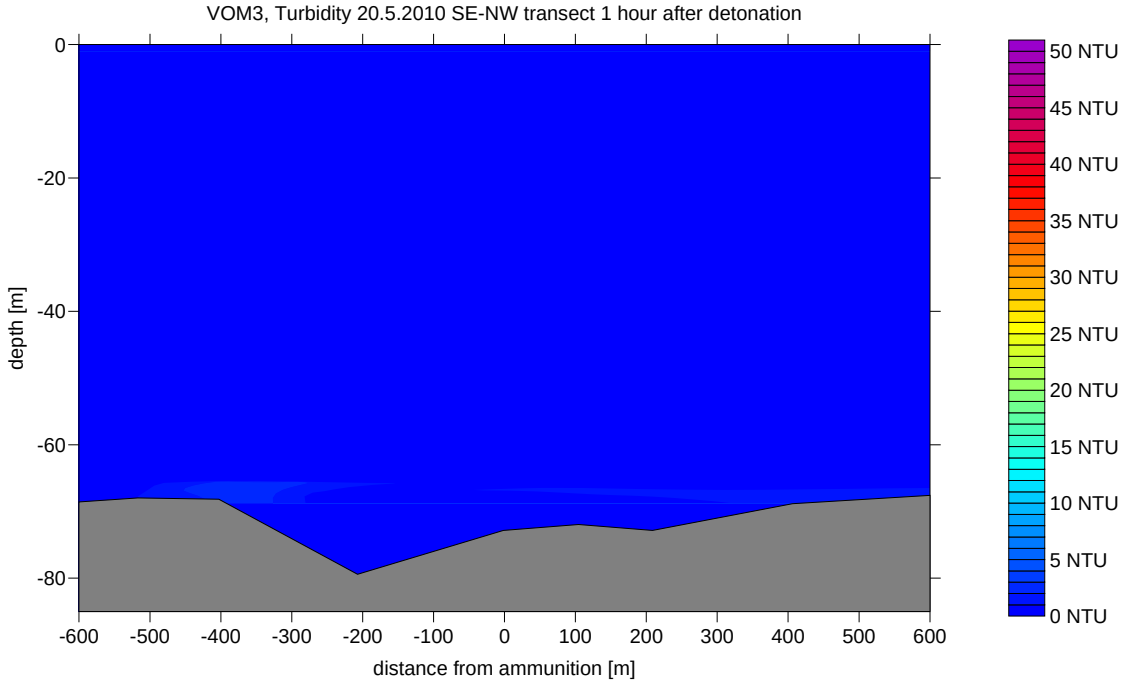


Figure 19. VOM3, vessel operated monitoring, first round, SE-NW, 20th May 2010.

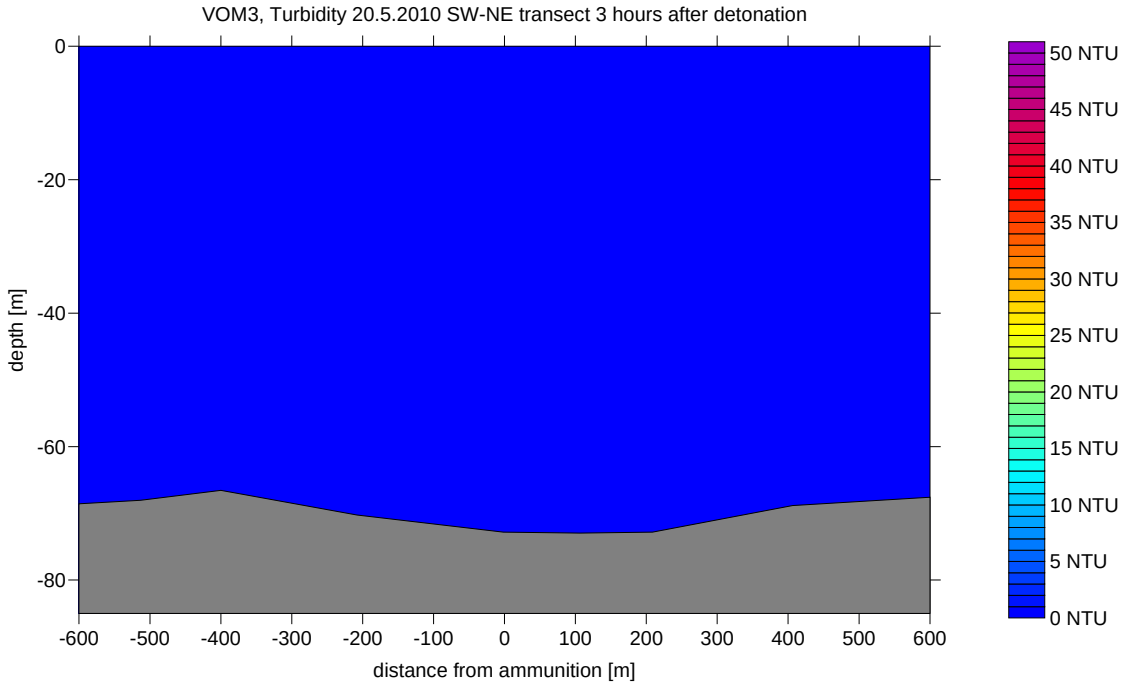


Figure 20. VOM3, vessel operated monitoring, second round, SW-NE, 20th May 2010.

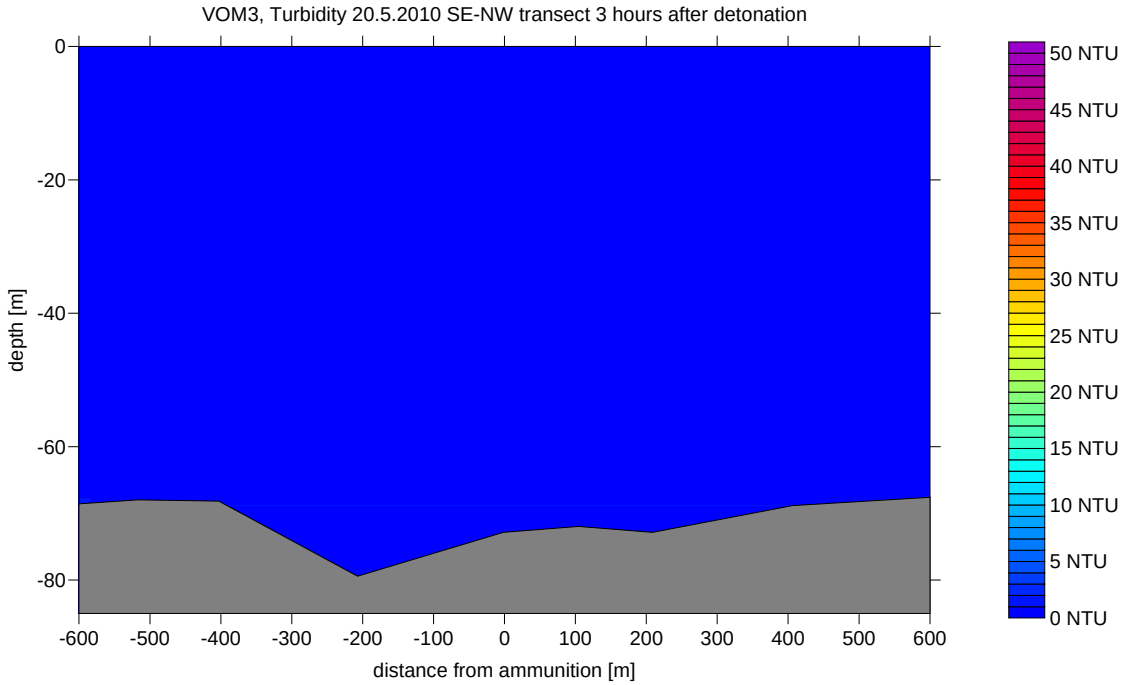


Figure 21. VOM3, vessel operated monitoring, second round, SE-NW, 20th May 2010.

3.3.2 Water sampling

Table 8. Laboratory results of the water samples taken during the vessel operated monitoring from VOM3 on 20.5.2010. Laboratory: Kokemäenjoen vesistön vesiensuojeluyhdistys ry.

Date	Site, sample depth	Cr	Cu	Hg	Co	Zn	Ni	Pb	Cd	As	Turbidity	Solid matter	dissolved oxygen	tot,N	NO3-N	NO2-N	NO23-N	NH4-N,M	tot,P	po4-p
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	FNU	mg/l	mg/l	µg/l	µg/l N	µg/l N	µg/l	µg/l	µg/l	µg/l
20.5.2010	20m background	<0,05	0,23	<0,002	0,09	0,69	0,54	<0,05	<0,01	0,76	0,54	1	12,9	280	<5	<2,5	<5	11	17	10
20.5.2010	40m background	<0,05	0,26	<0,002	0,1	1,2	0,52	<0,05	<0,01	0,83	0,51	3,8	11,7	280	<5	<2,5	5	12	20	15
20.5.2010	60m background	<0,05	0,06	<0,002	0,12	1,7	0,54	<0,05	<0,01	0,89	0,68	19	7,5	350	97	<2,5	100	8	62	56
20.5.2010	1m	<0,05	0,3	0,002	0,09	0,77	0,51	<0,05	<0,01	0,77	0,73	3,3	12,8	330	<5	<2,5	<5	10	20	6
20.5.2010	10m	0,07	0,61	<0,002	0,09	0,91	0,53	0,1	<0,01	0,76	0,65	2,6	13,1	320	<5	<2,5	<5	37	20	7
20.5.2010	20m	<0,05	0,2	<0,002	0,08	0,7	0,5	<0,05	<0,01	0,75	0,44	<1	12,8	280	<5	<2,5	<5	14	20	9
20.5.2010	30m	<0,05	0,15	<0,002	0,09	0,8	0,5	0,17	<0,01	0,81	0,57	2,7	11,8	300	15	<2,5	17	14	30	20
20.5.2010	40m	<0,05	0,17	<0,002	0,09	1,4	0,55	<0,05	<0,01	0,83	0,33	<1	11,9	290	17	<2,5	19	16	28	20
20.5.2010	50m	<0,05	0,06	<0,002	0,09	0,88	0,46	<0,05	<0,01	0,83	0,27	<1	10,8	330	83	<2,5	85	<7	32	27
20.5.2010	60m	<0,05	<0,05	<0,002	0,11	1	0,5	<0,05	<0,01	0,89	0,6	3,6	6,8	340	97	<2,5	99	<7	56	50
20.5.2010	70m	<0,05	<0,05	<0,002	0,16	1,2	0,5	<0,05	<0,01	1	1,4	4,3	1,8	330	38	2,5	40	66	120	110

Turbidity units: Formazin Nephelometric Unit (FNU) is used for laboratory analyses while field instrument uses Nephelometric Turbidity Units (NTU). Values are typically comparable 1:1 for values <100 NTU/FNU.

3.3.3 Sediment and benthos sampling in Finnish EEZ

Table 9. Laboratory results of the sediment samples taken during pre- and post clearance monitoring from VOM3/SED3. Laboratory: Eurofins Scientific Finland Oy.

VOM3/ SED3	**sample(cm below surface)**	**1A (0-2 cm)**		**1B (2-10 cm)**		**2A (0-2 cm)**		**2B (2-10 cm)**		**3A (0-2 cm)**		**4A (0-2 cm)**		**5A (0-2 cm)**		**6A (0-2 cm)**		**7A (0-2 cm)**	
	distance [m]	**50**		**50**		**100**		**100**		**200**		**400**		**800**		**1600**		**3200**	
	depth [m] latitude longitude	**74 59°46,06'N 24°25,81´E**		**74 59°46,06'N 24°25,81´E**		**70 59°46,08'N 24°25,81´E**		**70 59°46,88'N 24°25,81´E**		**69 59°46,14'N 24°25,81´E**		**71 59°46,24'N 24°25,81´E**		**82 59°46,46'N 24°25,81´E**		**68 59°46,89'N 24°25,81´E**		**64 59°47,75'N 24°25,81´E**	
Parameter	**Unit**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Metals																			
Arsenic, As	mg/kg dw	11	9,2	16	16	9,5	10	15	19	50	<5,0	<5,0	14	14	8,1	10	9,4	13	11
Cadmium, Cd	mg/kg dw	0,96	0,78	1	1,2	0,76	0,81	1,1	1,4	0,45	<0,40	<0,40	0,86	1,3	0,93	0,75	0,71	0,43	<0,40
Chromium, Cr	mg/kg dw	69	48	80	71	54	56	61	76	88	29	28	60	54	55	58	56	79	84
Cobalt, Co	mg/kg dw	16	14	17	17	15	16	16	18	26	7,4	8,5	19	16	14	14	15	18	22
Copper, Cu	mg/kg dw	45	37	45	47	38	41	44	52	47	14	15	42	39	38	38	38	40	47
Mercury, Hg	mg/kg dw	<0,10	<0,10	0,16	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	0,16	<0,10	<0,10	0,1
Nickel, Ni	mg/kg dw	42	34	42	41	37	39	35	43	53	15	16	41	39	36	37	37	42	52
Lead, Pb	mg/kg dw	35	27	53	54	32	29	50	56	26	<10	<10	35	26	26	29	28	31	18
Zinc, Zn	mg/kg dw	160	140	190	200	140	150	170	210	170	52	52	170	150	140	150	150	150	140
Auxiliary parameters																			
Fraction < 2000 µm	% dw	54,9	62,3	63	63,7	58,2	69,5	60,4	60,7	68	82,4	82,4	90,5	5,1	64,4	4,5	55,2	62,8	82,1
Fraction < 63 µm	% dw	54	61,8	62,2	63,3	58	68,9	54	56,6	55,1	26,7	26,2	87,6	4,9	63,6	4,3	54,9	59,1	78,4
Fraction < 45 µm	% dw	53,2	61,6	58,7	62,8	57,4	68,4	52,5	55,4	54,6	26,2	24,6	87,4	4,9	63,2	4,3	54,1	56,4	77,9
Fraction < 16 µm	% dw	50,9	61,6	57,3	62,1	57,3	66,1	51,8	54,9	52,4	26	24,4	85,4	4,6	62,9	3,9	53,7	56	76,5
Fraction < 2 µm	% dw	41,5	49,7	50	48,3	47,7	46,9	45,4	43,1	53,1	18,2	19,9	67,7	2,8	48,4	2,5	46,9	49,6	62,2
Organic matter	% dw	11,1	12,2	6,1	7,6	10,8	12,4	5,1	8,1	3,8	0,9	1,3	7,9	16,7	13,3	15,4	13,0	4,5	0,0
Residual of ignition	% dw	86	84,3	90,4	89,0	85,9	84,3	91,7	88,9	92,5	97,8	97,3	87,3	83,1	83,3	84,4	83,7	92,1	95,8
Dry matter	g/kg dw	131	153	217	228	147	121	292	225	301	598	420	150	91	108	102	123	250	403
Dry matter concentration	%	12,8	14,1	21,7	22,6	14,5	12,3	24,4	22,3	25,8	61,4	39,8	15,8	9,4	11	10,4	12,8	21,4	40,2
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl. LOQ	ng/kg dw	7,12	9,27	14,6	20	6,89	9,87	17,4	20,5	0,443	0,15	0,288	9,99	6,22	7,89	7,26	8,38	3,57	0,153
I-TEQ (NATO/CCMS) excl. LOQ	ng/kg dw	7,26	9,02	13,8	19,1	7,03	9,54	16,7	19,8	0,496	0,166	0,318	9,48	6,34	7,4	7,42	9,08	3,65	0,175
Organotins																			

Monobutyltin, MBT	µg/kg dw	1,9	15,3	1,3	7,1	1,7	13,9	<1,0	5,4	<1,0	0,7	<1,0	7,1	<1,0	6,3	<1,0	109	<1,0	1,1
Dibutyltin, DBT	µg/kg dw	3	21,8	2,5	10,5	2,2	15,9	1,4	8,6	1,8	0,8	1,7	13,4	<1,0	11,6	1,4	167	1,5	1
Tributyltin, TBT	µg/kg dw	13,1	175	5,5	35,8	7,7	90,9	2,6	33,5	5,8	3,2	4,7	81,8	1,4	87,6	3,8	1020	3,2	3
Tetrabutyltin, TTBT	µg/kg dw	<1,0	3,2	<1,0	<0,9	<1,0	3,3	<1,0	0,8	<1,0	<0,3	<1,0	<1,3	<1,0	<1,6	<1,0	57,6	<1,0	<0,4
Mono-octyltin, MOT	µg/kg dw	<1,0	2,8	<1,0	<0,9	<1,0	2,4	<1,0	<0,8	<1,0	0,9	<1,0	<1,2	<1,0	3,1	<1,0	66	<1,0	<0,4
Dioctylintin, DOT	µg/kg dw	<1,0	2,6	<1,0	<0,9	<1,0	1,8	<1,0	<0,8	<1,0	0,7	<1,0	<1,2	<1,0	2,8	<1,0	<17,0	<1,0	<0,4
Tricyclohexyltin, TCHT	µg/kg dw	<1,0	<1,3	<1,0	<0,9	<1,0	<1,5	<1,0	<0,8	<1,0	<0,3	<1,0	<1,2	<1,0	<1,6	<1,0	<5,7	<1,0	<0,4
Triphenyltin, TPhT	µg/kg dw	<1,0	<1,3	<1,0	1,8	<1,0	<1,5	<1,0	<0,8	<1,0	<0,3	<1,0	<1,3	<1,0	<1,6	<1,0	<13,2	<1,0	<0,4
Nutrients																			
Nitrogen, sludge	g/kg dw	6,2	5,9	4,7	4,6	5,9	6,2	4,2	4,5	1,9	0,6	1,2	5,2	6,7	6,6	6,8	6,7	3,2	1
Total phosporus	g/kg dw	1,7	1,2	0,93	0,98	1,1	1,1	0,96	0,98	1,7	0,81	0,51	1	2,2	1,1	1,3	1,3	1,3	1,6
Phosphatephosporus	mg/g ww	0,0001	0,0001	0,0005	0,0002	0,0001	<0,0001	0,001	0,0002	0,0006	0,0006	0,0005	<0,0001	0,0004	<0,0001	<0,0001	<0,0001	0,0009	0,002
Nitritenitrogen	mg/g ww	0,00005	0,0002	0,00008	0,0002	0,00006	0,0003	0,00009	0,0001	0,00006	0,0002	0,00006	0,00009	<0,00005	0,00008	0,0001	0,0002	N/A	0,0003
Nitratenitrogen	mg/g ww	0,0002	0,0003	<0,0001	0,0002	0,0002	0,0002	0,0001	0,0002	0,0003	0,0004	0,0002	0,0001	<0,0001	<0,0001	0,0001	0,0001	0,0009	0,001
Ammonium nitrogen	mg/g ww	0,003	0,004	0,004	0,004	0,003	0,007	0,004	0,002	0,001	0,001	0,001	0,004	0,08	0,009	0,005	0,006	0,001	0,0004
NORMALISED CONCENTRATIONS																			
Metals																			
Arsenic, As Level 1: 15 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	8,9	6,7	12,4	12,4	7,2	7,5	12,4	15,5	38,4	<5,0	<5,0	9,0	17,8	5,9	13,1	7,0	10,3	8,0
Cadmium, Cd Level 1: 0,5 mg/kg dw Level 2: 2,5 mg/kg dw	mg/kg dw	0,8	0,6	0,9	1,0	0,6	0,6	1,0	1,3	0,4	<0,40	<0,40	0,6	1,3	0,7	0,8	0,6	0,4	<0,40
Chromium, Cr Level 1: 65 mg/kg dw Level 2: 270 mg/kg dw	mg/kg dw	51,9	32,1	53,3	48,4	37,1	38,9	43,3	55,8	56,3	33,6	31,2	32,4	97,1	37,5	105,5	38,9	52,9	48,2
Copper, Cu Level 1: 50 mg/kg dw Level 2: 90 mg/kg dw	mg/kg dw	34,8	25,5	33,3	34,9	27,3	29,2	35,0	40,9	34,4	19,0	19,2	25,0	52,6	26,3	53,1	26,9	30,3	32,3
Mercury, Hg Level 1: 0,1 mg/kg dw Level 2: 1,0 mg/kg dw	mg/kg dw	<0,10	<0,10	0,1	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	<0,10	0,2	<0,10	<0,10	0,1
Nickel, Ni Level 1: 45 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	28,5	19,9	24,5	24,6	22,4	24,0	22,1	28,3	29,4	18,6	18,7	18,5	106,6	21,6	103,6	22,8	24,7	25,2
Lead, Pb Level 1: 40 mg/kg dw Level 2: 200 mg/kg dw	mg/kg dw	29,0	20,5	42,5	43,3	25,1	22,5	42,3	47,0	20,7	<10	<10	23,7	31,8	19,8	36,3	21,7	25,3	13,6
Zinc, Zn Level 1: 170 mg/kg dw Level 2: 500 mg/kg dw	mg/kg dw	117,2	90,2	127,2	135,7	93,6	100,3	122,8	153,6	110,7	68,7	64,6	89,8	251,6	91,1	260,5	99,9	102,2	82,8
Organotins																			
Monobutyltin, MBT	µg/kg dw	1.7	12.5	2.1	9.3	1.6	11.2	<1,0	6.7	<1,0	3.5	<1,0	9.0	<1,0	4.7	<1,0	83.8	<1,0	5.5
Dibutyltin, DBT	µg/kg dw	2.7	17.9	4.1	13.8	2.0	12.8	2.7	10.6	4.7	4.0	8.5	17.0	<1,0	8.7	0.9	128.5	3.3	5.0
Tributyltin, TBT	µg/kg dw	11.8	143.4	9.0	47.1	7.1	73.3	5.1	41.4	15.3	16.0	23.5	103.5	0.8	65.9	2.5	784.6	7.1	15.0

Level 1: 3 µg/kg dw Level 2: 200 µg/kg dw																		
Tetrabutyltin, TTBT	µg/kg dw	<1,0	2.6	<1,0	<0,9	<1,0	2.7	<1,0	1.0	<1,0	<0,3	<1,0	<1,3	<1,0	<1,6	<1,0	44.3	<1,0	<0,4
Mono-octyltin, MOT	µg/kg dw	<1,0	2.3	<1,0	<0,9	<1,0	1.9	<1,0	<0,8	<1,0	4.5	<1,0	<1,2	<1,0	2.3	<1,0	50.8	<1,0	<0,4
Dioctylintin, DOT	µg/kg dw	<1,0	2.1	<1,0	<0,9	<1,0	1.5	<1,0	<0,8	<1,0	3.5	<1,0	<1,2	<1,0	2.1	<1,0	<17,0	<1,0	<0,4
Tricyclohexyltin, TCHT	µg/kg dw	<1,0	<1,3	<1,0	<0,9	<1,0	<1,5	<1,0	<0,8	<1,0	<0,3	<1,0	<1,2	<1,0	<1,6	<1,0	<5,7	<1,0	<0,4
Triphenyltin, TPhT	µg/kg dw	<1,0	<1,3	<1,0	2.4	<1,0	<1,5	<1,0	<0,8	<1,0	<0,3	<1,0	<1,3	<1,0	<1,6	<1,0	<13,2	<1,0	<0,4
Dioxin and Furan																			
WHO(1998)-PCDD/F TEQ excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6.4	7.6	23.9	26.3	6.4	8.0	34.1	25.3	1.2	0.8	1.4	12.6	3.7	5.9	4.7	6.4	7.9	0.8
I-TEQ (NATO/CCMS) excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6.5	7.4	22.6	25.1	6.5	7.7	32.7	24.4	1.3	0.8	1.6	12.0	3.8	5.6	4.8	7.0	8.1	0.9

dw = dry weight
ww = wet weight
Level 1 = slightly contaminated mass and Level 2 = contaminated mass, classification based on Dredging manual

Table 10. Dissolved oxygen concentration, salinity, water temperature, number of species, total number of individuals and total biomass in VOM3/BENT3 station. There was no pre-sampling at BENT3/1 and BENT3/2 locations because of rough weather, which hindered the sampling by Van Veen grab. Results: Kala- ja vesitutkimus Oy.

BENT3	**pre-sampling 5.5.2010 and post-sampling 3.8.2010**													
sample site	**BENT3/1**		**BENT3/2**		**BENT3/3**		**BENT3/4**		**BENT3/5**		**BENT3/6**		**BENT3/7**	
phase	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*
Dissolved oxygen, mg/l	4	0,7	4,2	0,7	4,8	1,5	5,8	0,4	N/A	<1	7,7	2,9	7,9	3,3
Salinity, ‰	N/A	10	N/A	9,8	N/A	8,36	7,66	N/A	N/A	N/A	7,14	N/A	7,24	6,6
Temperature, °C	4,2	7,3	4,3	7,2	4,2	7,4	4,1	8	N/A	N/A	5,3	6,2	4,2	6,7
Taxa	N/A	0	N/A	1	3	1	1	0	1	0	0	1	5	3
Individuals / m^2	N/A	0	N/A	3	91	36	48	0	3	0	0	6	1057	774
Total biomass, g ww / m^2	N/A	0	N/A	0,01	1,55	0,33	0,68	0	0,04	0	0	0,07	102	123,3

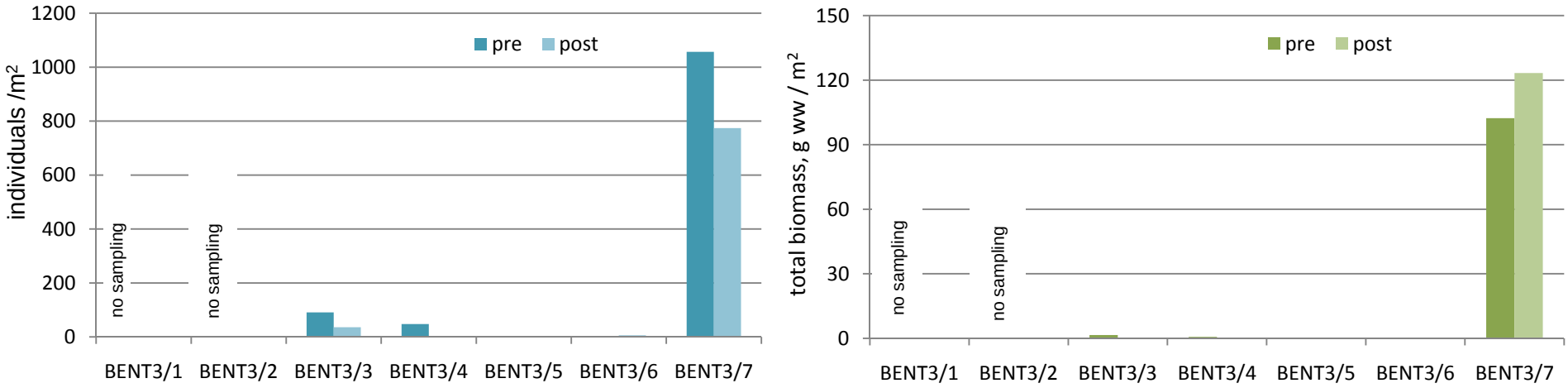


Figure 22. Abundance and biomass at BENT3 benthos samples.

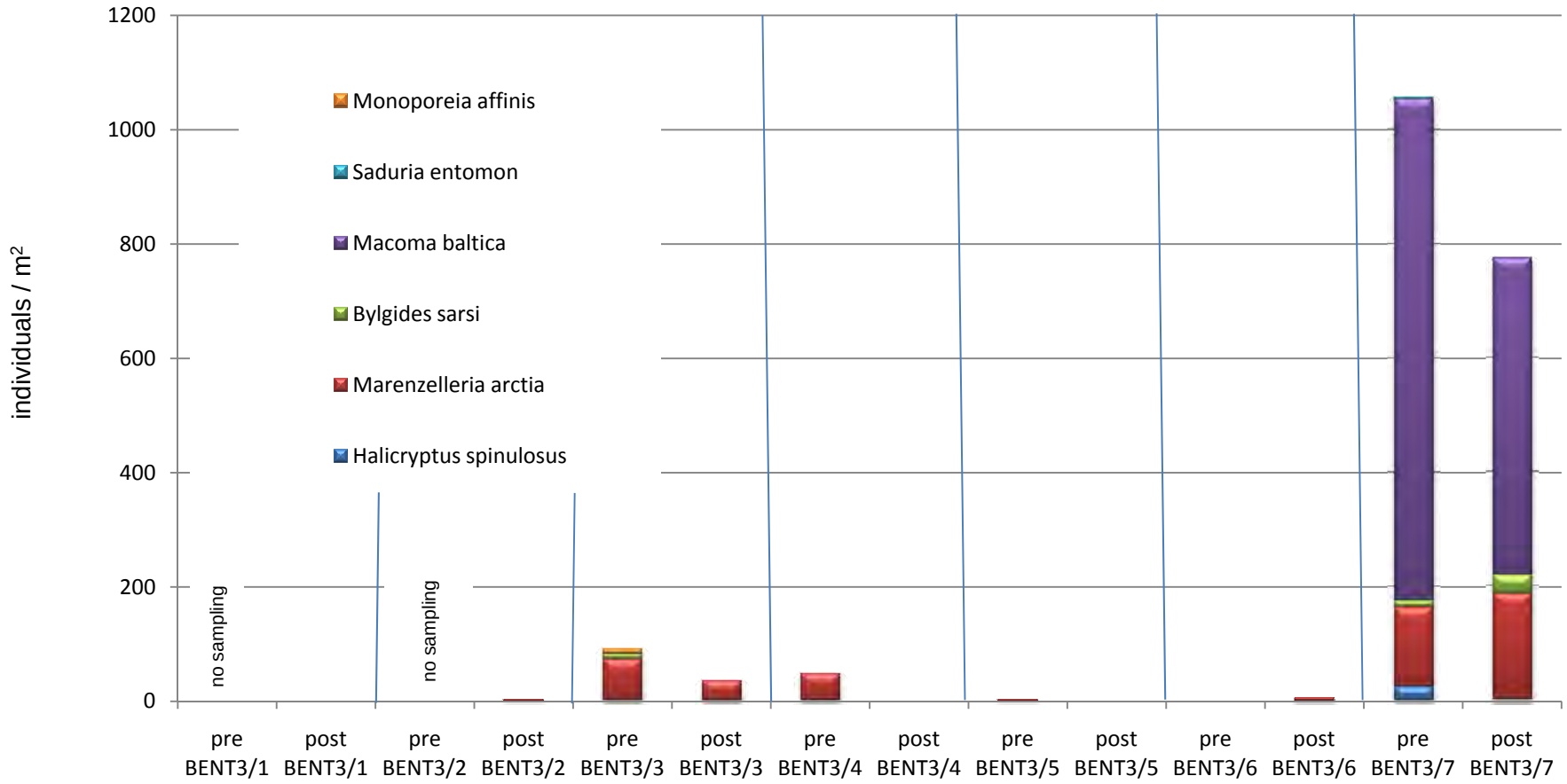


Figure 23. Species-specific abundances at BENT3 station.

Vessel operated monitoring showed low turbidity values at VOM3. Only a thin layer of turbid water (1-3 NTU) was seen on first round of vessel operated monitoring.

Water sampling showed that the oxygen concentration was good in uppermost water mass in Finnish EEZ whereas lowermost 10 metres layer suffered from oxygen depletion. Other parameters showed values typical for the Gulf of Finland and prevailing season.

Sediment samples showed an increase in TBT values in the post-sampling phase after the ammunition clearance operations while the concentrations of metals and dioxins were mostly of the same order of magnitude or smaller (See Attachment 5). Several shipping lanes are crossing the sampling area and the probable origin of TBT is antifouling paints of vessels. Normalised dioxin concentration was above the Level 1 at two sampling locations prior to and after the clearance. One normalised TBT values was above Level 2. It is possible that sample contained a flake of antifouling paint from vessel, which would show as high value in laboratory analyses.

The bottom in Finnish EEZ at BENT3 station was practically lifeless except for BENT3/3 and BENT3/7 locations. The site BENT3/7 which is at shallower waters (~64m) than other locations had good oxygen conditions. The site was dominated by *Macoma baltica.* Samples taken from BENT3/3 after the clearance showed a slight decrease in benthos abundance when compared with samples taken prior to clearance from the same location. Furthermore *Monoporeia affinis* and *Bylgides sarsi* were absent from samples taken after the clearance. In general the number of individuals in both taxa is, however, very low in all BENT3 locations, as seen both in pre and post sampling. The changes of macrozoobenthos community when comparing the results for the samples taken prior to clearance with samples taken after the clearance were small and are most likely caused by natural variance.

3.3.4 Sediment and benthos sampling in Estonian EEZ

Table 11. Laboratory results of the sediment samples taken during pre- and post clearance monitoring from VOM3/SED3 (Est). Laboratory: Eurofins Scientific Finland Oy.

VOM3/SED3 (Est)	**sample (cm below surface)**	**VOM3(EST)/1 (0-2 cm)**		**VOM3(EST)/2 (0-2 cm)**		**VOM3(EST)/3 (0-2 cm)**	
	depth [m] latitude longitude	**75 59°44,55´N 24°26,89´E**		**65 59°44,72´N 24°27,53´E**		**65 59°44,13´N 24°26,31´E**	
Parameter	**Unit**	**Before**	**After**	**Before**	**After**	**Before**	**After**
Metals							
Arsenic, As	mg/kg dw	9.8	11	10	12	8.6	11
Cadmium, Cd	mg/kg dw	0.83	<0.40	1.1	<0.40	<0.40	0.57
Chromium, Cr	mg/kg dw	59	38	54	72	59	64
Cobalt, Co	mg/kg dw	16	10	17	19	16	16
Copper, Cu	mg/kg dw	47	23	43	42	33	38
Mercury, Hg	mg/kg dw	0.14	<0.10	<0.10	<0.10	<0.10	0.18
Nickel, Ni	mg/kg dw	43	25	38	41	35	43
Lead, Pb	mg/kg dw	33	19	25	16	17	31
Zinc, Zn	mg/kg dw	150	94	150	110	100	150
Auxiliary parameters							
Fraction < 2000 µm	% dw	60.2	89.6	62.9	91.7	50.5	66.7
Fraction < 63 µm	% dw	58	38.3	61.9	73.8	42	61.8
Fraction < 45 µm	% dw	57.7	37.1	60.9	73.3	41.1	61.1
Fraction < 16 µm	% dw	55.5	34.4	58.5	72.3	40.9	58.8
Fraction < 2 µm	% dw	37.9	28.7	40	68.4	33.5	51.9
Organic matter	% dw	11.7	6.7	13.6	0.0	2.5	13.5
Residual of ignition	% dw	85.6	91.3	83.6	96.1	95.2	82.9

Dry matter	g/kg	135	206	100	456	362	117
Dry matter concentration	%	12.7	28	9.7	40.5	34.9	11.5
Dioxin and Furan							
WHO(1998)-PCDD/F TEQ excl. LOQ	ng/kg dw	7.83	3.85	6.07	0.067	0.316	6.6
I-TEQ (NATO/CCMS) excl. LOQ	ng/kg dw	7.95	3.91	5.67	0.067	0.341	6.71
Organotins							
Monobutyltin, MBT	µg/kg dw	<1.0	7.9	<1.0	1.8	<1.0	15.5
Dibutyltin, DBT	µg/kg dw	2.3	9	<1.0	2.1	4.2	21.3
Tributyltin, TBT	µg/kg dw	16.4	28.5	3.3	6.7	17	88.5
Tetrabutyltin, TTBT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	4.7
Mono-octyltin, MOT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	2
Dioctylintin, DOT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Tricyclohexyltin, TCHT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Triphenyltin, TPhT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Nutrients							
Nitrogen, sludge	g/kg dw	6.4	3.4	6.9	0.8	1.4	6.7
Total phosporus	g/kg dw	1.3	1	1.3	1.1	1.8	1.2
Phosphatephosporus	mg/g ww	0.0002	0.0003	<0.0001	0.002	0.0001	0.0002
Nitritenitrogen	mg/g ww	0.0001	0.0001	<0.00005	0.00006	<0.00005	0.0002
Nitratenitrogen	mg/g ww	0.0002	0.0002	<0.0001	0.0004	<0.0001	0.0001
Ammonium nitrogen	mg/g ww	0.004	0.007	0.03	0.001	0.001	0.008
NORMALISED CONCENTRATIONS							
Metals							
Arsenic, As Level 1: 15 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	8.2	10.9	8.0	8.1	8.5	7.8
Cadmium, Cd Level 1: 0,5 mg/kg dw Level 2: 2,5 mg/kg dw	mg/kg dw	0.7	<0.40	0.9	<0.40	<0.40	0.4
Chromium, Cr Level 1: 65 mg/kg dw Level 2: 270 mg/kg dw	mg/kg dw	46.9	35.4	41.5	38.5	50.4	41.6
Copper, Cu Level 1: 50 mg/kg dw Level 2: 90 mg/kg dw	mg/kg dw	37.8	22.8	32.8	26.4	32.5	25.2
Mercury, Hg Level 1: 0,1 mg/kg dw Level 2: 1,0 mg/kg dw	mg/kg dw	0.1	<0.10	<0.10	<0.10	<0.10	0.1
Nickel, Ni Level 1: 45 mg/kg dw Level 2: 60 mg/kg dw	mg/kg dw	31.4	22.6	26.6	18.3	28.2	24.3
Lead, Pb Level 1: 40 mg/kg dw Level 2: 200 mg/kg dw	mg/kg dw	28.2	18.9	20.5	11.3	16.8	22.8
Zinc, Zn Level 1: 170 mg/kg dw Level 2: 500 mg/kg dw	mg/kg dw	115.9	90.0	110.3	59.6	90.8	93.0
Organotins							
Monobutyltin, MBT	µg/kg dw	<1.0	11.8	<1.0	9.0	<1.0	11.5
Dibutyltin, DBT	µg/kg dw	2.0	13.4	<1.0	10.5	16.8	15.8
Tributyltin, TBT Level 1: 3 µg/kg dw Level 2: 200 µg/kg dw	µg/kg dw	14.0	42.5	2.4	33.5	68.0	65.6
Tetrabutyltin, TTBT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	3.5
Mono-octyltin, MOT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	1.5
Dioctylintin, DOT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Tricyclohexyltin, TCHT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Triphenyltin, TPhT	µg/kg dw	<1.0	<1.6	<1.0	<1.4	<1.0	<1.7
Dioxin and Furan							
WHO(1998)-PCDD/F TEQ excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6.7	5.7	4.5	0.3	1.3	4.9
I-TEQ (NATO/CCMS) excl. LOQ Level 1: 20 ng/kg dw Level 2: 500 ng/kg dw	ng/kg dw	6.8	5.8	4.2	0.3	1.4	5.0

dw = dry weight
ww = wet weight
Level 1 = slightly contaminated mass and Level 2 = contaminated mass, classification based on Dredging manual

Table 12. Dissolved oxygen concentration, salinity, water temperature, number of species, total number of individuals and total biomass in BENT3 (Est) sampling locations. Samples were taken from Estonian EEZ. Results: Kala- ja vesitutkimus Oy.

BENT3 (Est)	Pre-sampling on 12.5.2010 and post-sampling on 12.7.2010					
sample site	BENT3/1 (Est)		BENT3/2 (Est)		BENT3/3 (Est)	
depth [m] latitude longitude	75 59°44,55´N 24°26,89´E		65 59°44,72´N 24°27,53´E		65 59°44,13´N 24°26,31´E	
phase	*PRE*	*POST*	*PRE*	*POST*	*PRE*	*POST*
Dissolved oxygen, mg/l	6,2	4,2	4,0	3,8	5,3	2,8
Salinity, ‰	7,4	7,5	7,6	8,2	6,7	7,3
Temperature, °C	4,1	6	4,8	5,9	5,2	6,2
Taxa	4	3	2	1	5	2
Individuals / m^2	924	246	21	21	84	9
Total biomass, g ww / m^2	55,8	26,4	0,33	0,04	5,4	0,05

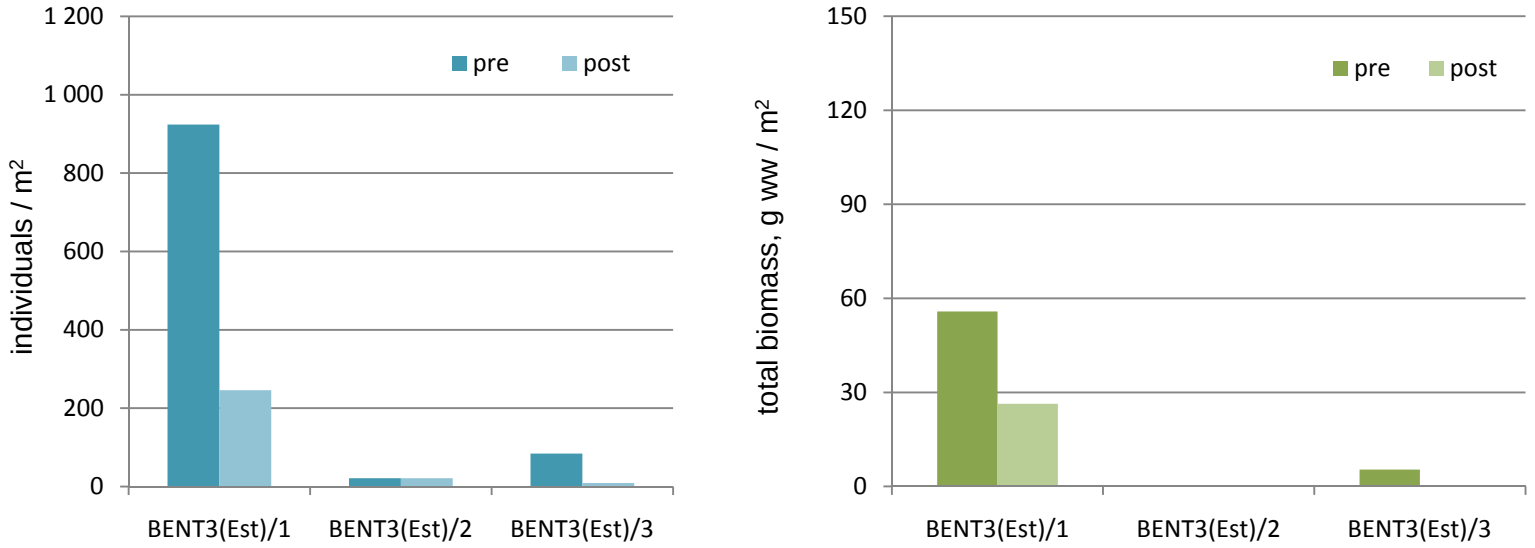


Figure 24. Abundance and biomass at BENT3 (Est) benthos samples taken from Estonian EEZ.

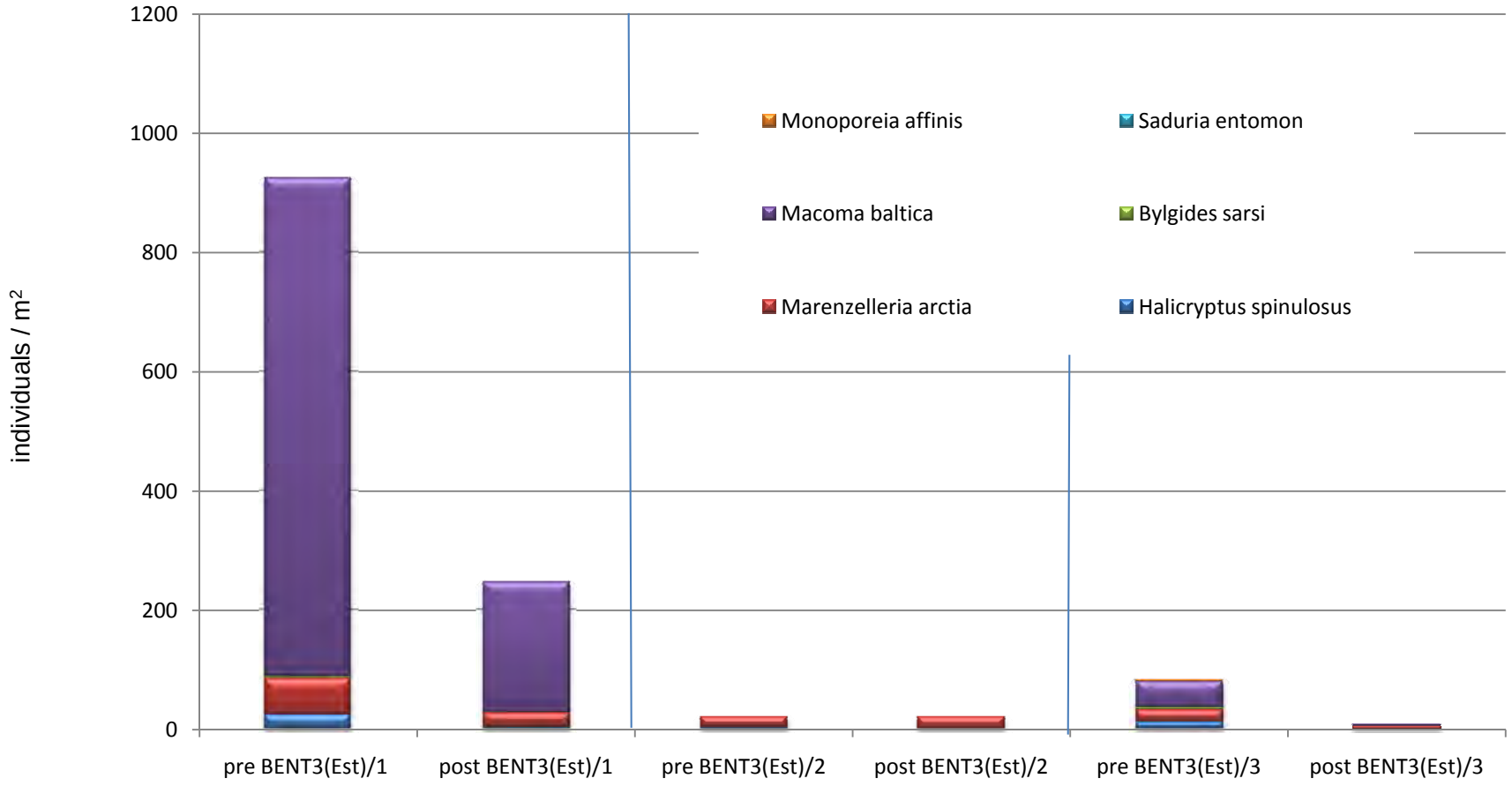


Figure 25. Species-specific abundances at BENT3 (Est) station.

Sediment samples showed a strong decrease in organic matter concentrations on SED3/1(Est) and SED3/2 (Est) locations in the post sampling phase. There was an increase in TBT values at all sampling locations in the post sampling phase while the concentrations of metals and dioxins were mostly of the same order of magnitude or smaller (See Attachment 6). However, the normalised TBT values remained below the Level 2 in all sites. The normalised dioxin concentrations of all samples were below the Level 1.

An increase in TBT values in the post sampling phase was also seen in the Finnish EEZ in samples taken from VOM3/SED3. Likewise in the sampling area in the Finnish EEZ, there are several shipping lanes crossing the monitoring area in the Estonian EEZ. The antifouling paints of vessels are therefore the probable origin of TBT.

Benthos sampling showed that the number of individuals and taxa were in general small at BENT3/2 (Est) and BENT3/3 (Est) locations. Only BENT3/1 (Est) location had higher amount of benthic animals in sediment.

At the site BENT3(Est)/1 and to some extent at BENT3(Est)/3, there was a strong decline in the abundance and the biomass when comparing the results for the samples taken prior to clearance with samples taken after the clearance.

Species that were found from the samples (*Macoma baltica, Bylgides sarsi* and *Saduria entomon)* indicate good seabed conditions. The decline has occurred especially within the *Macoma baltica* community and furthermore in small (<4 mm) and medium (4-10 mm) size classes. *Bylgides sarsi* and *Saduria entomon* have disappeared from the samples taken after the clearance at BENT3 (Est)/1 and BENT3 (Est)/3. Water mass right above sediment samples showed that oxygen level was not a restrictive factor at BENT3 (Est) sampling locations in Estonian EEZ. Oxygen levels varied from 3 to 6 mg/l. Main reason for the change in abundance of species and biomass after the clearance is the natural heterogeneity of seafloor.

3.4 VOM4 station

3.4.1 Real-time turbidity monitoring with automatic instrument

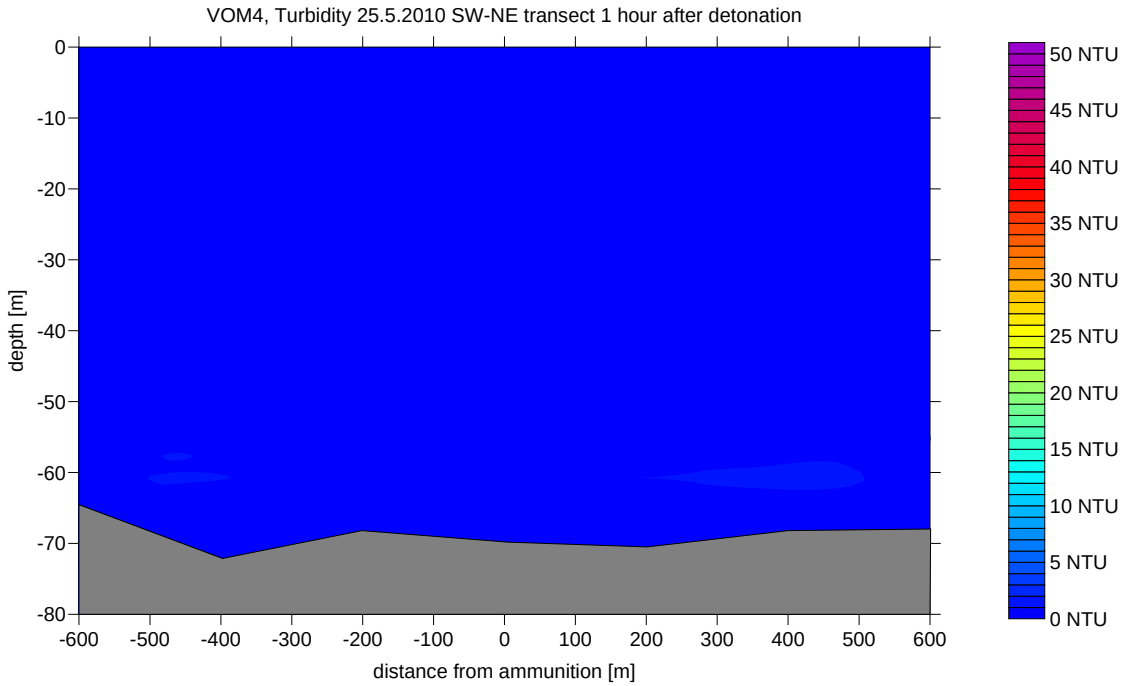


Figure 26. VOM4, vessel operated monitoring, first round, SW-NE, 25th May 2010.

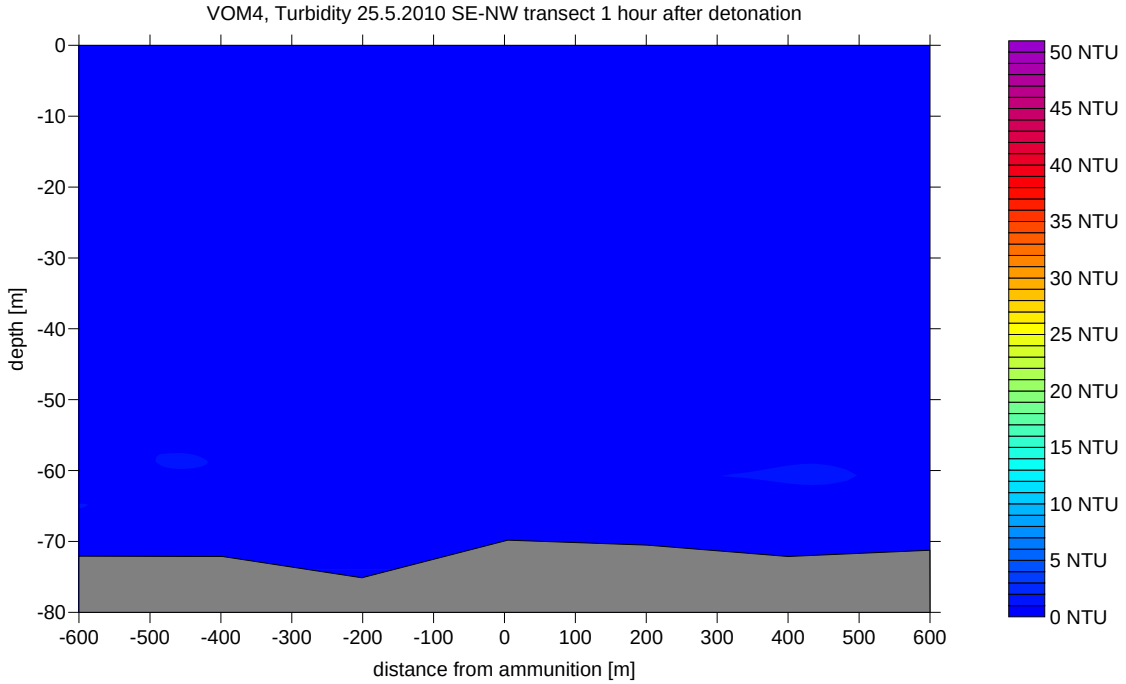


Figure 27. VOM4, vessel operated monitoring, first round, SE-NW, 25th May 2010.

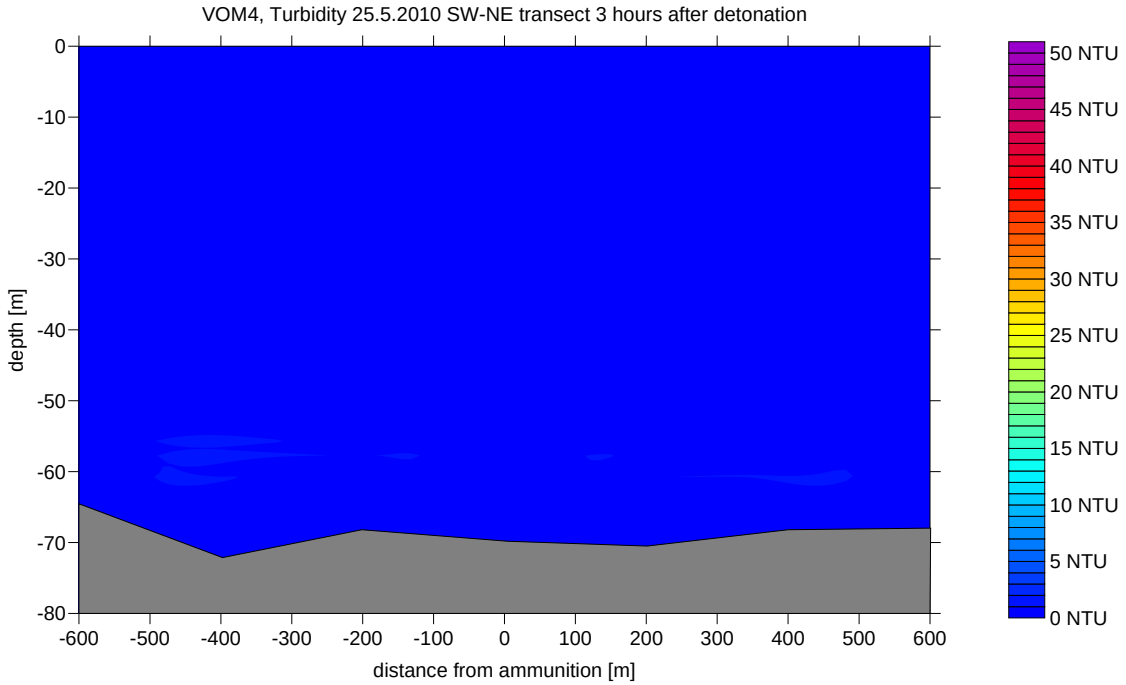


Figure 28. VOM4, vessel operated monitoring, second round, SW-NE, 25th May 2010.

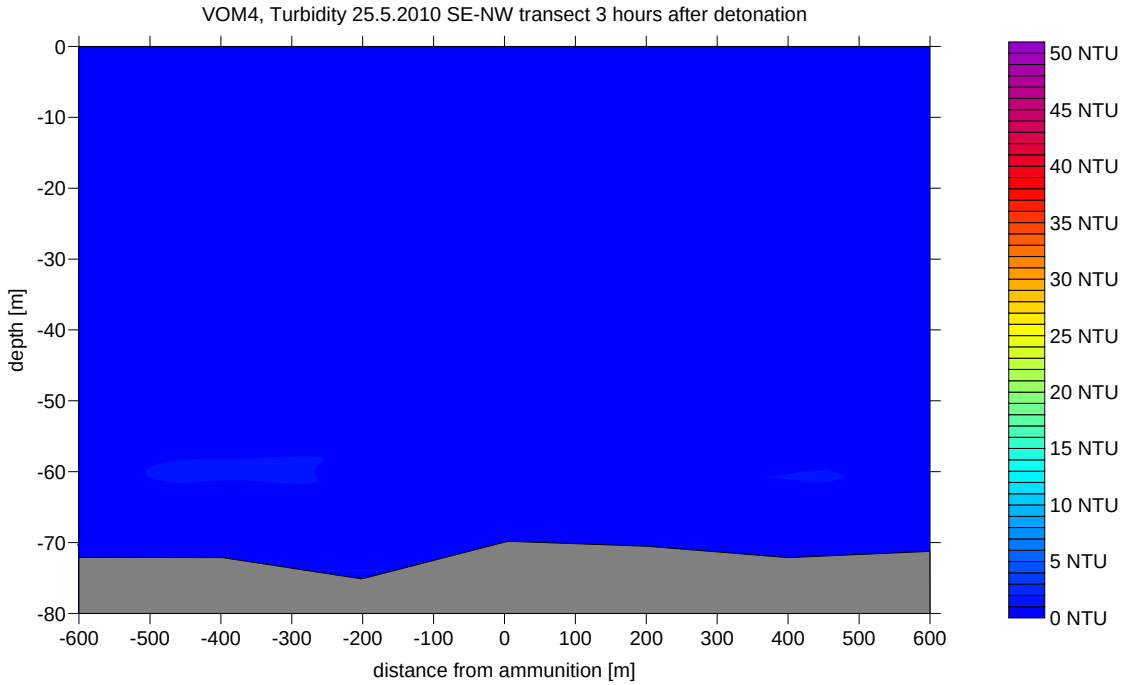


Figure 29. VOM4, vessel operated monitoring, second round, SE-NW, 25th May 2010.

3.4.2 Water sampling

Table 13. Laboratory results of the water samples taken during the vessel operated monitoring from VOM4 on 25.5.2010

Date	Site, sample depth	Cr	Cu	Hg	Co	Zn	Ni	Pb	Cd	As	Turbidity	Solid matter	dissolved oxygen	tot,N	NO3-N	NO2-N	NO23-N	NH4-N,M	tot,P	po4-p
		µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	FNU	mg/l	mg/l	µg/l	µg/l N	µg/l N	µg/l	µg/l	µg/l	µg/l
25.5.2010	10m background	<0,05	0,15	<0,002	0,08	0,67	0,63	<0,05	<0,01	0,72	0,6	2,9	21,9	320	<5	<2,5	<5	<7	22	5
25.5.2010	30m background	<0,05	<0,05	0,002	0,09	0,86	0,46	<0,05	<0,01	0,84	0,61	<1	12,0	310	53	<2,5	55	7	29	23
25.5.2010	50m background	<0,05	0,11	0,002	0,1	1	<0,05	<0,05	<0,01	0,85	0,32	<1	11,4	310	60	<2,5	63	<7	29	25
25.5.2010	70m background	<0,05	<0,05	<0,002	0,16	1,2	0,47	<0,05	<0,01	1,1	2,4	1,6	0,7	350	<5	2,7	<5	100	140	140
25.5.2010	1m	<0,05	0,16	<0,002	0,08	0,68	0,46	<0,05	<0,01	0,75	0,47	<1	12,7	280	<5	<2,5	<5	<7	19	6
25.5.2010	10m	<0,05	0,14	0,003	0,08	0,71	0,47	<0,05	<0,01	0,73	0,53	1,4	12,8	290	<5	<2,5	<5	<7	19	7
25.5.2010	20m	<0,05	0,09	0,002	0,09	0,82	0,46	<0,05	<0,01	0,78	0,34	2,7	12,0	270	<5	<2,5	6	<7	24	16
25.5.2010	30m	<0,05	0,07	<0,002	0,09	1,1	0,48	<0,05	<0,01	0,81	0,32	2,4	11,6	370	75	<2,5	78	8	34	29
25.5.2010	40m	<0,05	<0,05	<0,002	0,09	0,91	0,43	<0,05	<0,01	0,82	0,3	<1	11,4	330	66	2,5	69	<7	29	25
25.5.2010	50m	<0,05	<0,05	<0,002	0,1	0,98	0,44	<0,05	<0,01	0,86	0,7	1,3	10,7	310	70	<2,5	72	<7	31	27
25.5.2010	60m	<0,05	<0,05	0,003	0,1	1	0,43	<0,05	<0,01	0,9	0,56	3,3	7,7	320	82	<2,5	85	<7	51	50
25.5.2010	65m	0,24	<0,05	<0,002	0,12	1,2	0,5	<0,05	<0,01	0,97	0,98	3,5	3,0	330	87	<2,5	89	10	98	84

Turbidity units: Formazin Nephelometric Unit (FNU) is used for laboratory analyses while field instrument uses Nephelometric Turbidity Units (NTU). Values are typically comparable 1:1 for values <100 NTU/FNU.

Vessel operated monitoring showed low turbidity values at VOM4. Oxygen level was lower in the lowest 10 metres layer. Other concentrations were typical for the Gulf of Finland and prevailing season.

4. Conclusions

Vessel operated monitoring showed that turbidity levels remained low in all four sites after the munitions clearance operations. Only at site VOM1 some elevated turbidity values were recorded after the detonation, highest single values being still under 10 NTU, which is typically considered as a threshold value for visible turbidity. In addition sites VOM3 and VOM4 showed turbidity values of 1-3 NTU in very small area. These elevated values were recorded in the water mass located maximum 10-15 metres above the bottom. Some small turbidity clouds were seen also closer to surface but the recorded turbidity levels were normally less than 1 NTU higher than in surrounding waters. Vessel operated monitoring showed no increase in turbidity values after the disposal at VOM2.

Laboratory results of analysed water samples confirmed the observations of low turbidity values made during the vessel operated monitoring. Metal or nutrient concentrations of the water samples taken after the disposal showed no changes to the concentrations of the background samples. As described in the monitoring programmes, the plan was to generate a correlation between suspended matter concentration and turbidity units. Due to the fact that both turbidity and suspended matter values remained very low in all four monitoring sites, no reliable correlation could be made. Average suspended matter concentration calculated for all water samples was 2.4 mg/l and turbidity 0.7 FNU.

The concentrations of metals and dioxins in sediment mostly either decrease or are of the same order of magnitude in the samples taken after the munitions clearance when compared with the values for samples taken prior to clearance in a more or less random manner (See attachments 3-6). The main reason for found behaviour is the natural heterogeneity of sediments. The only exception was the concentration of TBT which showed a strong increase at VOM3 / SED3 and SED3(EST) stations and a smaller increase at VOM1 station. The samplings areas at SED 3 stations in the Finnish and Estonian EEZ are crossed by several shipping lanes and the probable origin of TBT are the antifouling paints of vessels.

The 95% confidence limits of the analysed concentrations of harmful substances are according to the laboratory reports between 8% and 25% depending on the substance. Practically all organic and inorganic harmful substances (such as heavy metals, dioxins, furans), as well as nutrients, are associated either to organic matter or fine mineral, mainly clay, particles. Therefore the physical properties of sediment and changes in water depth are the main reasons for natural variability seen on results. No statistically significant correlation could be found for concentration changes when plotted against the measured distance from ammunition. Considering this and the low turbidity levels monitored after the clearances, it is unlikely that these recorded changes are related to ammunition clearance activities.

Finnish Ministry of the Environment has published Instructions for Dredging and Depositing Dredged Materials. The publication gives instructions about how the normalised concentrations of heavy metals, organotins, dioxins and furans can be compared with natural levels in sediments. Concentrations that are under the Level 1 represent the normal background concentration in the aquatic environment. Concentrations that exceed Level 1 but remain under Level 2 represent slightly contaminated sediment. Concentrations that exceed Level 2 represent contaminated sediment. The following Table 14 shows the number of collected samples in which the normalised concentrations were above these limits. In total 60 samples were taken including all stations. The values are shown separately for samples taken prior to clearance (pre) and after the clearance (post).

Table 14. The number of sediment samples with values above Level 1 and Level 2 together with maximum values. Table is shown for normalised values.

Parameter	Unit	Level 1	Level 2	number of samples > Level 1		number of samples > Level 2		Total number of samples		Max concentration
Phase		limit value	limit value	*pre*	*post*	*pre*	*post*	*pre*	*post*	
Arsenic, As	mg/kg dw	15	60	2	3	0	0	30	30	52,9
Cadmium, Cd	mg/kg dw	0.5	2.5	9	8	0	0	30	30	1,3
Chromium, Cr	mg/kg dw	65	270	2	0	0	0	30	30	105,5
Copper, Cu	mg/kg dw	50	90	2	0	0	0	30	30	53,1
Mercury, Hg	mg/kg dw	0.1	1	2	0	0	0	30	30	0,2
Nickel, Ni	mg/kg dw	45	60	0	0	2	0	30	30	106,6
Lead, Pb	mg/kg dw	40	200	2	2	0	0	30	30	47,0
Zinc, Zn	mg/kg dw	170	500	2	0	0	0	30	30	260,5
Tributyltin, TBT	µg/kg dw	3	200	23	26	0	2	30	30	784,6
Dioxin and Furan	ng/kg dw	20	500	5	4	0	0	30	30	34,1

Based on the collected data the number of TBT samples that were above Level 1 increased by three and the number of TBT samples above Level 2 by two, when comparing the samples taken prior to and after munitions clearance. A probable cause of the relatively high TBT values is the presence of shipping lanes in the sampling areas. An average normalised TBT concentration rose from 24 to 75 µg/kg dw calculated for all sediment samples. The number of arsenic samples that were above Level 1 increased by one sample, when comparing the samples taken prior to and after munitions clearance.

Five dioxin and furan samples taken before and four samples taken after ammunition clearance operations exceed Level 1, an average dioxin and furan concentration being 7,6 ng/kg dw before and 7,3 ng/kg dw after ammunition clearance operations. Concentrations of chromium, copper, mercury and zinc exceeded Level 1 in two samples taken prior to ammunition clearance operations while none of the samples taken after ammunition clearance operations showed concentrations above Level 1 .

Benthos sampling showed that the bottom in Finnish EEZ at BENT3 station was practically lifeless. Some macrozoobenthos was recorded at BENT3/3 and BENT3/7 locations. Samples taken from BENT3/3 after the clearance showed a slight decrease in benthos abundance when compared with samples taken prior to clearance. At the site BENT3(Est)/1 and to some extent in BENT3(Est)/3, there was a strong decline in the abundance and the biomass when comparing the results for the samples taken prior to clearance with samples taken after the clearance. Seasonal variations cannot explain the observed changes, but the changes are most likely caused by the uneven distribution of the macrozoobenthos at bottom.

Spatial heterogeneity was indicated e.g. by the samples taken from BENT3 (Est)/2 location where the bottom was almost lifeless with little macrozoobenthos present. This location was situated only 900 m from BENT3 (Est)/1 and BENT3 (Est)/3 locations, where the amount of bottom animals was larger. The level of turbidity increase caused by ammunition clearance was so low that the changes in benthos results cannot be caused by the clearance work.

Heterogeneity of the bottom was also seen in large gradient on organic matter and dry matter concentrations analysed before and after ammunition clearance activities.

Based on the collected monitoring dataset from the Gulf of Finland, munitions clearance operations in all four monitored sites did not cause any significant changes in the water or sediment quality.

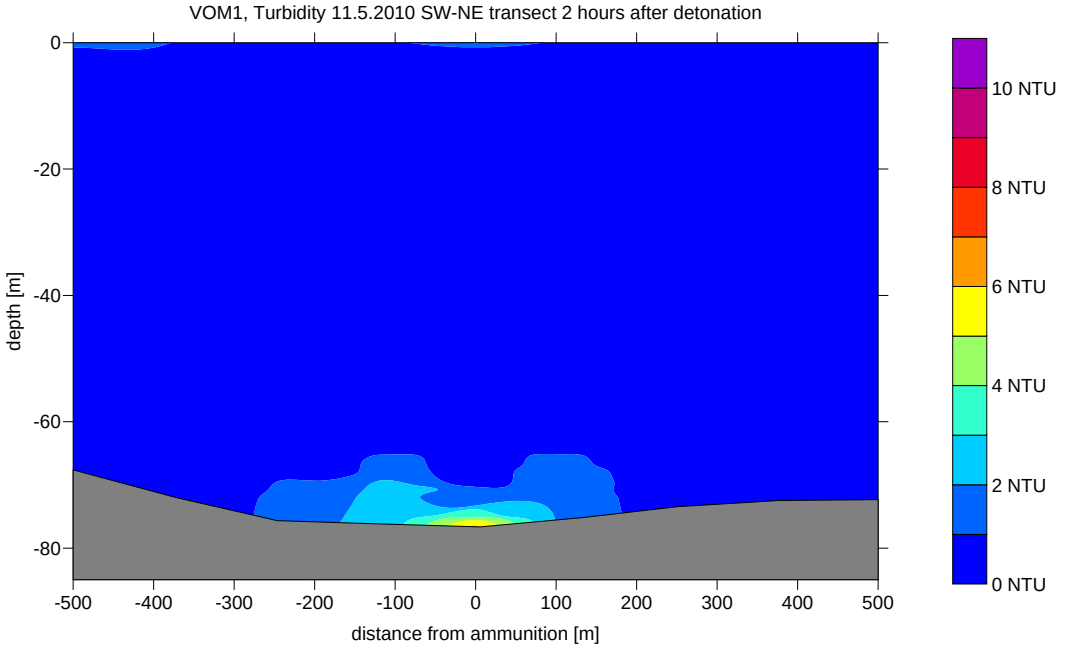
Changes seen in the number of benthos are likely to be caused by natural spatial and seasonal variability or changes in bottom close oxygen concentrations.

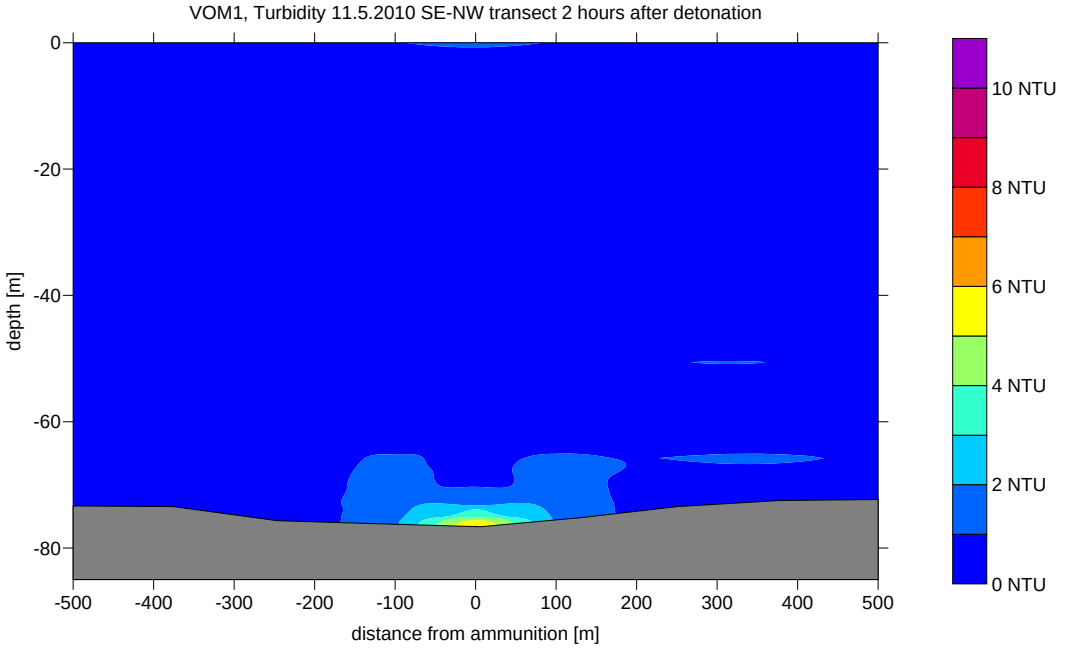
5. Attachments

Attachment 1. Parameters, ranges, resolution and accuracy of automatic probe.

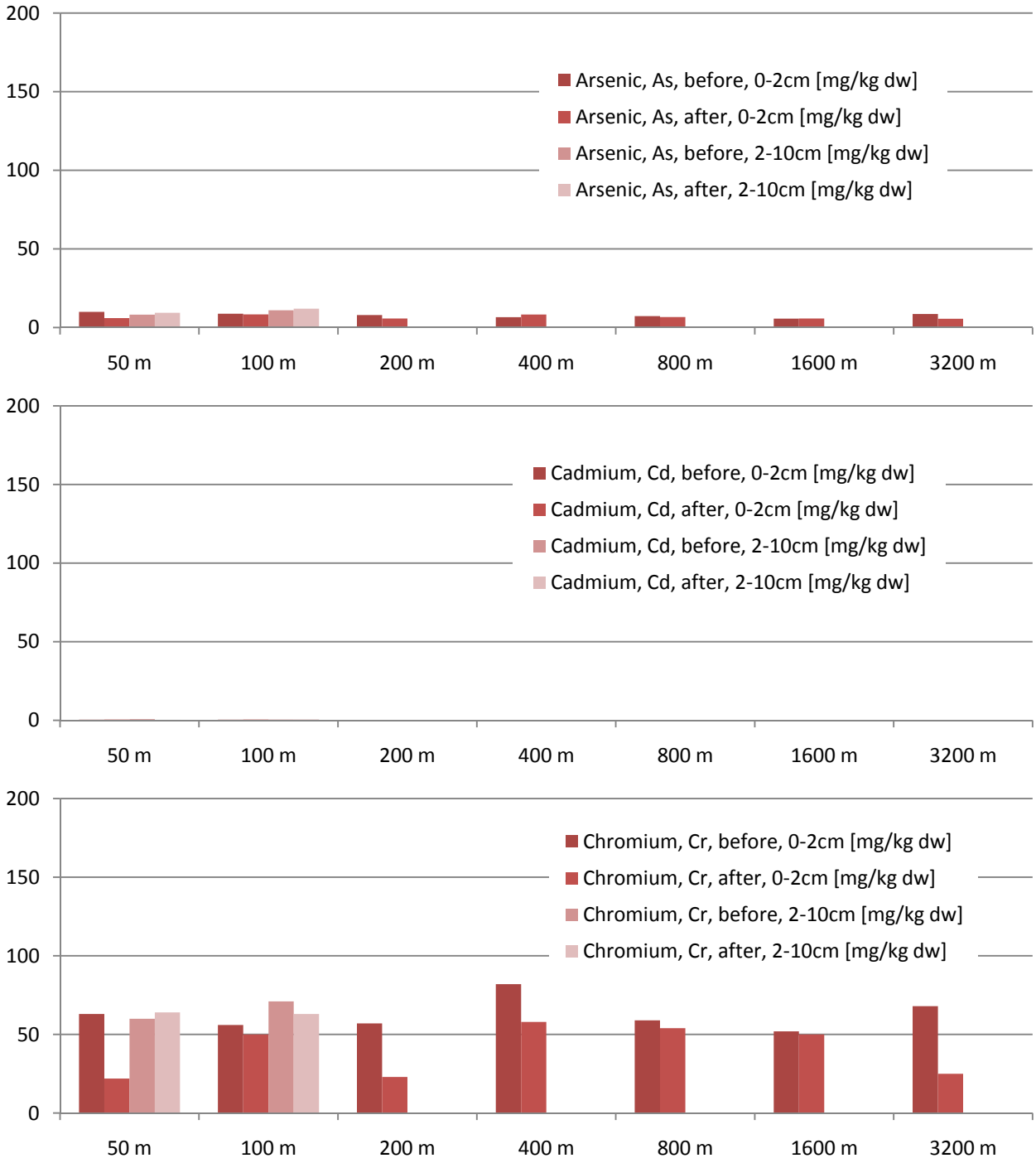
Parameter	Range	Resolution	Accuracy
Turbidity	0 – 1000 NTU	0.1 NTU	2% or 0.3 NTU
Salinity	0 – 70 ppt	0.01 ppt	1%
Conductivity	0 – 100 mS/cm	0.001 mS/cm – 0.1 mS/cm	0.5%
Temperature	-5 – +45°C	0.01°C	0.15°C

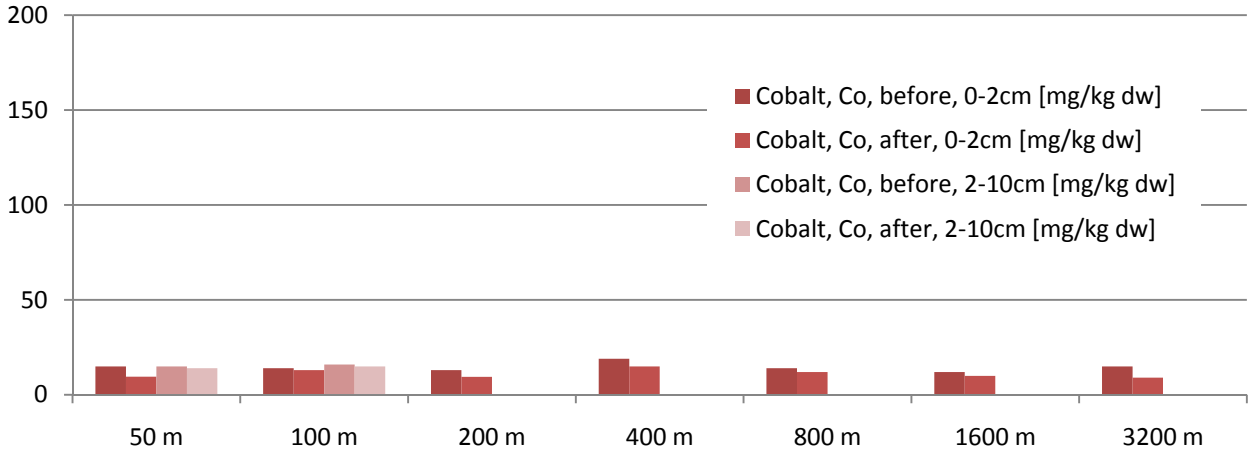
Attachment 2. Example of re-scaled turbidity transects results from site VOM1, 11th May 2010.

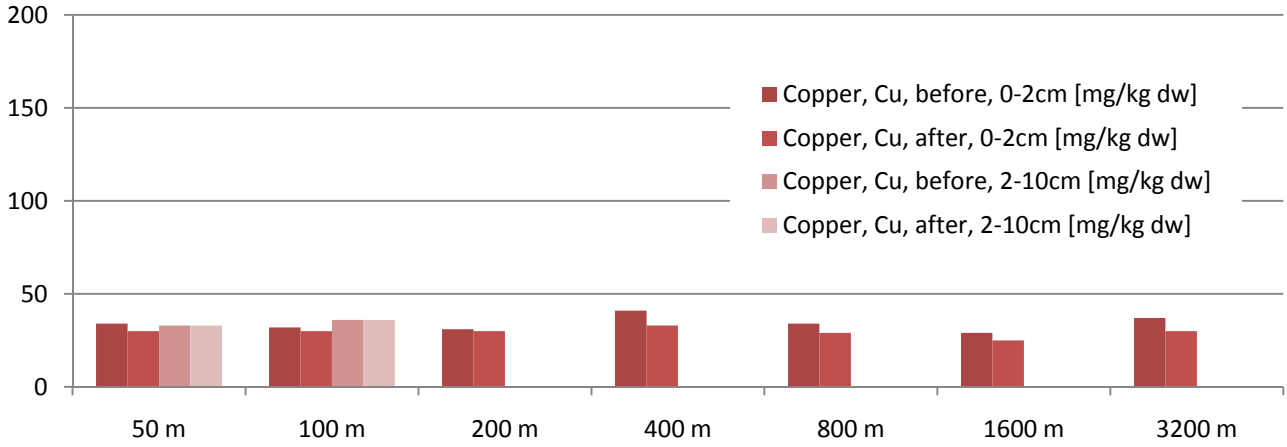


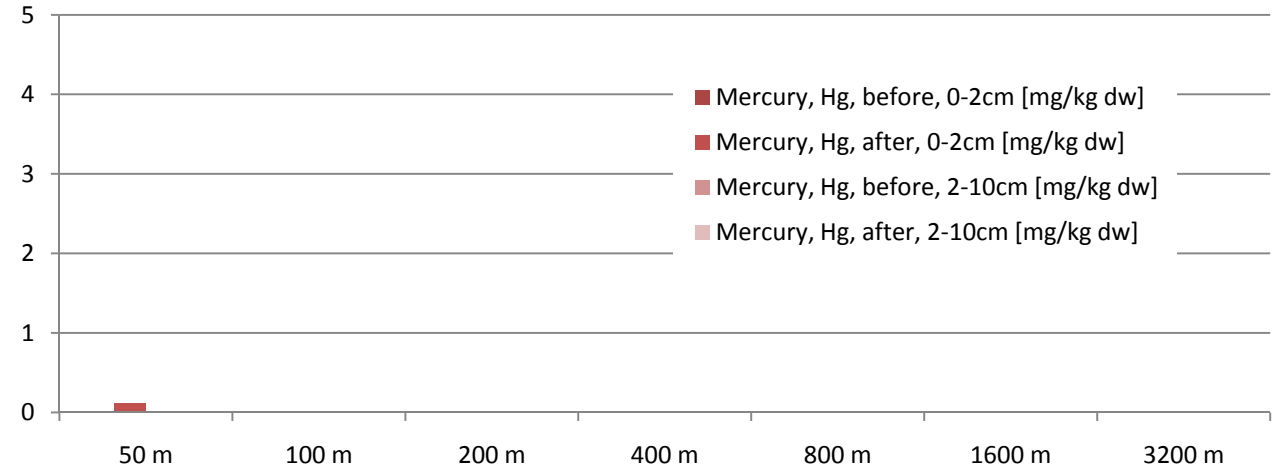


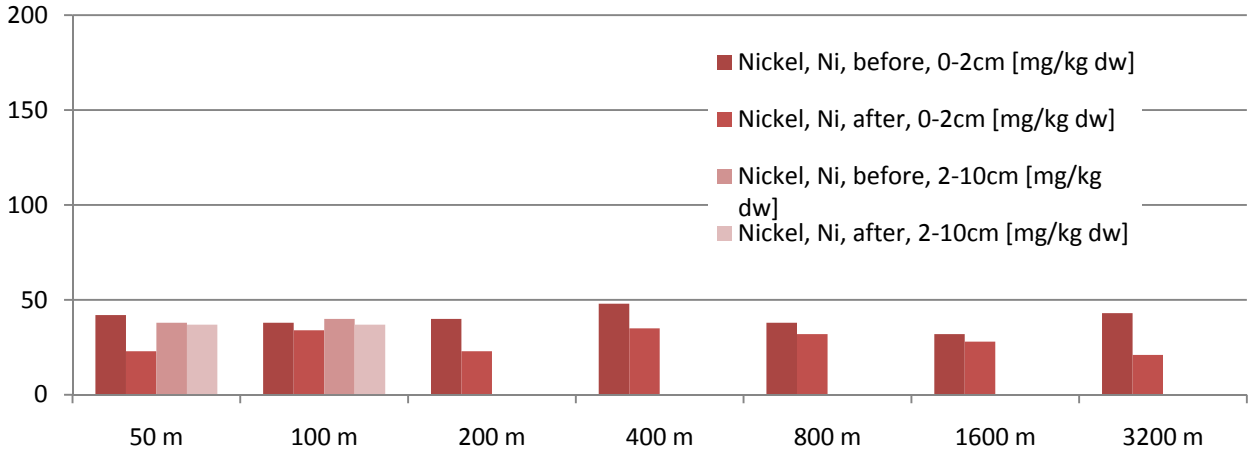
Attachment 3. Sediment analysis from VOM1 before and after ammunition clearance operations. All values are shown without normalisation. X-axis refers to location´s distance measured from the ammunition clearance site.

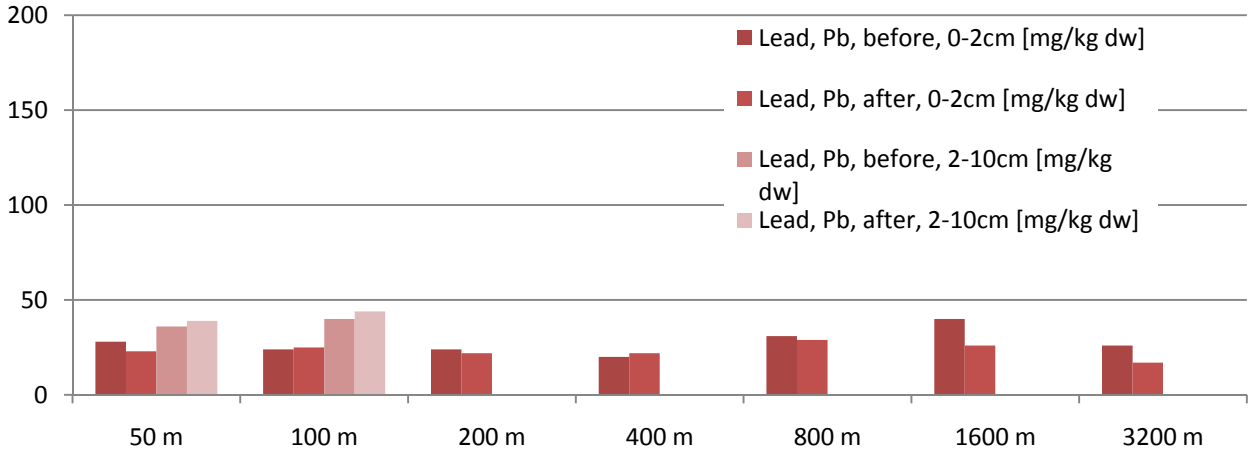


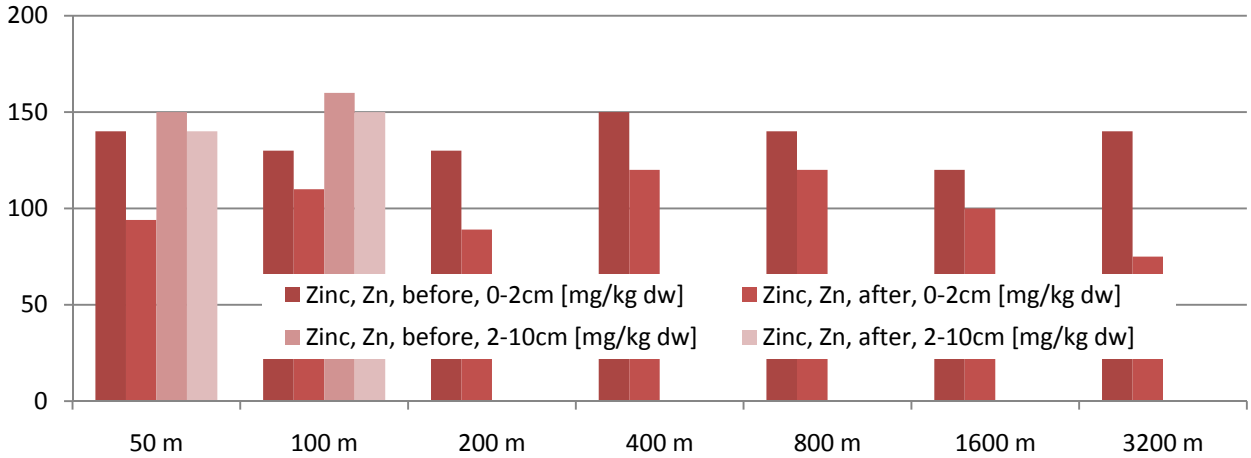

200
150
100
50
0
Cobalt, Co, before, 0-2cm [mg/kg dw]
Cobalt, Co, after, 0-2cm [mg/kg dw]
Cobalt, Co, before, 2-10cm [mg/kg dw]
Cobalt, Co, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

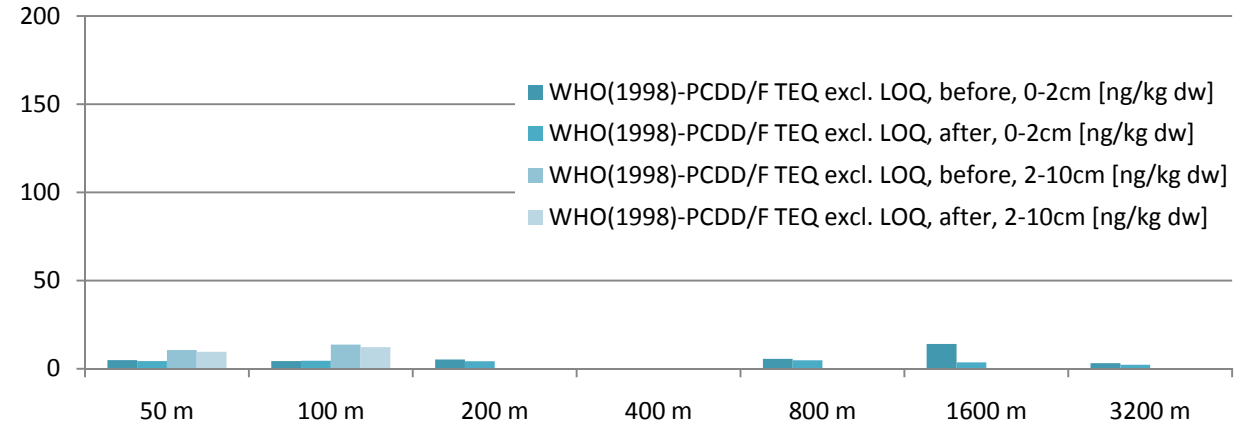

200
150
100
50
0
Copper, Cu, before, 0-2cm [mg/kg dw]
Copper, Cu, after, 0-2cm [mg/kg dw]
Copper, Cu, before, 2-10cm [mg/kg dw]
Copper, Cu, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

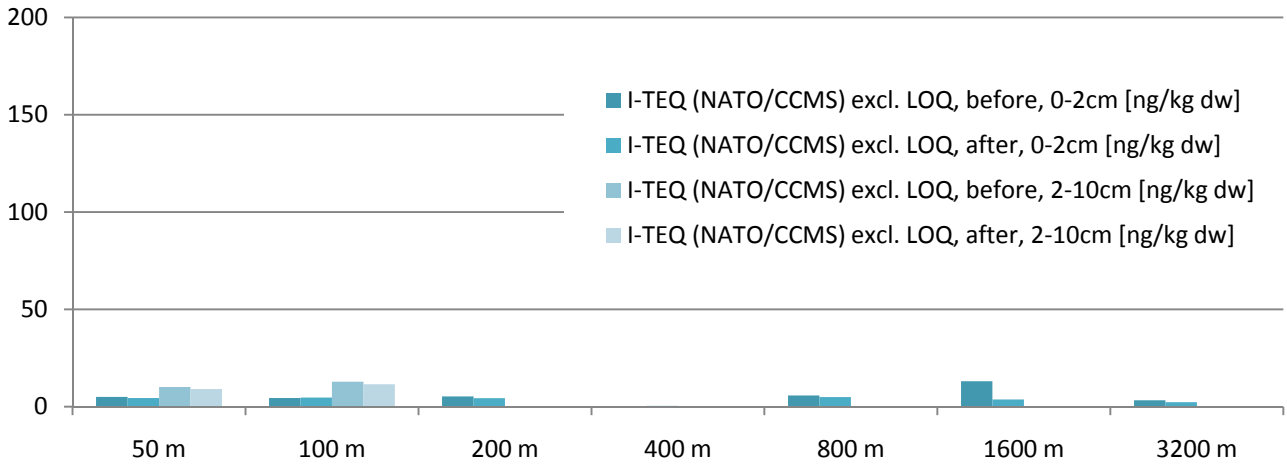

5
4
3
2
1
0
Mercury, Hg, before, 0-2cm [mg/kg dw]
Mercury, Hg, after, 0-2cm [mg/kg dw]
Mercury, Hg, before, 2-10cm [mg/kg dw]
Mercury, Hg, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

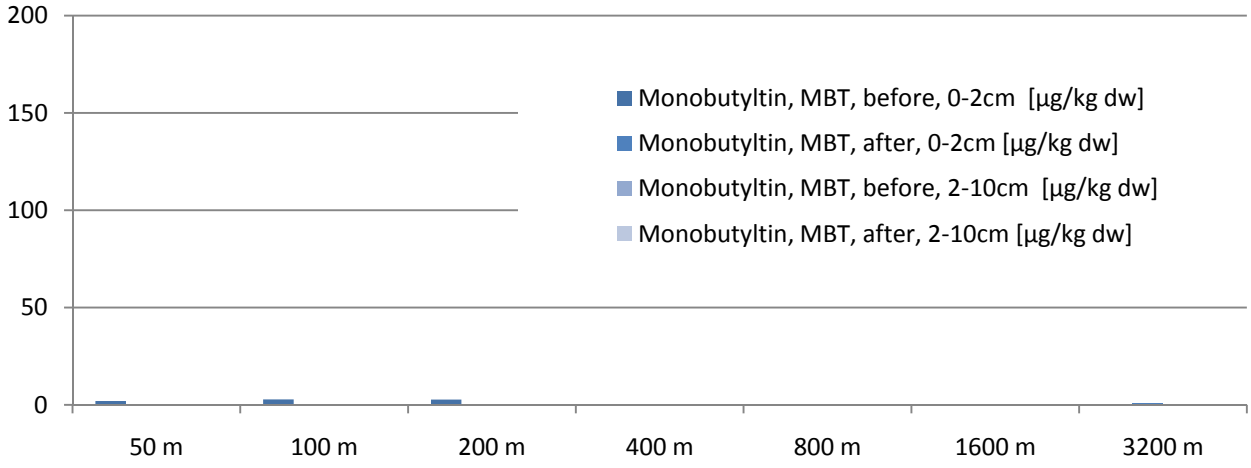

200
150
100
50
0
Nickel, Ni, before, 0-2cm [mg/kg dw]
Nickel, Ni, after, 0-2cm [mg/kg dw]
Nickel, Ni, before, 2-10cm [mg/kg dw]
Nickel, Ni, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

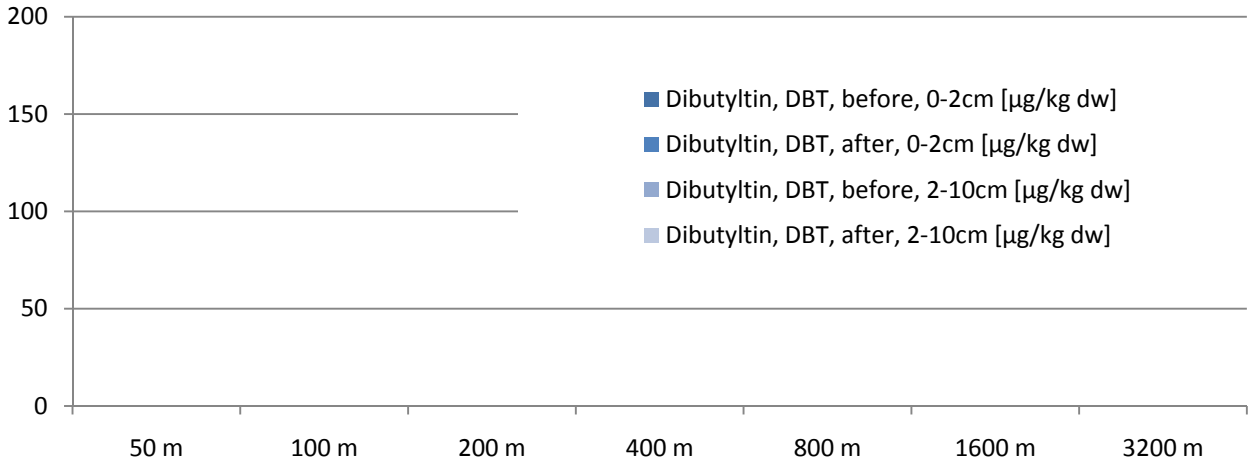

200
150
100
50
0
Lead, Pb, before, 0-2cm [mg/kg dw]
Lead, Pb, after, 0-2cm [mg/kg dw]
Lead, Pb, before, 2-10cm [mg/kg dw]
Lead, Pb, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

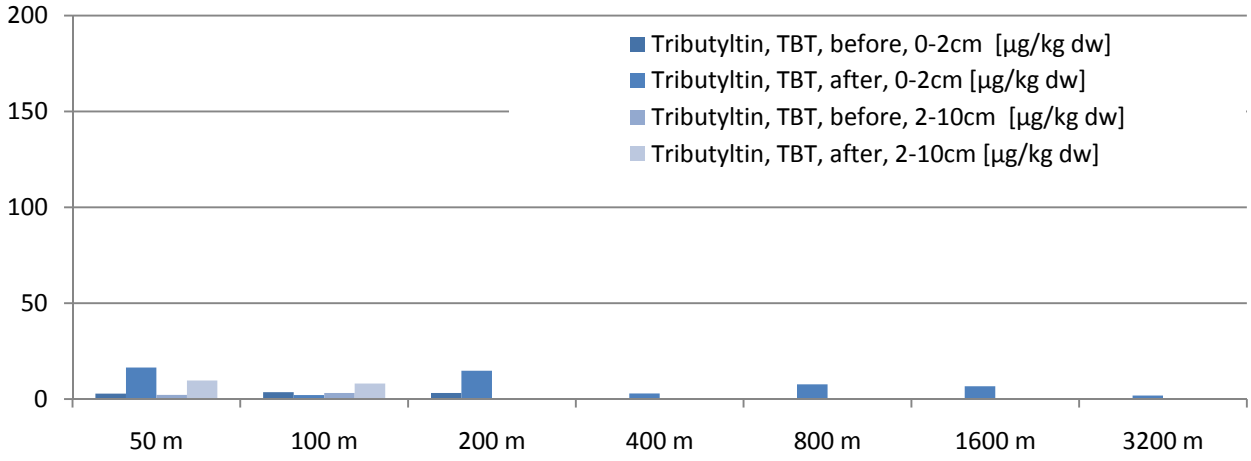

200
150
100
50
0
Zinc, Zn, before, 0-2cm [mg/kg dw]
Zinc, Zn, after, 0-2cm [mg/kg dw]
Zinc, Zn, before, 2-10cm [mg/kg dw]
Zinc, Zn, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

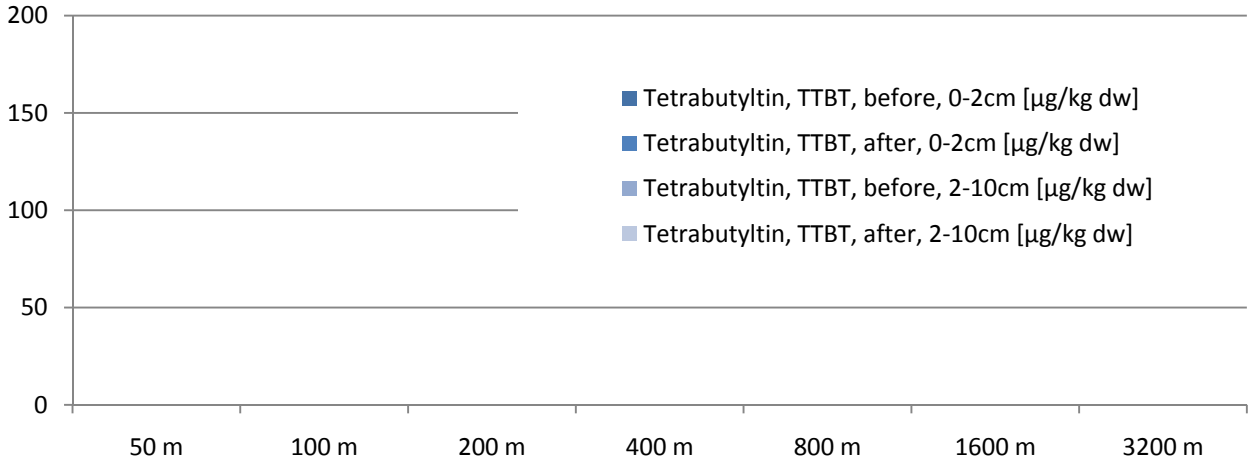

200
150
100
50
0
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 2-10cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

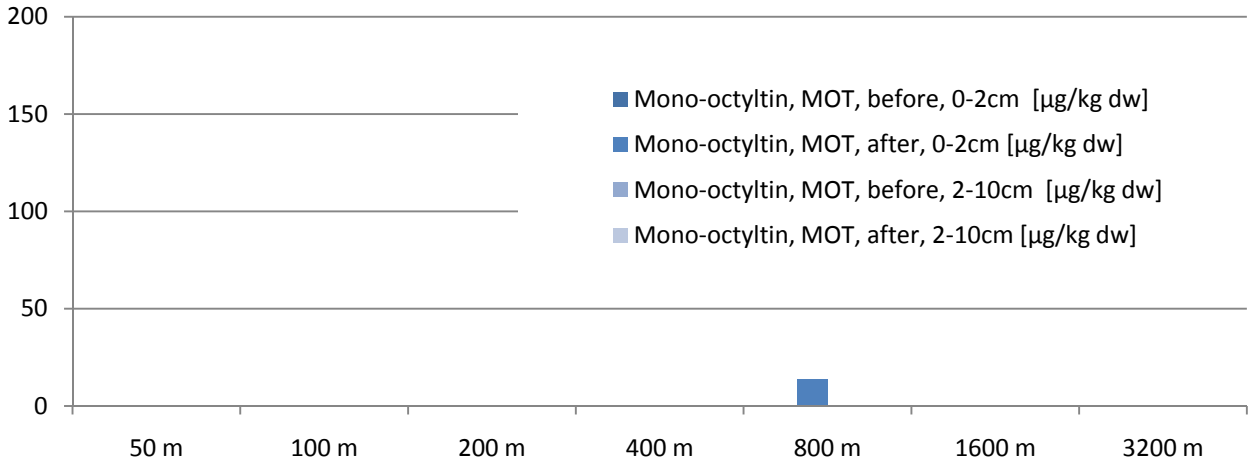

200
150
100
50
0
I-TEQ (NATO/CCMS) excl. LOQ, before, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, before, 2-10cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

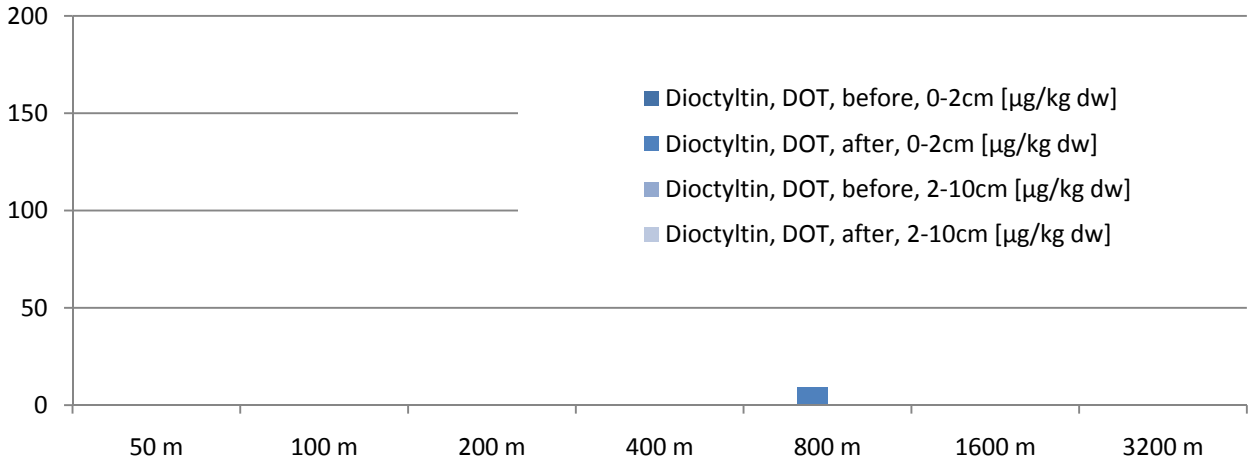

200
150
100
50
0
Monobutyltin, MBT, before, 0-2cm [µg/kg dw]
Monobutyltin, MBT, after, 0-2cm [µg/kg dw]
Monobutyltin, MBT, before, 2-10cm [µg/kg dw]
Monobutyltin, MBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

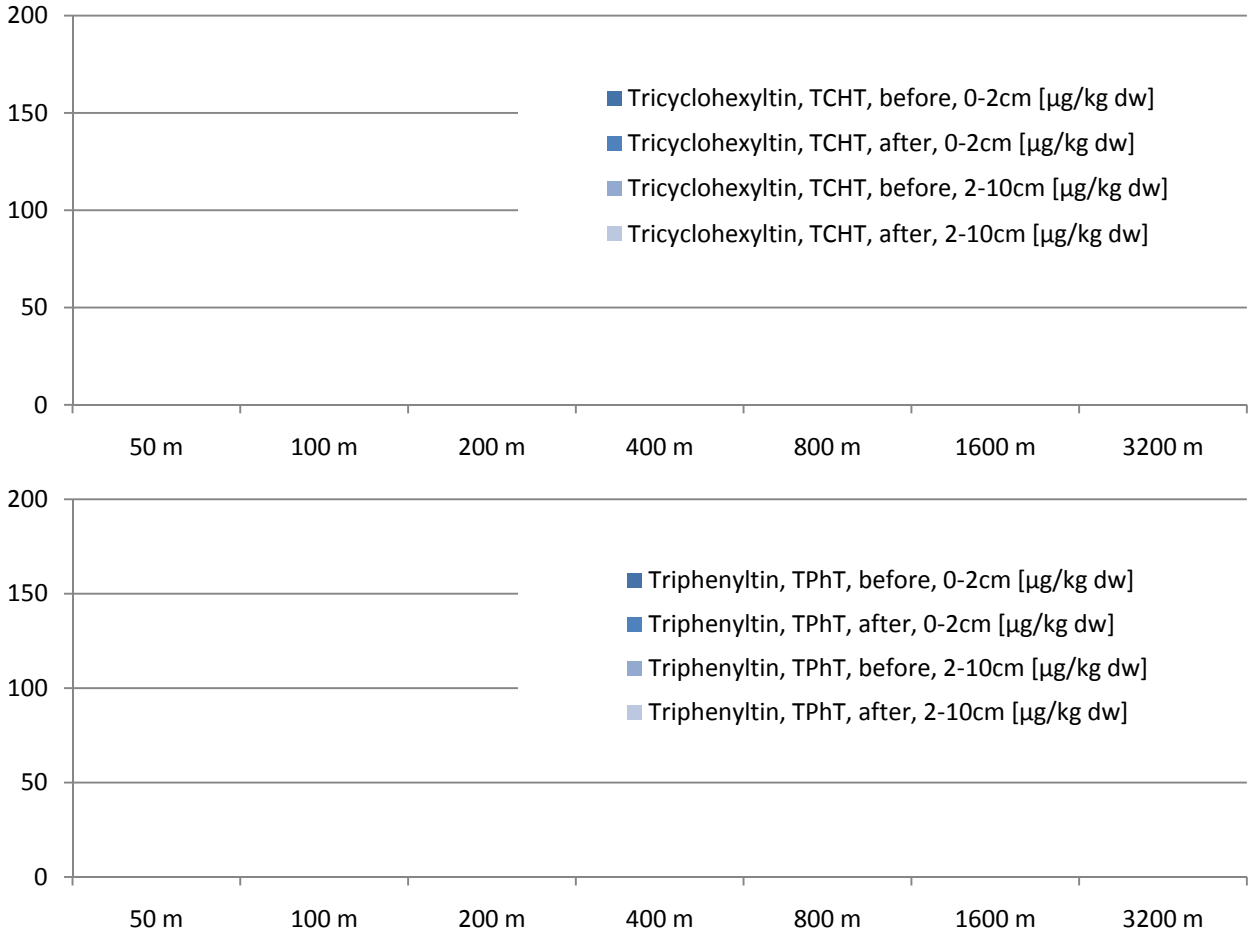

200
150
100
50
0
Dibutyltin, DBT, before, 0-2cm [µg/kg dw]
Dibutyltin, DBT, after, 0-2cm [µg/kg dw]
Dibutyltin, DBT, before, 2-10cm [µg/kg dw]
Dibutyltin, DBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Tributyltin, TBT, before, 0-2cm [µg/kg dw]
Tributyltin, TBT, after, 0-2cm [µg/kg dw]
Tributyltin, TBT, before, 2-10cm [µg/kg dw]
Tributyltin, TBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

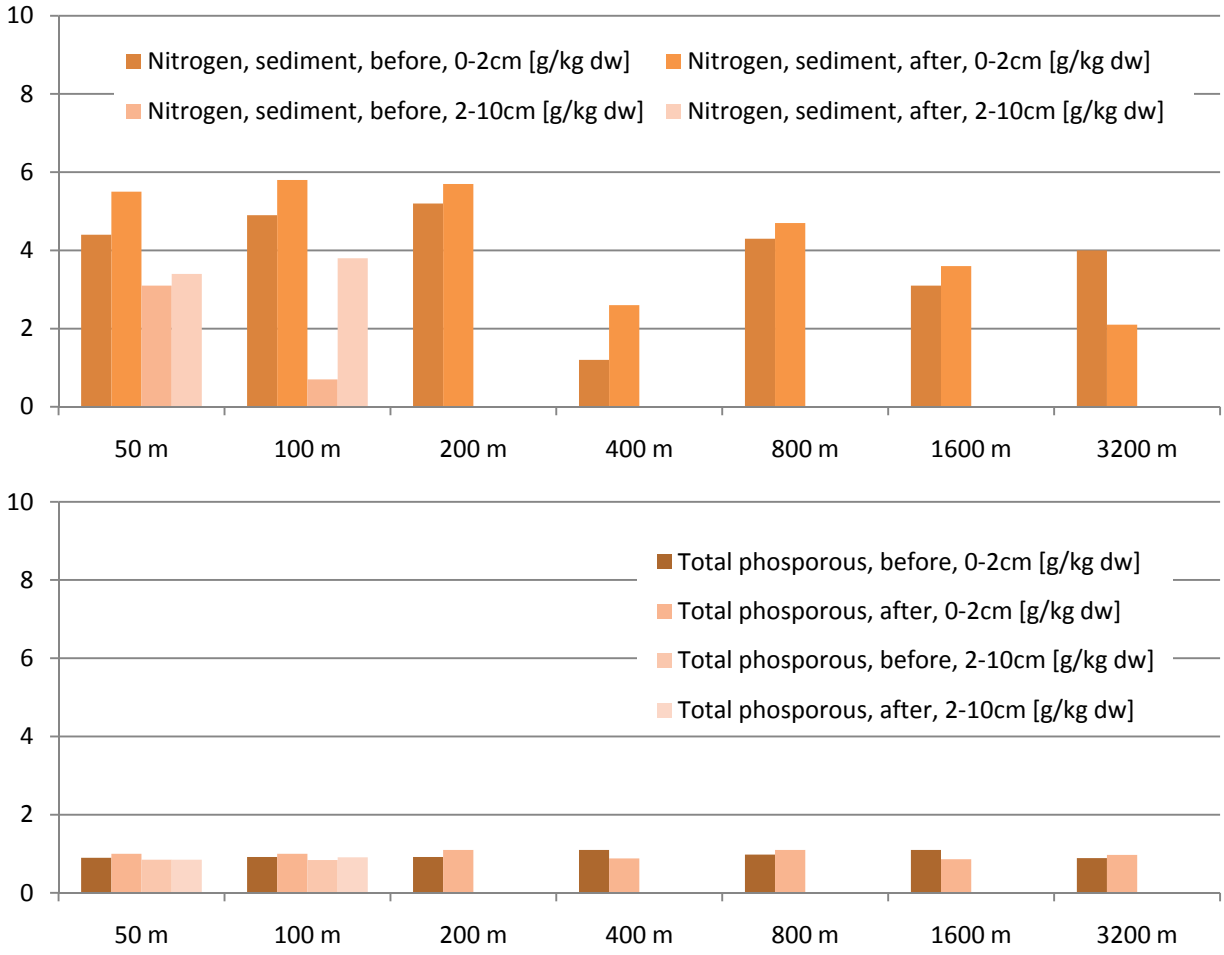

200
150
100
50
0
Tetrabutyltin, TTBT, before, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, before, 2-10cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Mono-octyltin, MOT, before, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, after, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, before, 2-10cm [µg/kg dw]
Mono-octyltin, MOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Dioctyltin, DOT, before, 0-2cm [µg/kg dw]
Dioctyltin, DOT, after, 0-2cm [µg/kg dw]
Dioctyltin, DOT, before, 2-10cm [µg/kg dw]
Dioctyltin, DOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

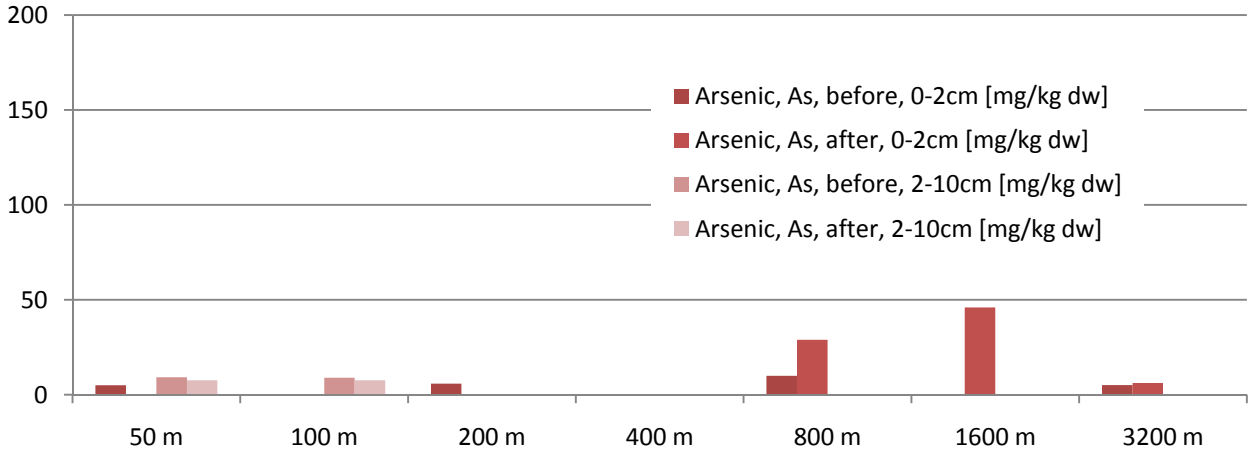

200
150
100
50
0
Tricyclohexyltin, TCHT, before, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, before, 2-10cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

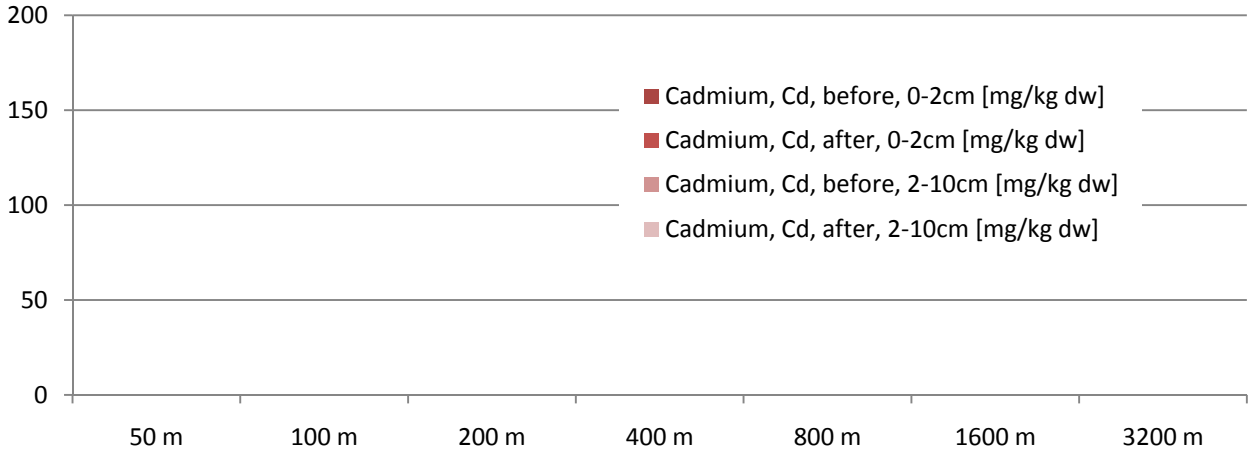
200
150
100
50
0
Triphenyltin, TPhT, before, 0-2cm [µg/kg dw]
Triphenyltin, TPhT, after, 0-2cm [µg/kg dw]
Triphenyltin, TPhT, before, 2-10cm [µg/kg dw]
Triphenyltin, TPhT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

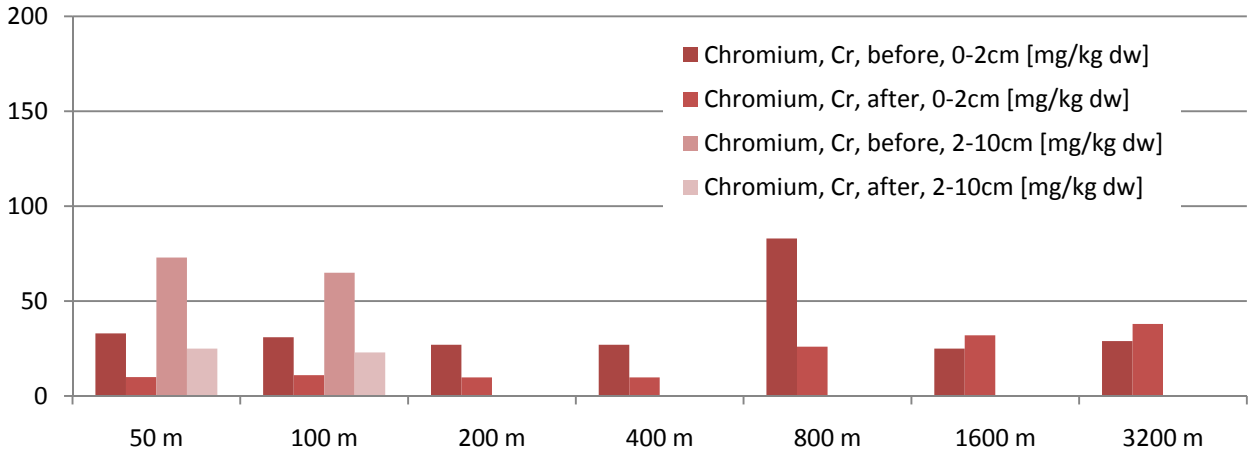

10
8
6
4
2
0
Nitrogen, sediment, before, 0-2cm [g/kg dw]
Nitrogen, sediment, after, 0-2cm [g/kg dw]
Nitrogen, sediment, before, 2-10cm [g/kg dw]
Nitrogen, sediment, after, 2-10cm [g/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

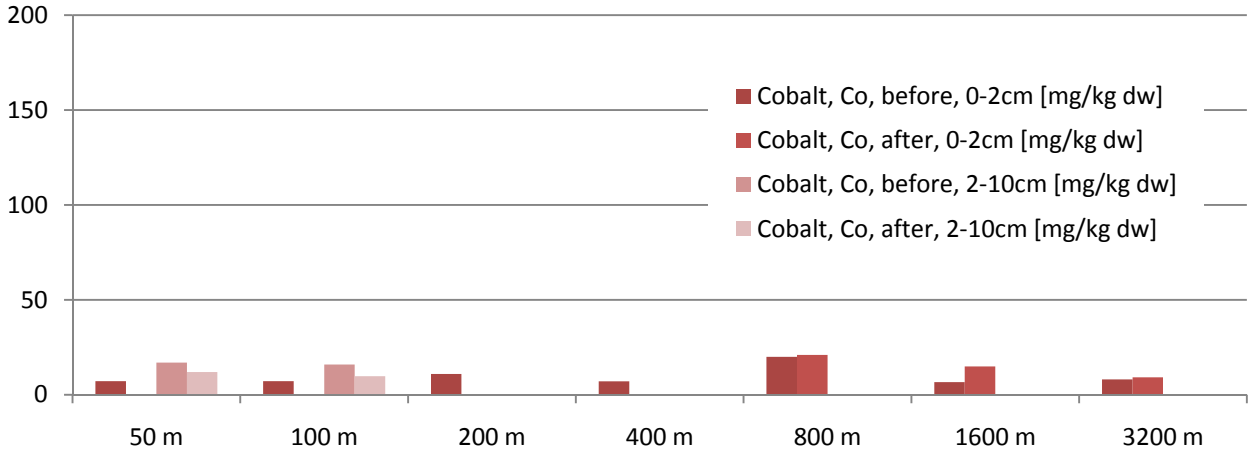
10
8
6
4
2
0
Total phosporous, before, 0-2cm [g/kg dw]
Total phosporous, after, 0-2cm [g/kg dw]
Total phosporous, before, 2-10cm [g/kg dw]
Total phosporous, after, 2-10cm [g/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

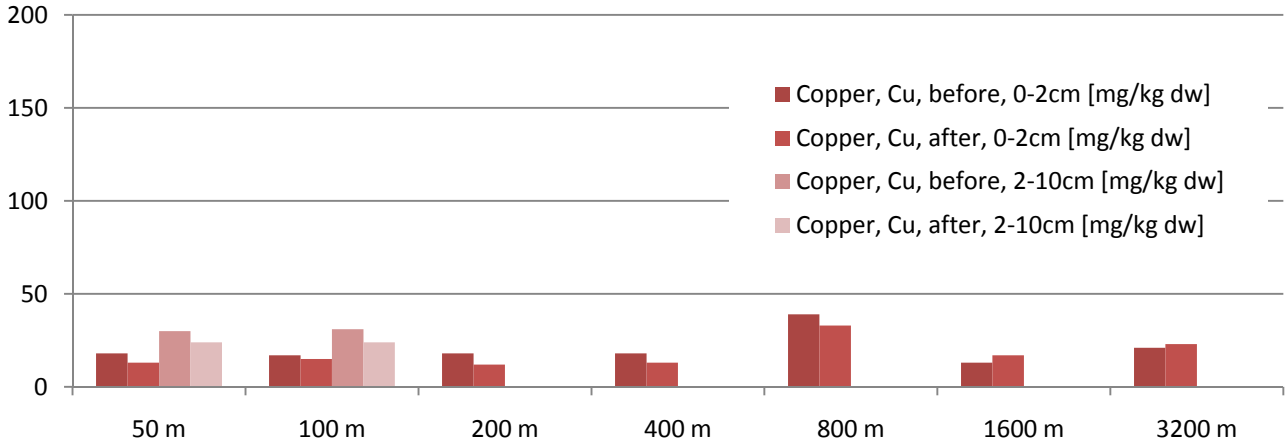
Attachment 4. Sediment analysis from VOM2 before and after ammunition clearance operations. All values are shown without normalisation. X-axis refers to location´s distance measured from the ammunition clearance site.

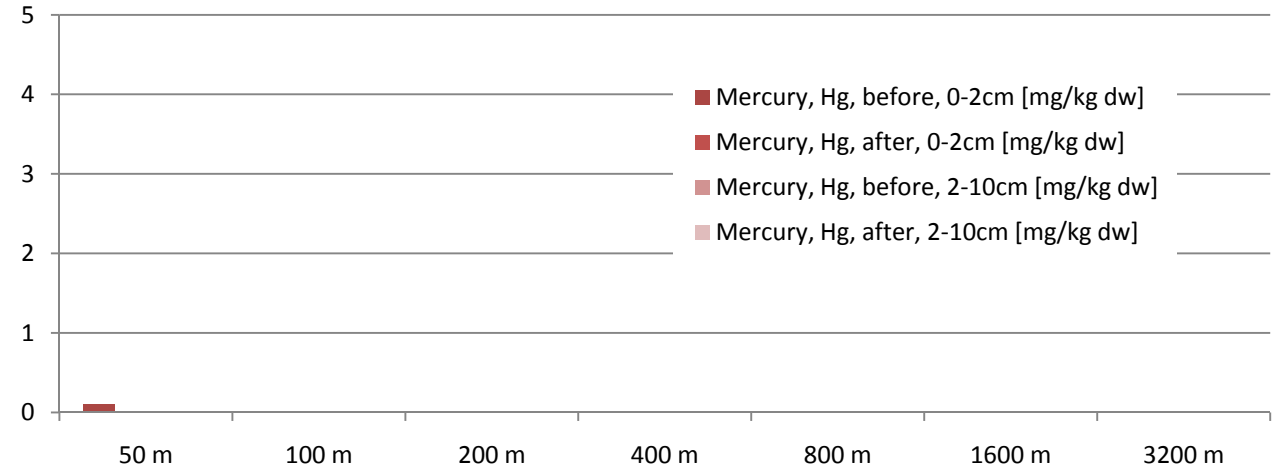


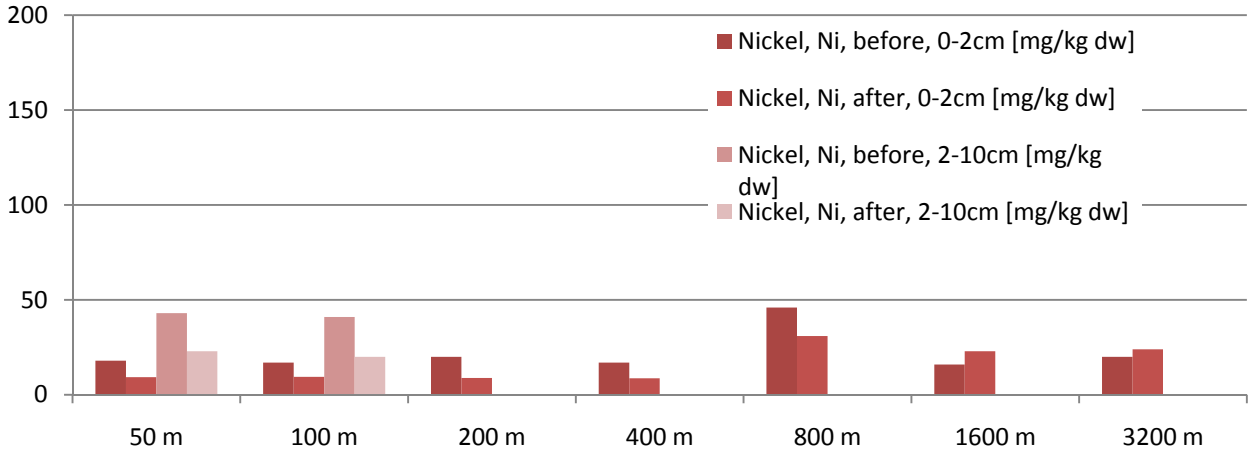


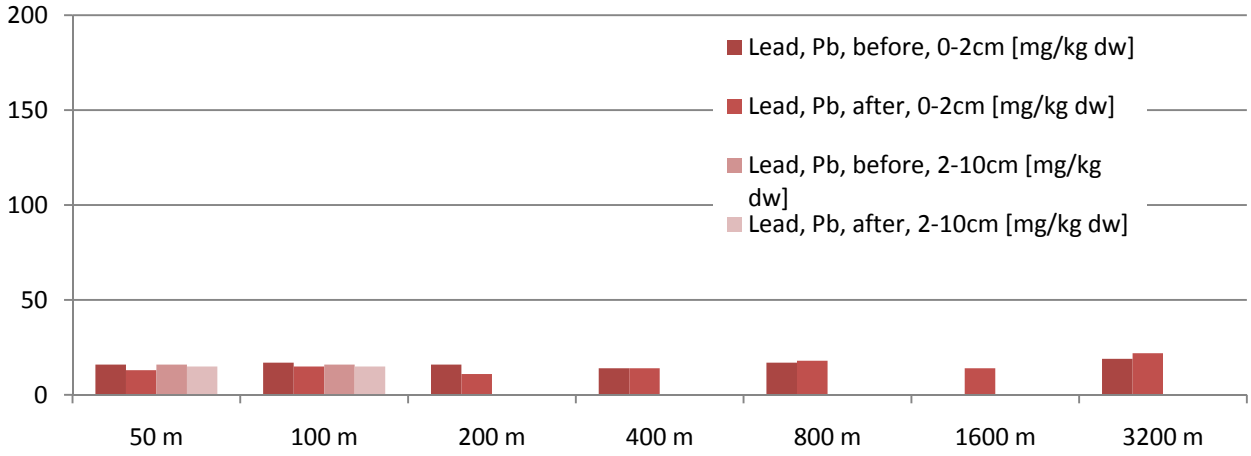


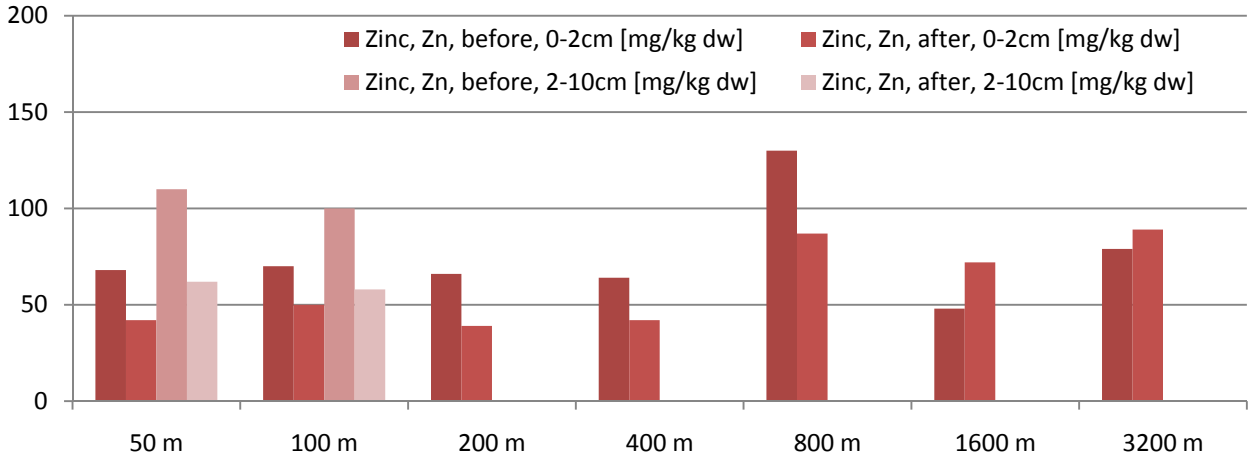

200
150
100
50
0
Cobalt, Co, before, 0-2cm [mg/kg dw]
Cobalt, Co, after, 0-2cm [mg/kg dw]
Cobalt, Co, before, 2-10cm [mg/kg dw]
Cobalt, Co, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

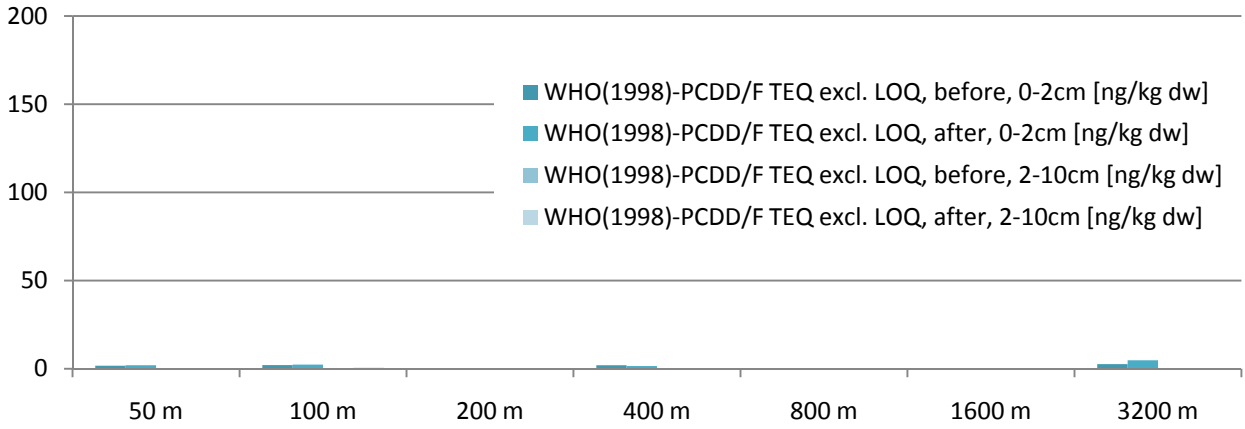

200
150
100
50
0
Copper, Cu, before, 0-2cm [mg/kg dw]
Copper, Cu, after, 0-2cm [mg/kg dw]
Copper, Cu, before, 2-10cm [mg/kg dw]
Copper, Cu, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

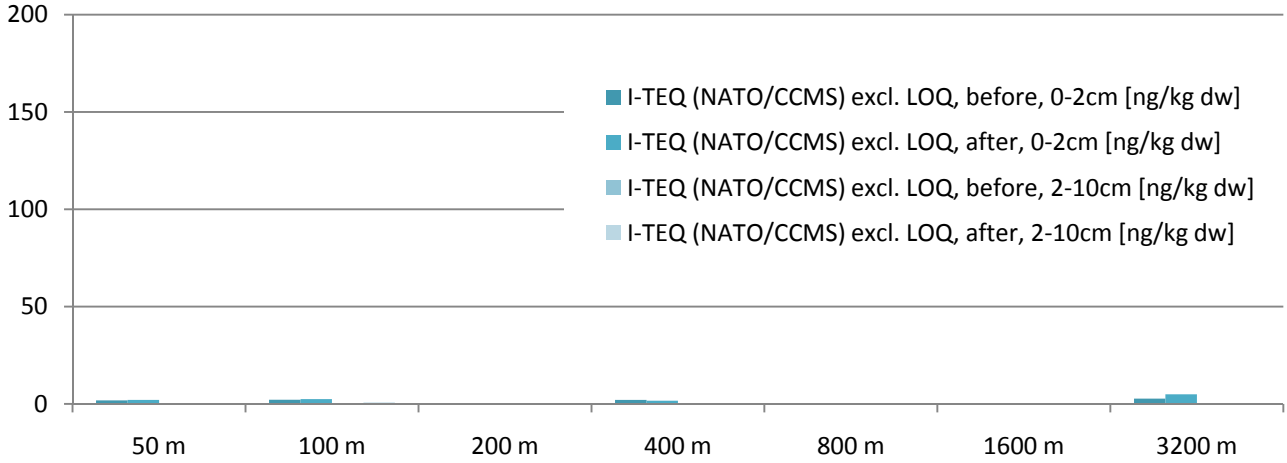

5
4
3
2
1
0
Mercury, Hg, before, 0-2cm [mg/kg dw]
Mercury, Hg, after, 0-2cm [mg/kg dw]
Mercury, Hg, before, 2-10cm [mg/kg dw]
Mercury, Hg, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

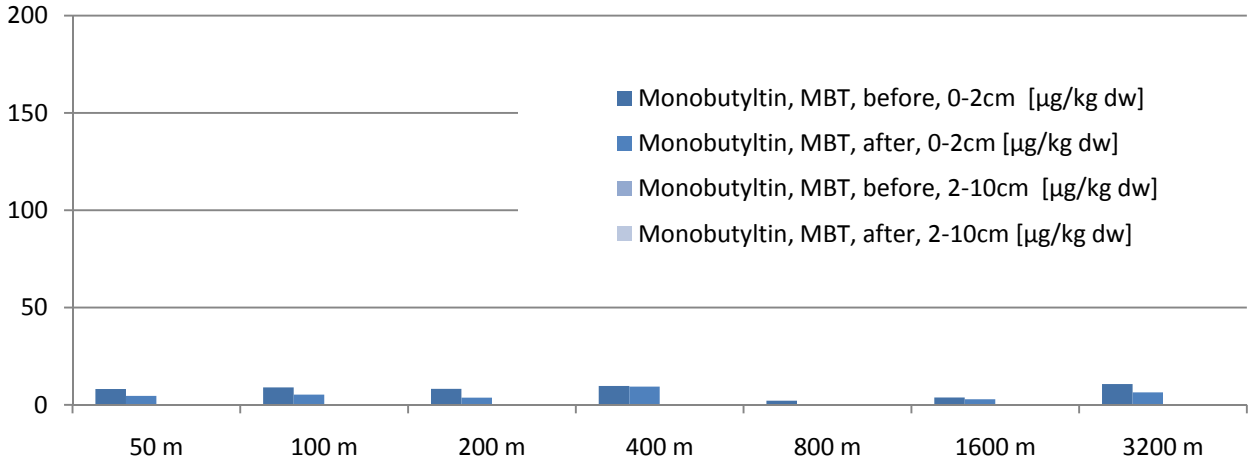

200
150
100
50
0
Nickel, Ni, before, 0-2cm [mg/kg dw]
Nickel, Ni, after, 0-2cm [mg/kg dw]
Nickel, Ni, before, 2-10cm [mg/kg dw]
Nickel, Ni, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

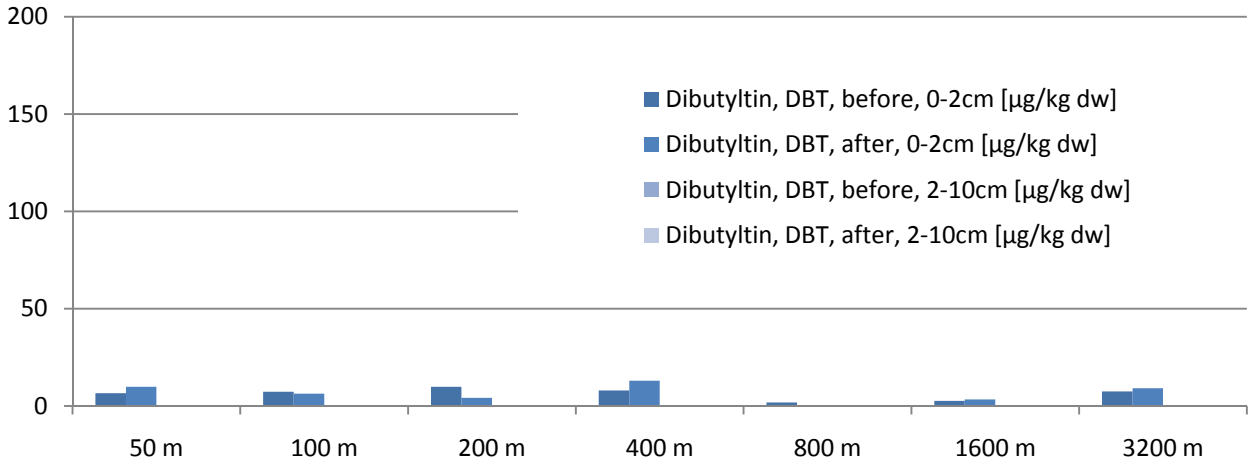

200
150
100
50
0
Lead, Pb, before, 0-2cm [mg/kg dw]
Lead, Pb, after, 0-2cm [mg/kg dw]
Lead, Pb, before, 2-10cm [mg/kg dw]
Lead, Pb, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

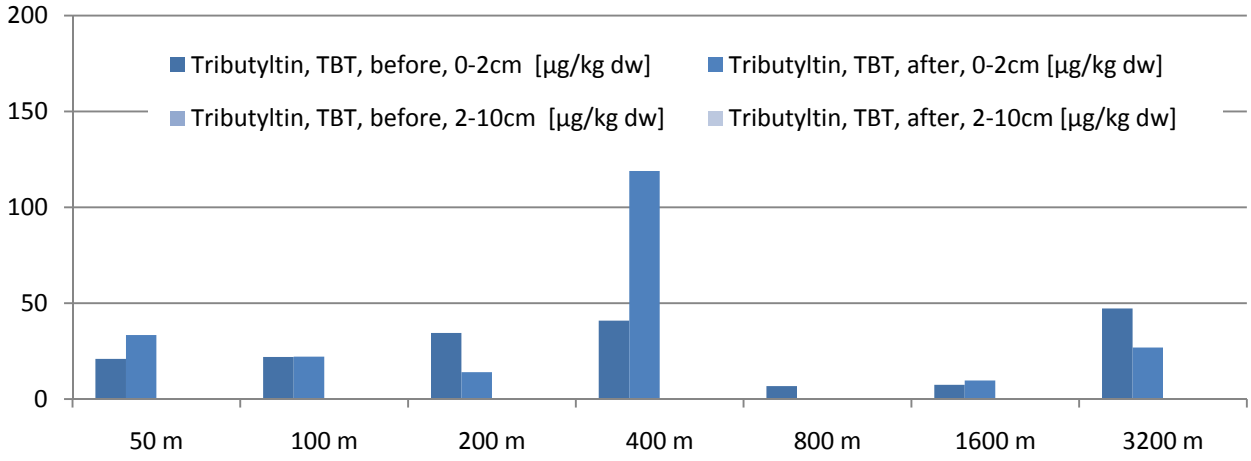

200
150
100
50
0
Zinc, Zn, before, 0-2cm [mg/kg dw]
Zinc, Zn, after, 0-2cm [mg/kg dw]
Zinc, Zn, before, 2-10cm [mg/kg dw]
Zinc, Zn, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

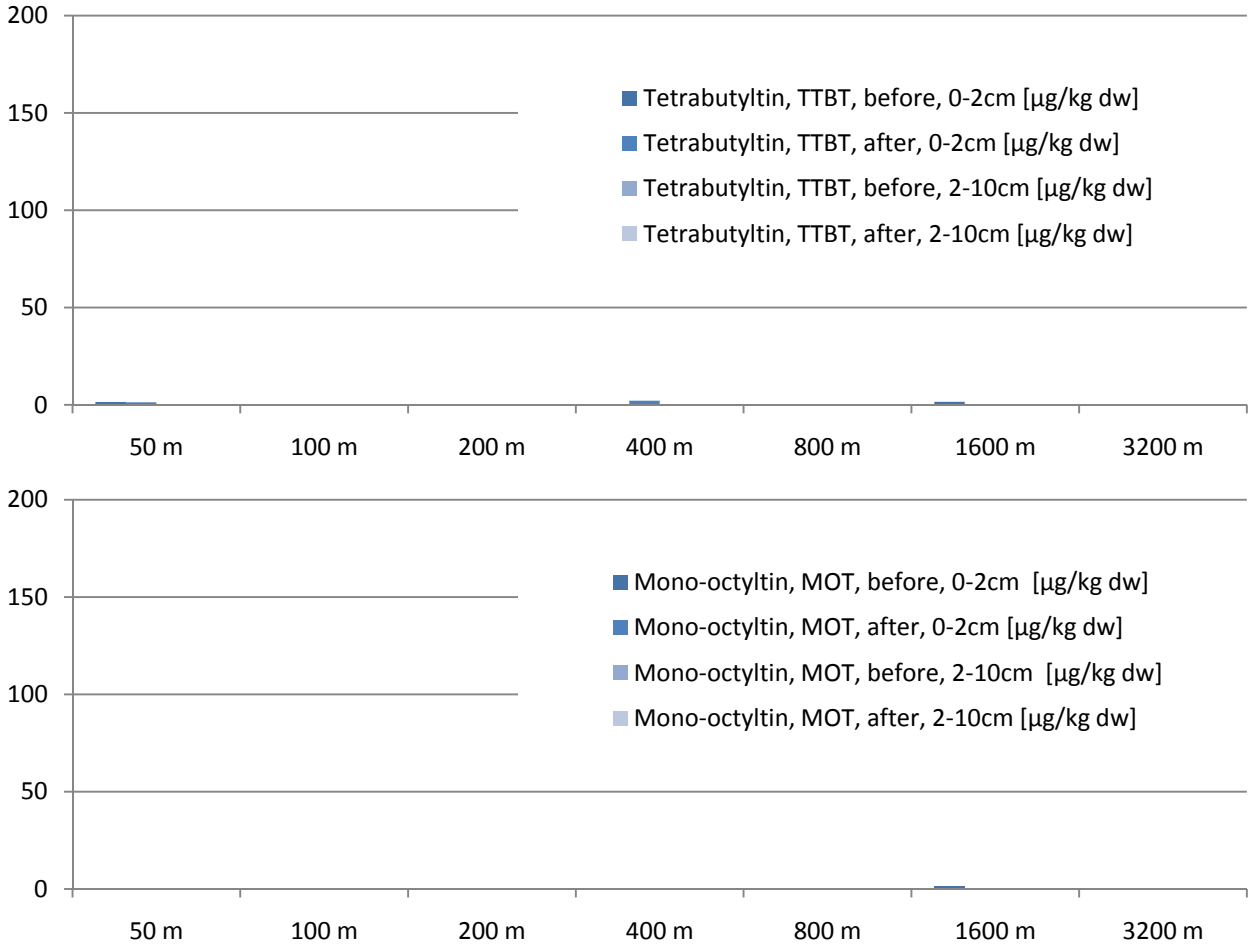

200
150
100
50
0
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 2-10cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
I-TEQ (NATO/CCMS) excl. LOQ, before, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, before, 2-10cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

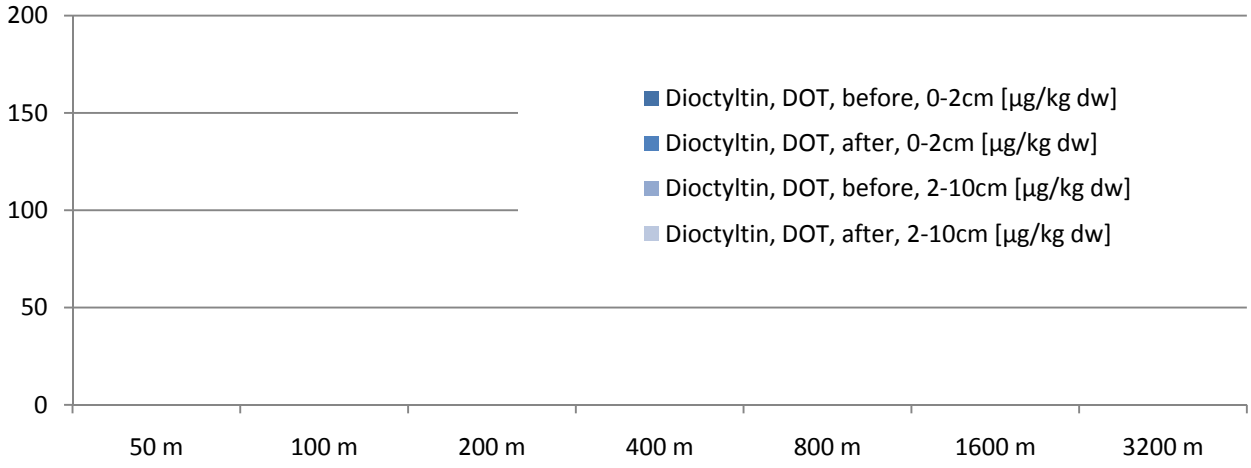

200
150
100
50
0
Monobutyltin, MBT, before, 0-2cm [µg/kg dw]
Monobutyltin, MBT, after, 0-2cm [µg/kg dw]
Monobutyltin, MBT, before, 2-10cm [µg/kg dw]
Monobutyltin, MBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

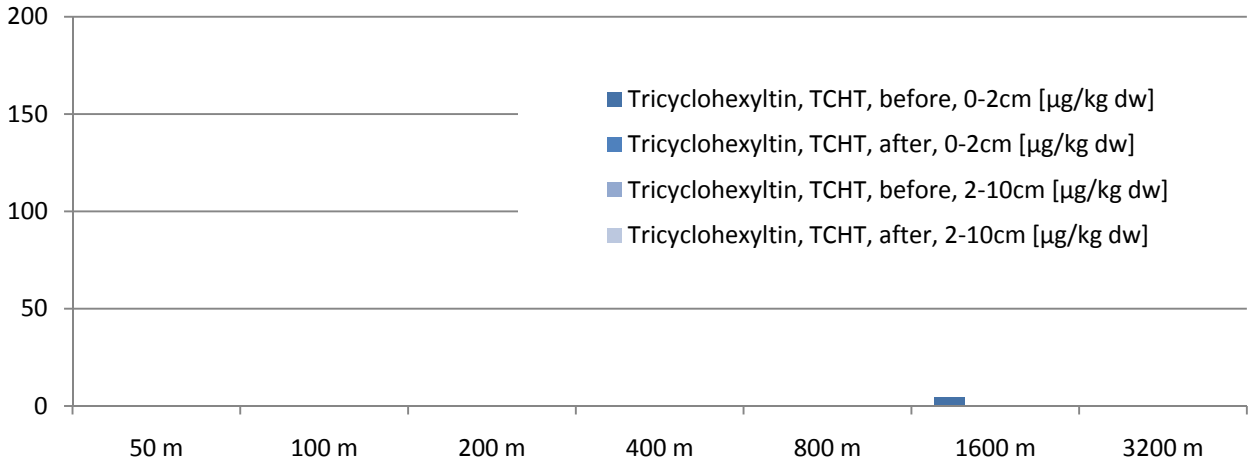

200
150
100
50
0
Dibutyltin, DBT, before, 0-2cm [µg/kg dw]
Dibutyltin, DBT, after, 0-2cm [µg/kg dw]
Dibutyltin, DBT, before, 2-10cm [µg/kg dw]
Dibutyltin, DBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Tributyltin, TBT, before, 0-2cm [µg/kg dw]
Tributyltin, TBT, after, 0-2cm [µg/kg dw]
Tributyltin, TBT, before, 2-10cm [µg/kg dw]
Tributyltin, TBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

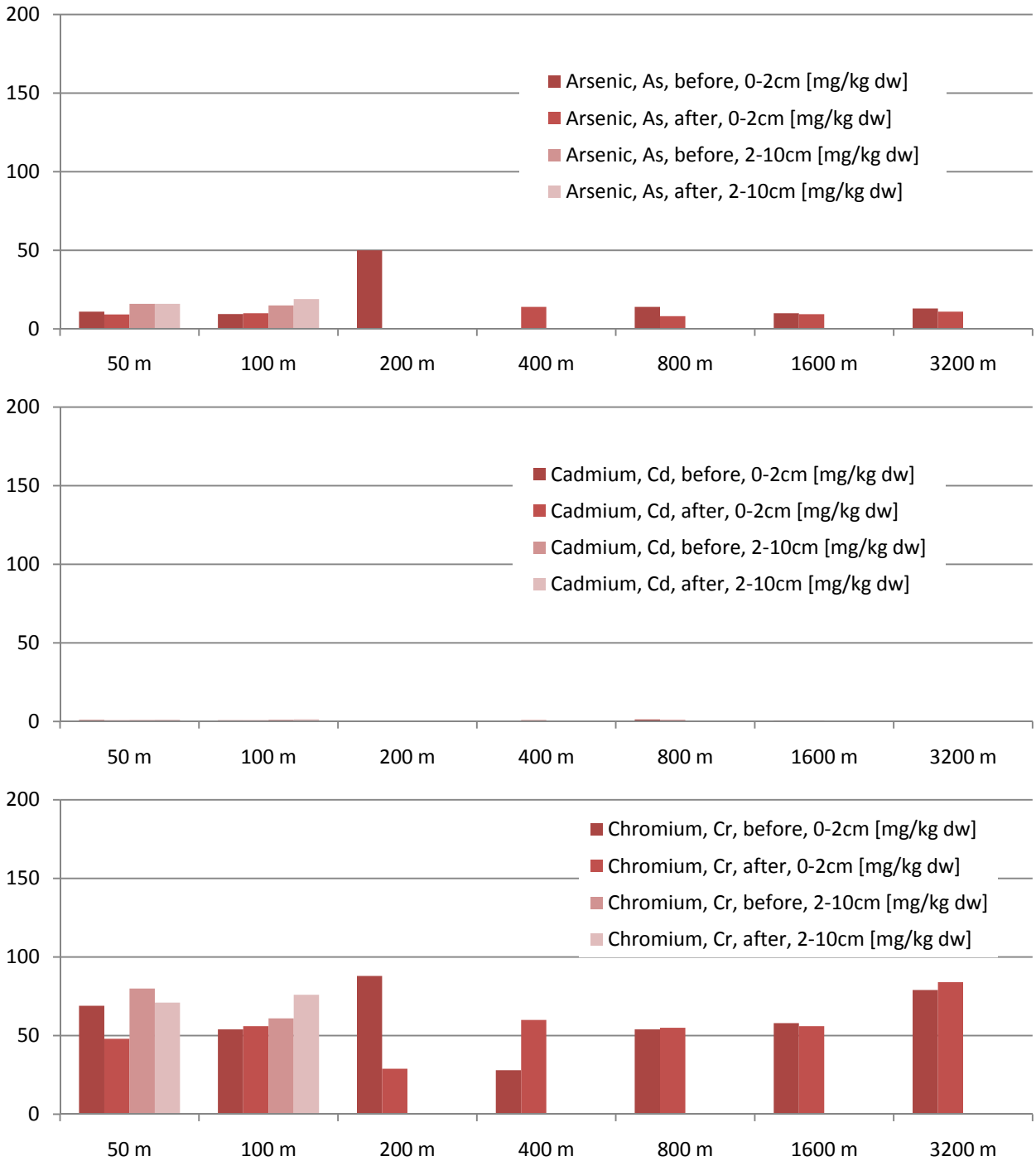

200
150
100
50
0
Tetrabutyltin, TTBT, before, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, before, 2-10cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

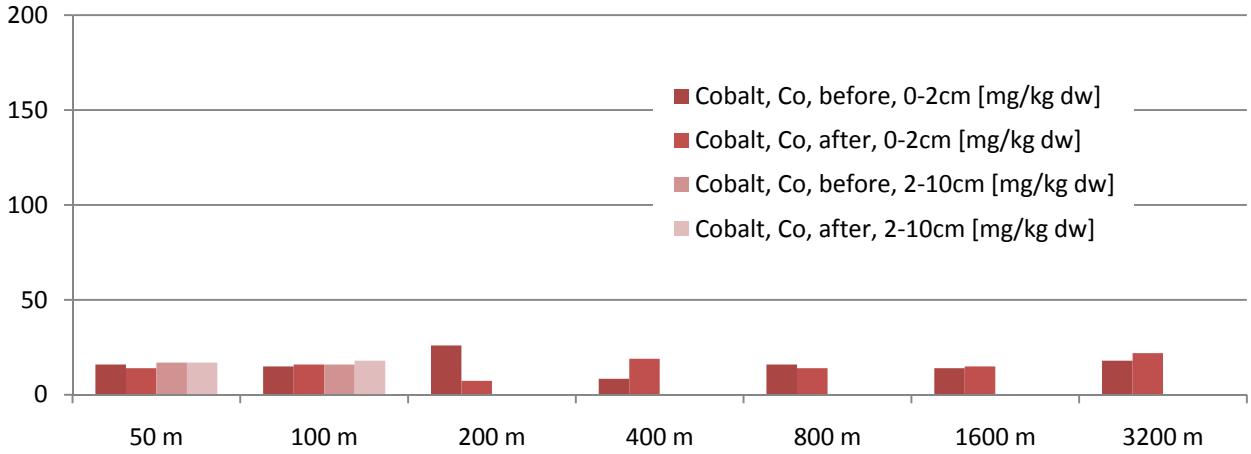
200
150
100
50
0
Mono-octyltin, MOT, before, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, after, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, before, 2-10cm [µg/kg dw]
Mono-octyltin, MOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

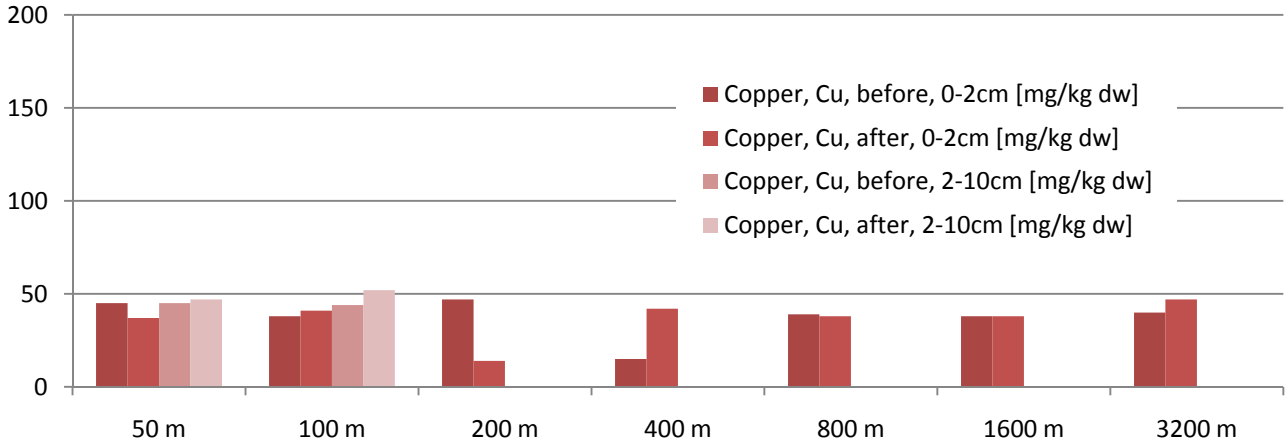

200
150
100
50
0
Dioctyltin, DOT, before, 0-2cm [µg/kg dw]
Dioctyltin, DOT, after, 0-2cm [µg/kg dw]
Dioctyltin, DOT, before, 2-10cm [µg/kg dw]
Dioctyltin, DOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

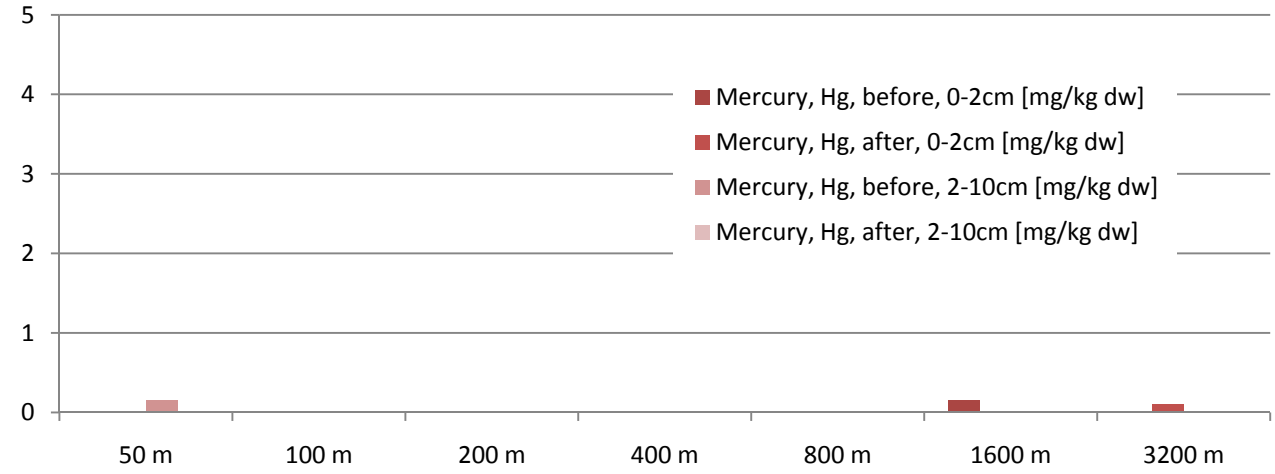

200
150
100
50
0
Tricyclohexyltin, TCHT, before, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, before, 2-10cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

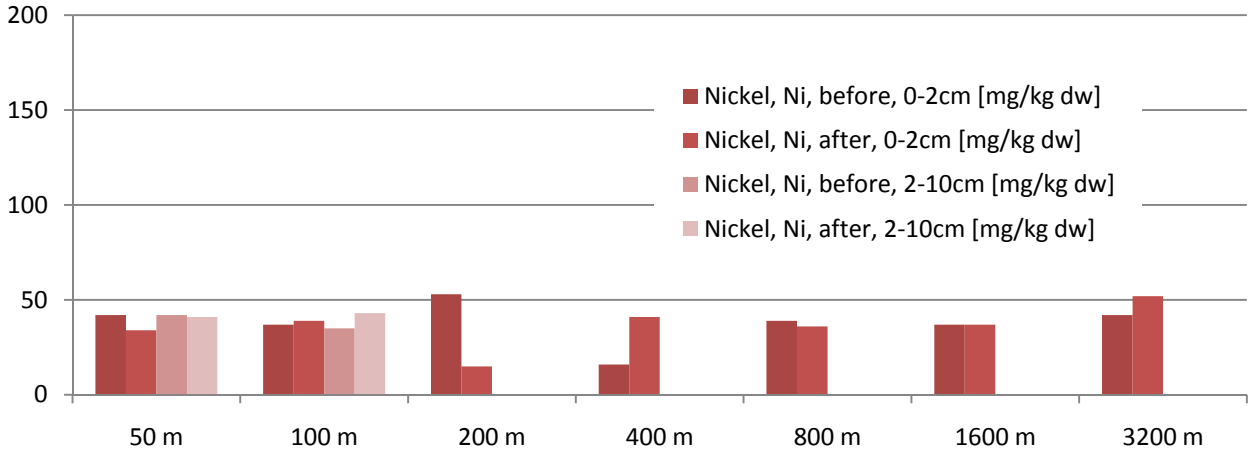
Attachment 5. Sediment analysis from VOM3 before and after ammunition clearance operations. All values are shown without normalisation. X-axis refers to location´s distance measured from the ammunition clearance site.

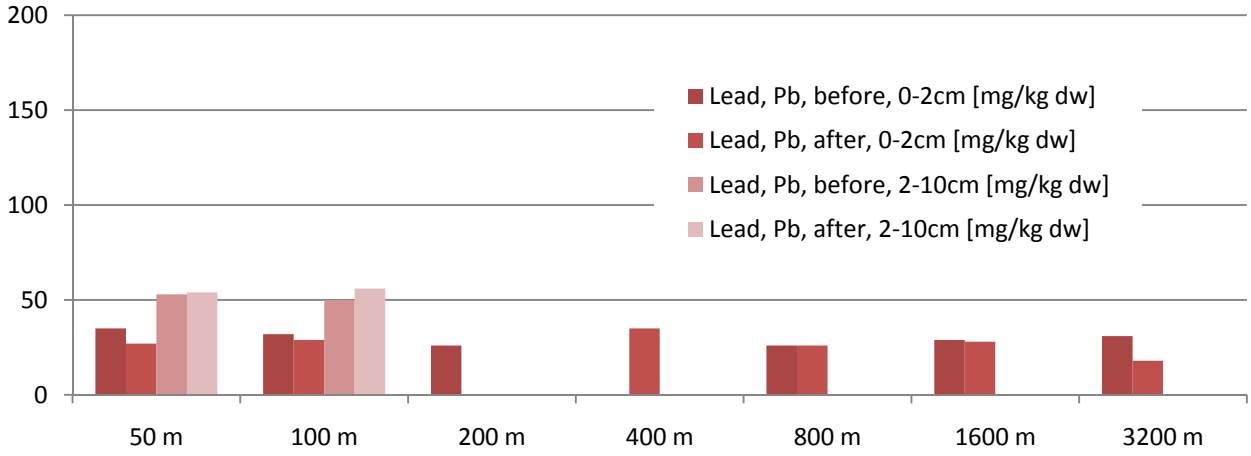


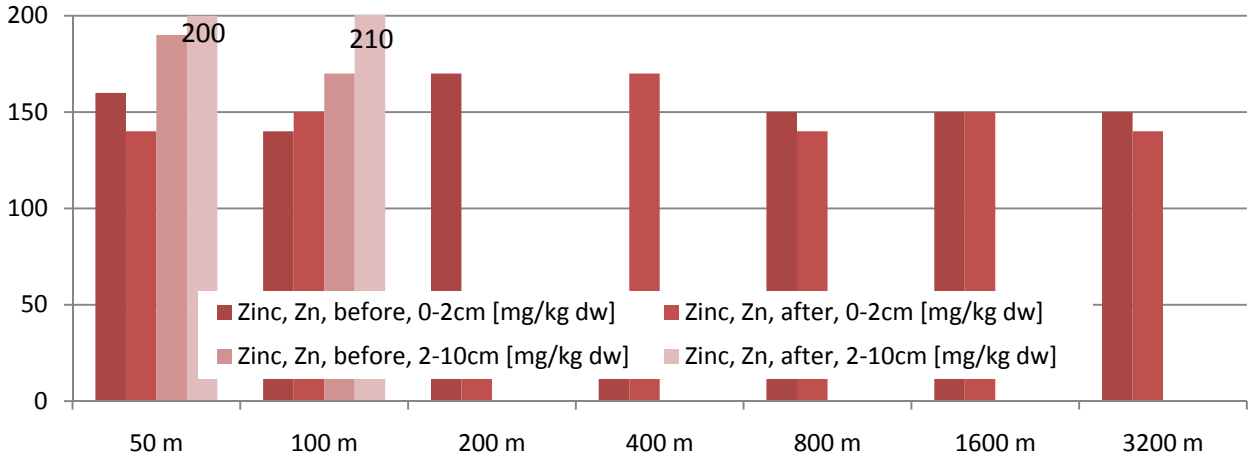

200
150
100
50
0
Cobalt, Co, before, 0-2cm [mg/kg dw]
Cobalt, Co, after, 0-2cm [mg/kg dw]
Cobalt, Co, before, 2-10cm [mg/kg dw]
Cobalt, Co, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

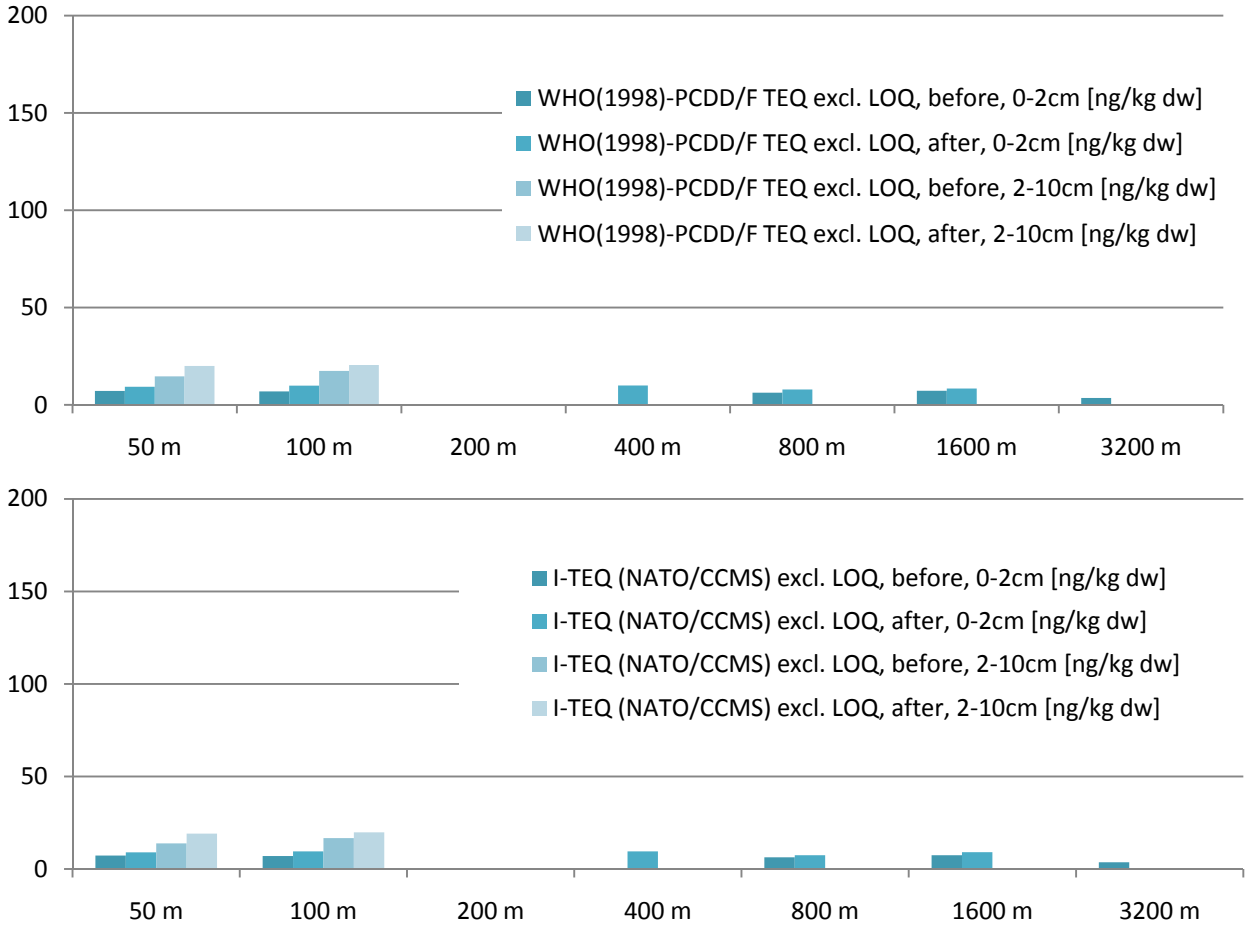

200
150
100
50
0
Copper, Cu, before, 0-2cm [mg/kg dw]
Copper, Cu, after, 0-2cm [mg/kg dw]
Copper, Cu, before, 2-10cm [mg/kg dw]
Copper, Cu, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


5
4
3
2
1
0
Mercury, Hg, before, 0-2cm [mg/kg dw]
Mercury, Hg, after, 0-2cm [mg/kg dw]
Mercury, Hg, before, 2-10cm [mg/kg dw]
Mercury, Hg, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

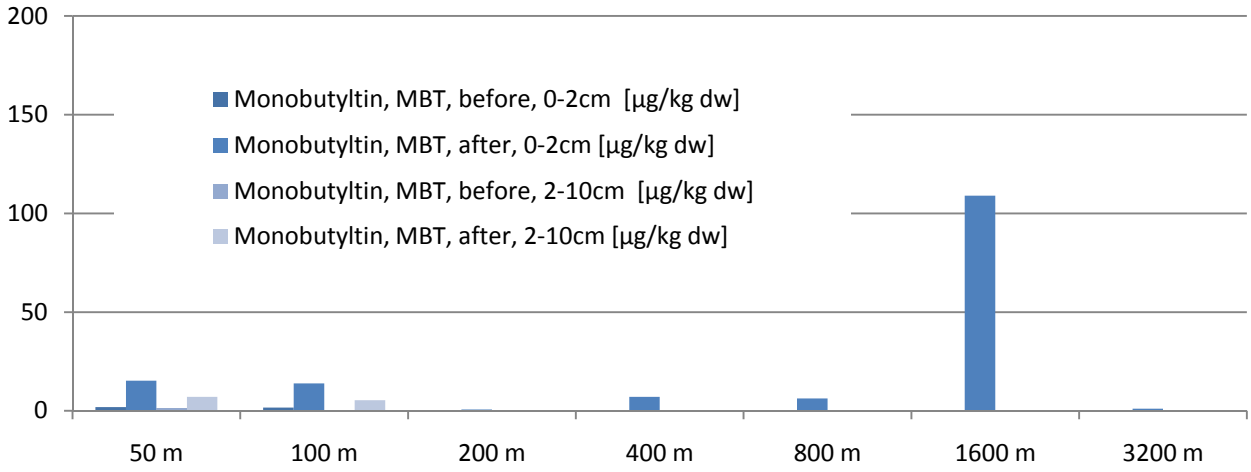

200
150
100
50
0
Nickel, Ni, before, 0-2cm [mg/kg dw]
Nickel, Ni, after, 0-2cm [mg/kg dw]
Nickel, Ni, before, 2-10cm [mg/kg dw]
Nickel, Ni, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

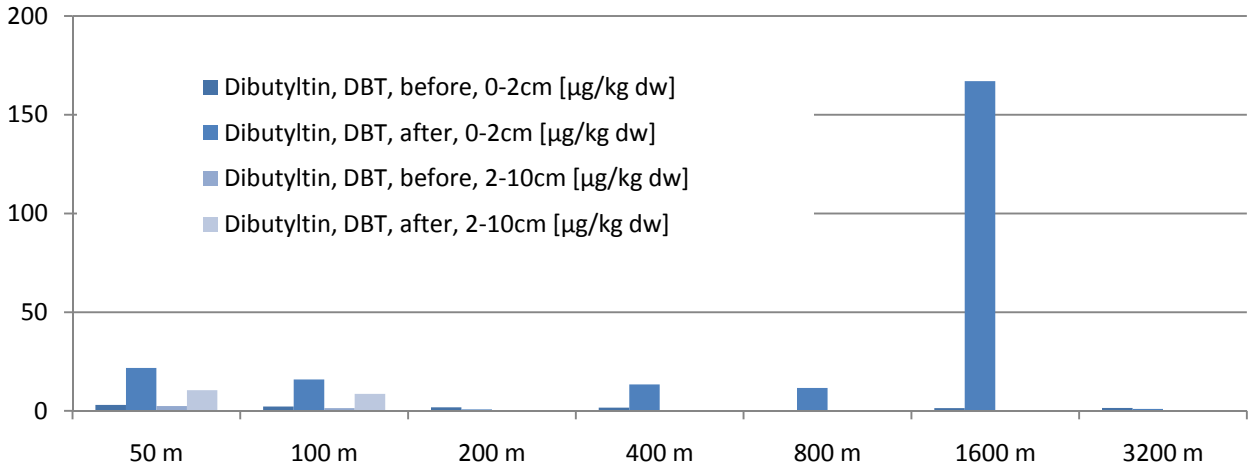

200
150
100
50
0
Lead, Pb, before, 0-2cm [mg/kg dw]
Lead, Pb, after, 0-2cm [mg/kg dw]
Lead, Pb, before, 2-10cm [mg/kg dw]
Lead, Pb, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

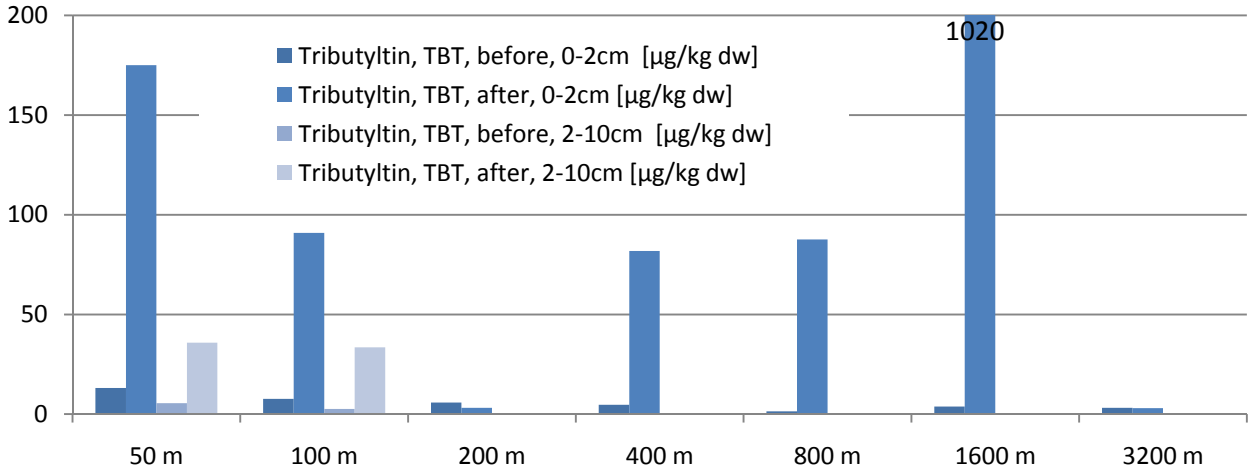

200
150
100
50
0
200
210
Zinc, Zn, before, 0-2cm [mg/kg dw]
Zinc, Zn, after, 0-2cm [mg/kg dw]
Zinc, Zn, before, 2-10cm [mg/kg dw]
Zinc, Zn, after, 2-10cm [mg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

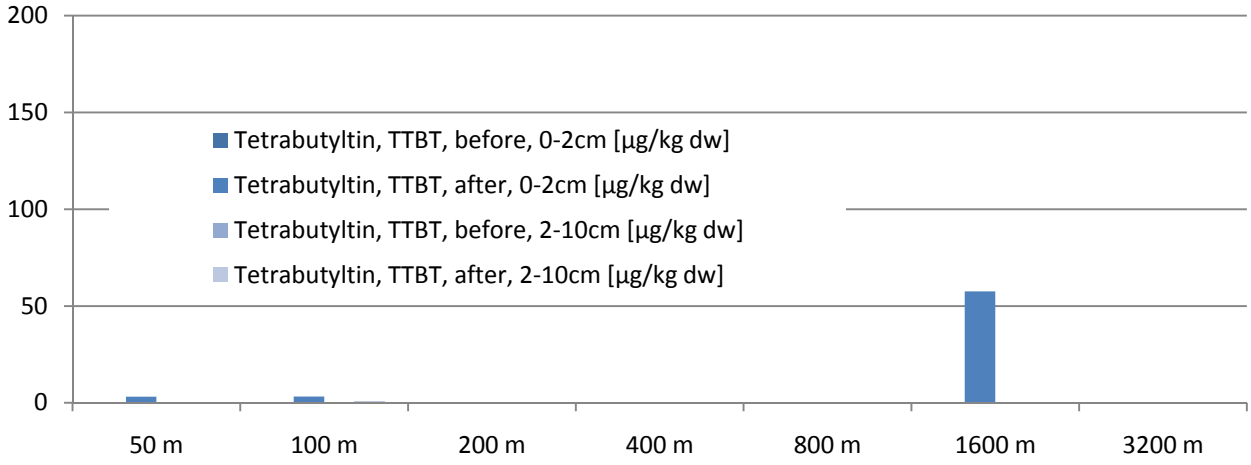

200
150
100
50
0
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 2-10cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

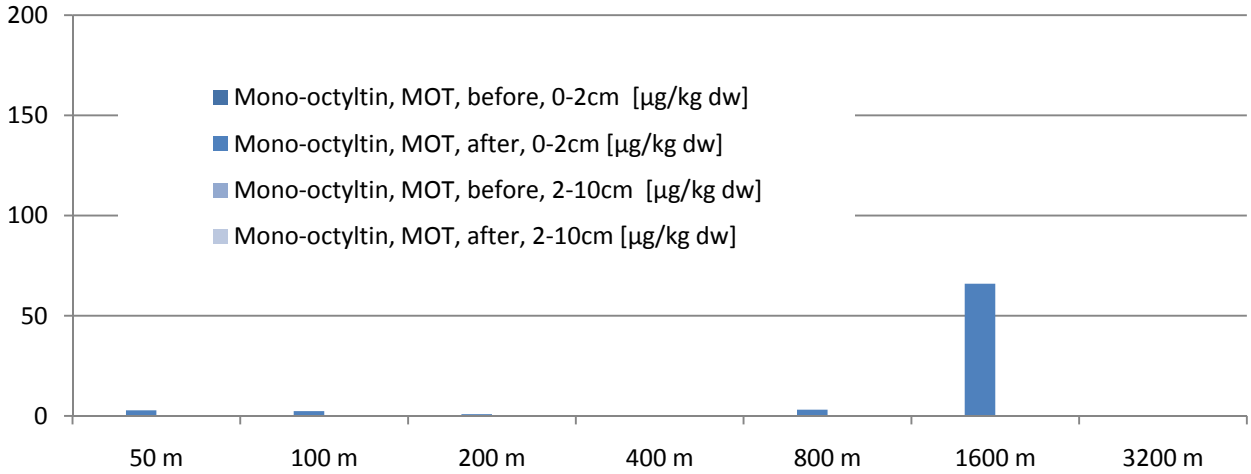
200
150
100
50
0
I-TEQ (NATO/CCMS) excl. LOQ, before, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 0-2cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, before, 2-10cm [ng/kg dw]
I-TEQ (NATO/CCMS) excl. LOQ, after, 2-10cm [ng/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

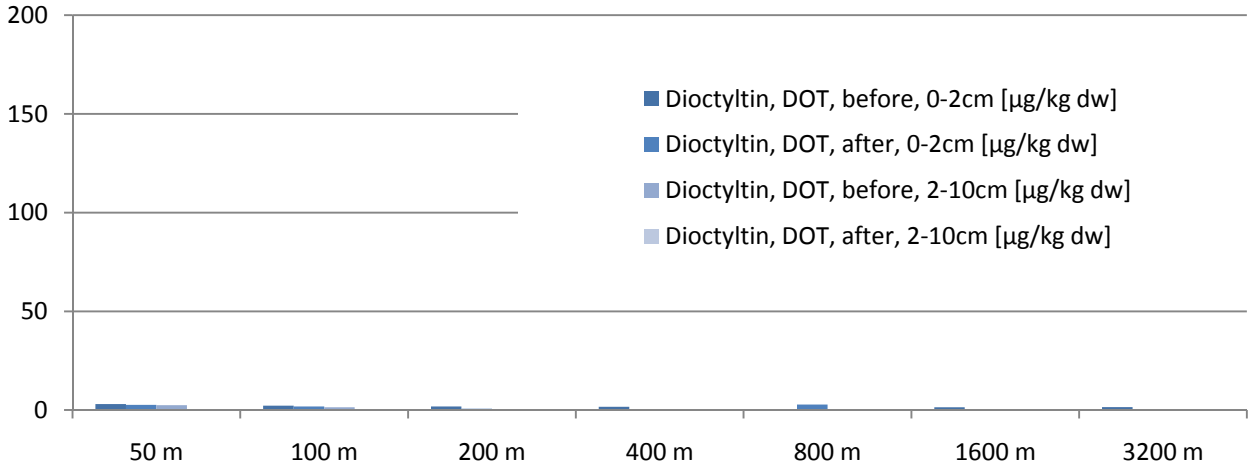

200
150
100
50
0
Monobutyltin, MBT, before, 0-2cm [µg/kg dw]
Monobutyltin, MBT, after, 0-2cm [µg/kg dw]
Monobutyltin, MBT, before, 2-10cm [µg/kg dw]
Monobutyltin, MBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

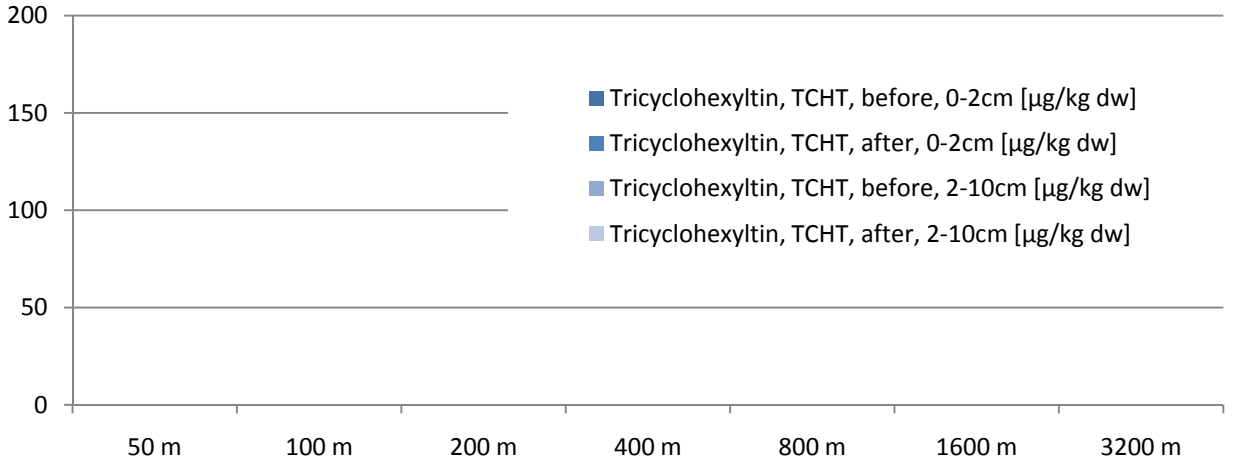

200
150
100
50
0
Dibutyltin, DBT, before, 0-2cm [µg/kg dw]
Dibutyltin, DBT, after, 0-2cm [µg/kg dw]
Dibutyltin, DBT, before, 2-10cm [µg/kg dw]
Dibutyltin, DBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

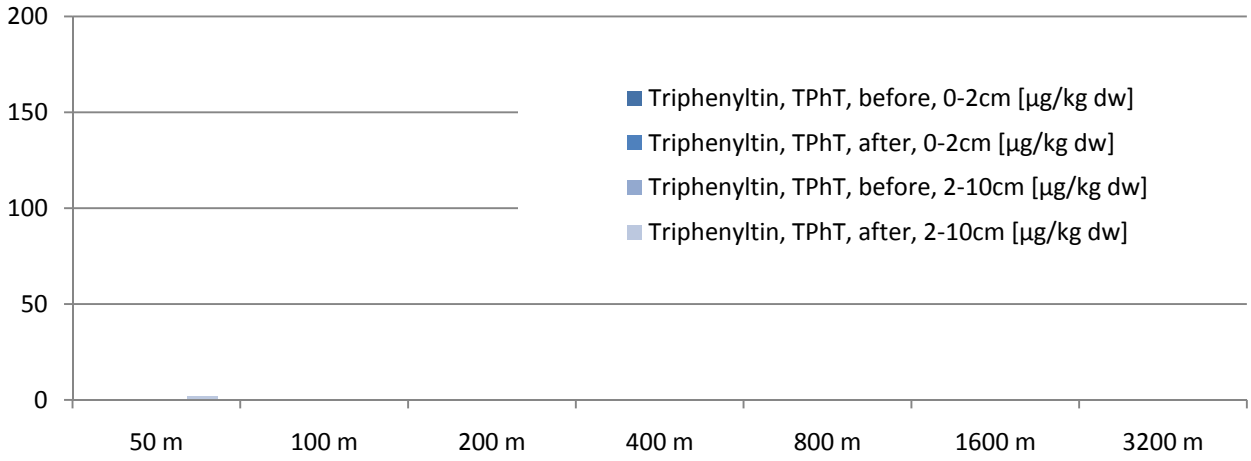

200
150
100
50
0
1020
Tributyltin, TBT, before, 0-2cm [µg/kg dw]
Tributyltin, TBT, after, 0-2cm [µg/kg dw]
Tributyltin, TBT, before, 2-10cm [µg/kg dw]
Tributyltin, TBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

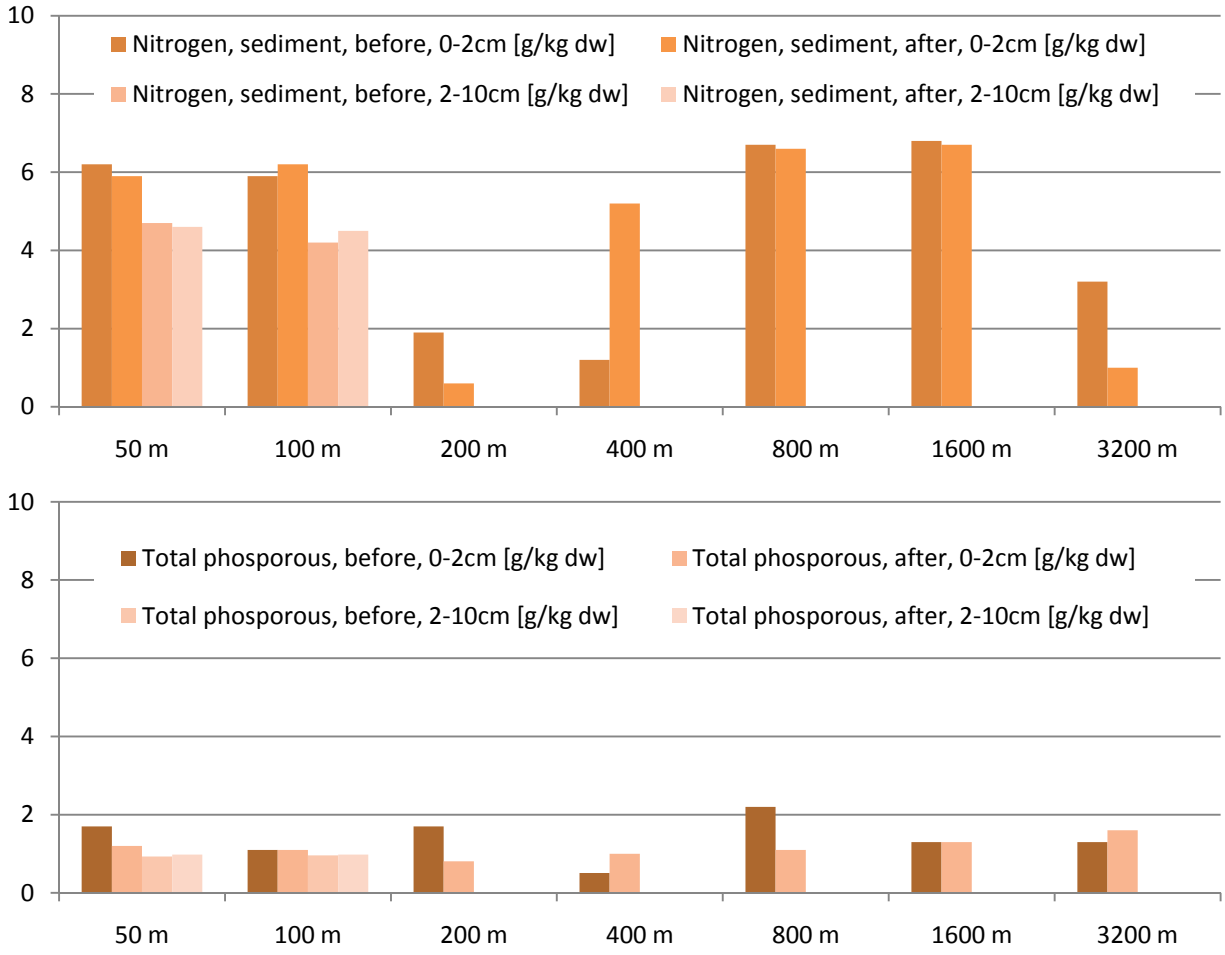

200
150
100
50
0
Tetrabutyltin, TTBT, before, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, before, 2-10cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Mono-octyltin, MOT, before, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, after, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, before, 2-10cm [µg/kg dw]
Mono-octyltin, MOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m


200
150
100
50
0
Dioctyltin, DOT, before, 0-2cm [µg/kg dw]
Dioctyltin, DOT, after, 0-2cm [µg/kg dw]
Dioctyltin, DOT, before, 2-10cm [µg/kg dw]
Dioctyltin, DOT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

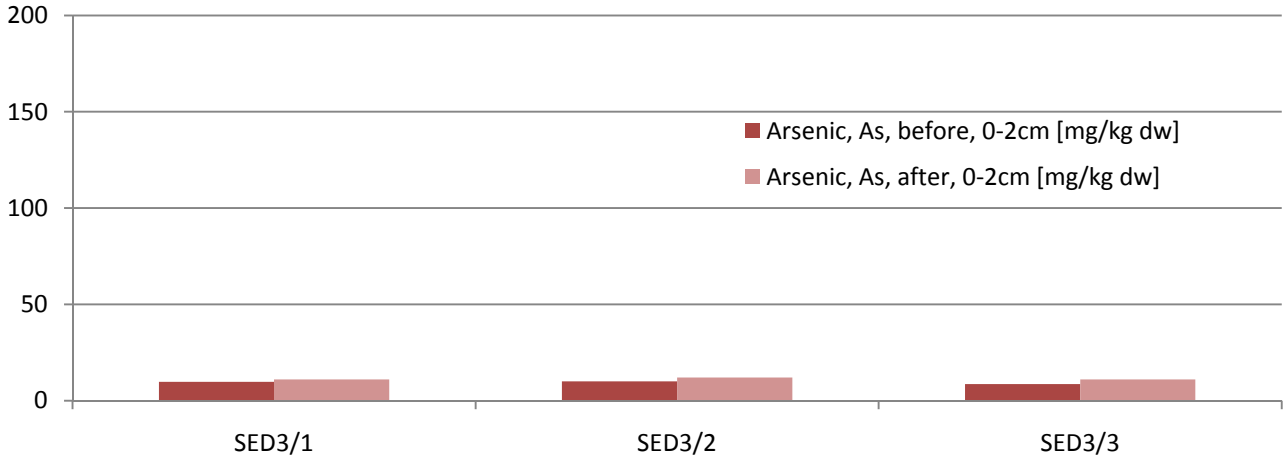

200
150
100
50
0
Tricyclohexyltin, TCHT, before, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, before, 2-10cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

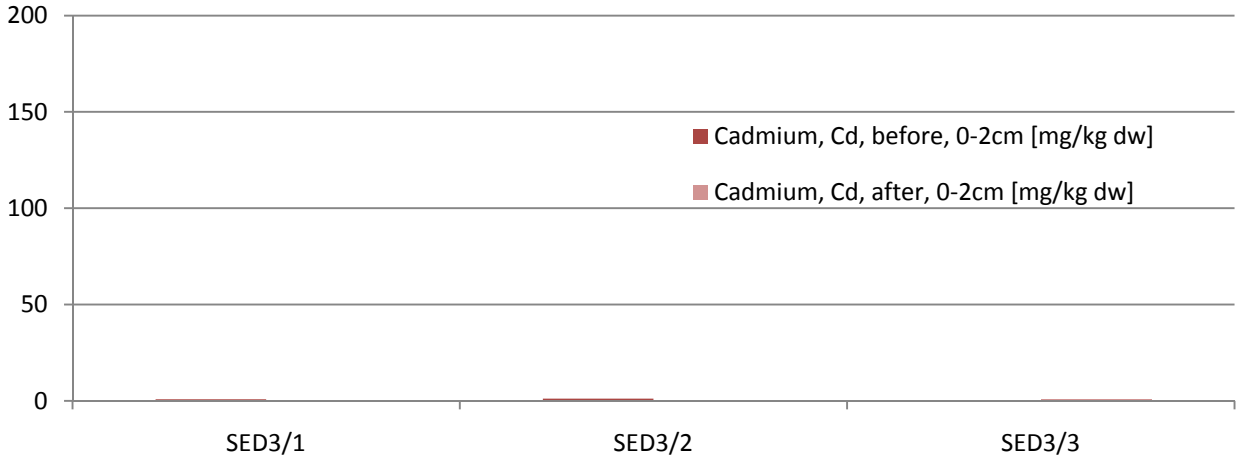

200
150
100
50
0
Triphenyltin, TPhT, before, 0-2cm [µg/kg dw]
Triphenyltin, TPhT, after, 0-2cm [µg/kg dw]
Triphenyltin, TPhT, before, 2-10cm [µg/kg dw]
Triphenyltin, TPhT, after, 2-10cm [µg/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

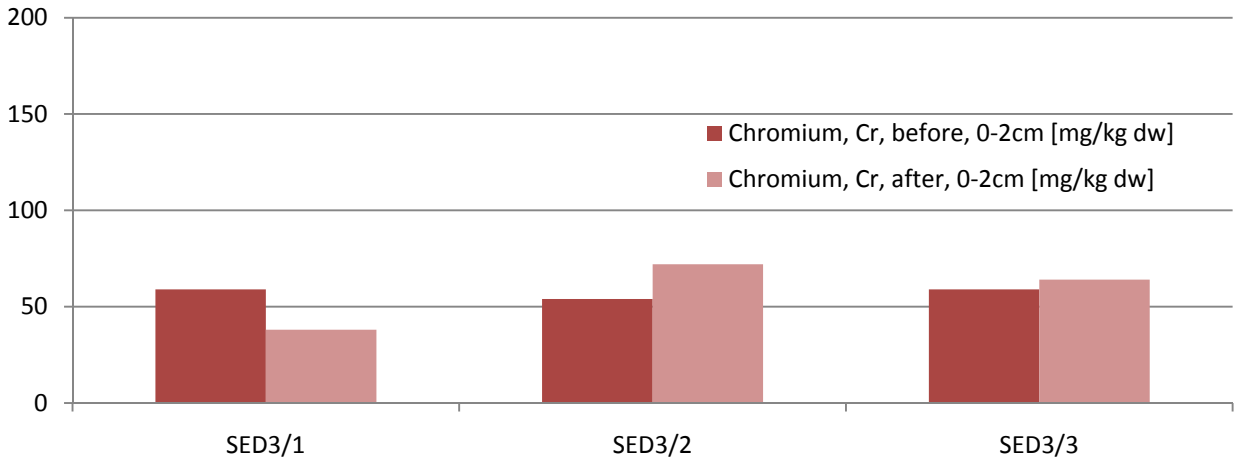

10
8
6
4
2
0
Nitrogen, sediment, before, 0-2cm [g/kg dw]
Nitrogen, sediment, after, 0-2cm [g/kg dw]
Nitrogen, sediment, before, 2-10cm [g/kg dw]
Nitrogen, sediment, after, 2-10cm [g/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

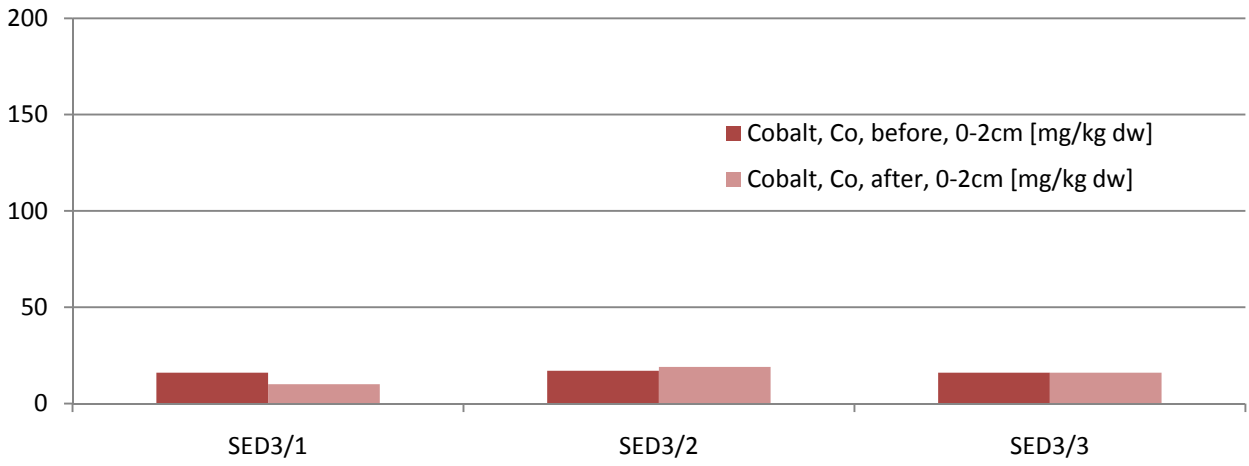
10
8
6
4
2
0
Total phosporous, before, 0-2cm [g/kg dw]
Total phosporous, after, 0-2cm [g/kg dw]
Total phosporous, before, 2-10cm [g/kg dw]
Total phosporous, after, 2-10cm [g/kg dw]
50 m
100 m
200 m
400 m
800 m
1600 m
3200 m

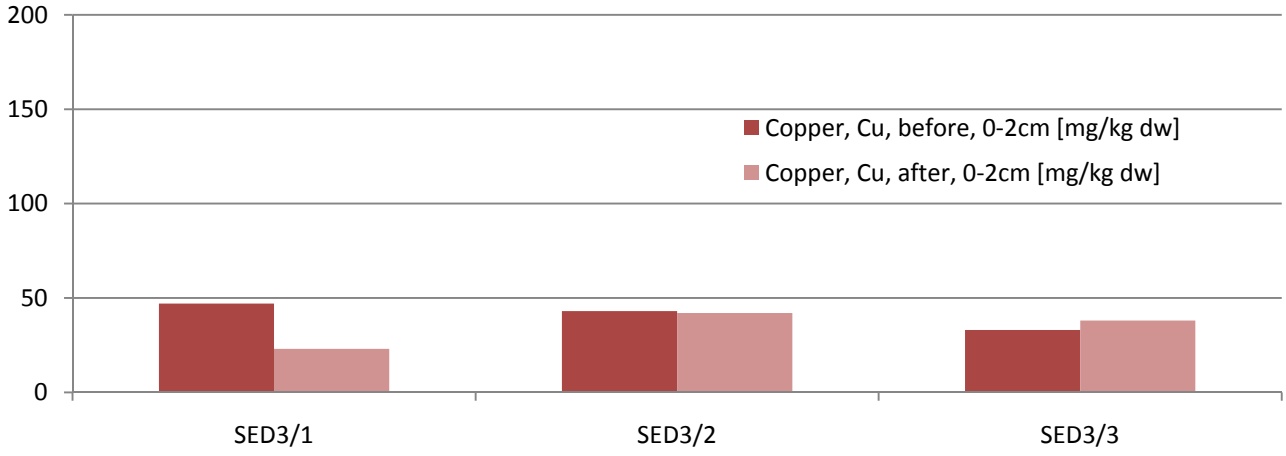
Attachment 6. Sediment analysis from SED3(Est) before and after ammunition clearance operations. All values are shown without normalisation. X-axis refers to location´s name.

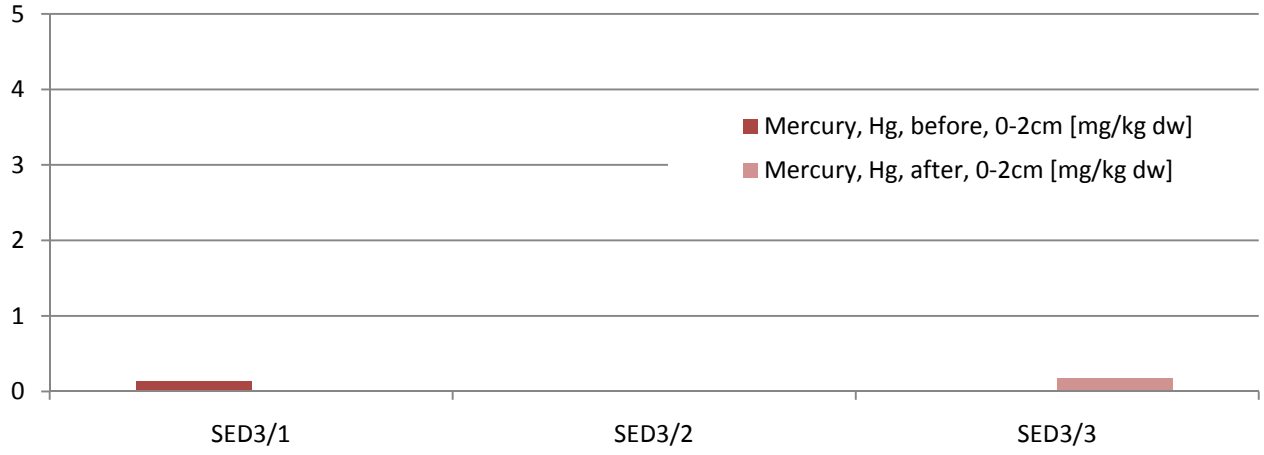


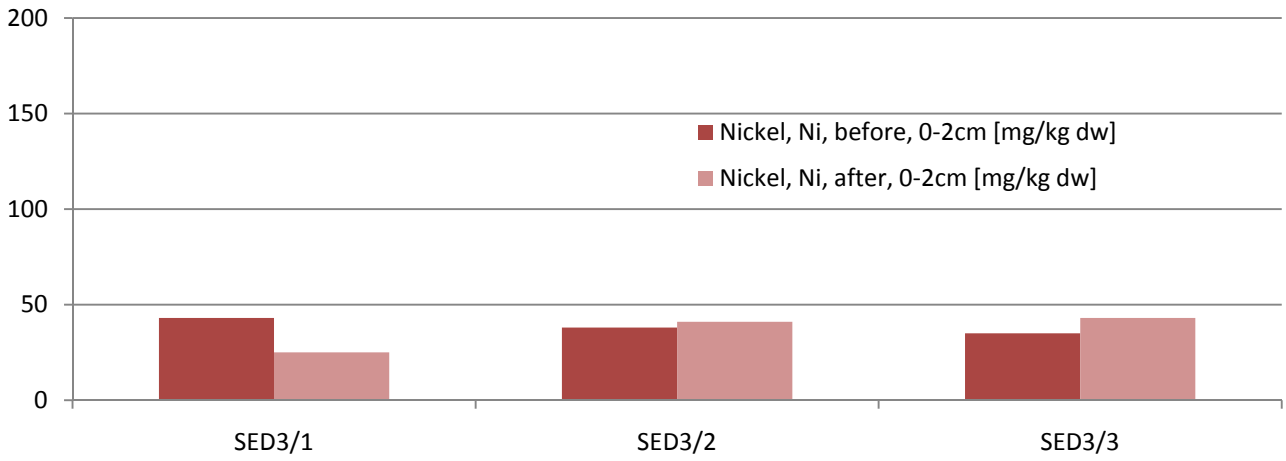


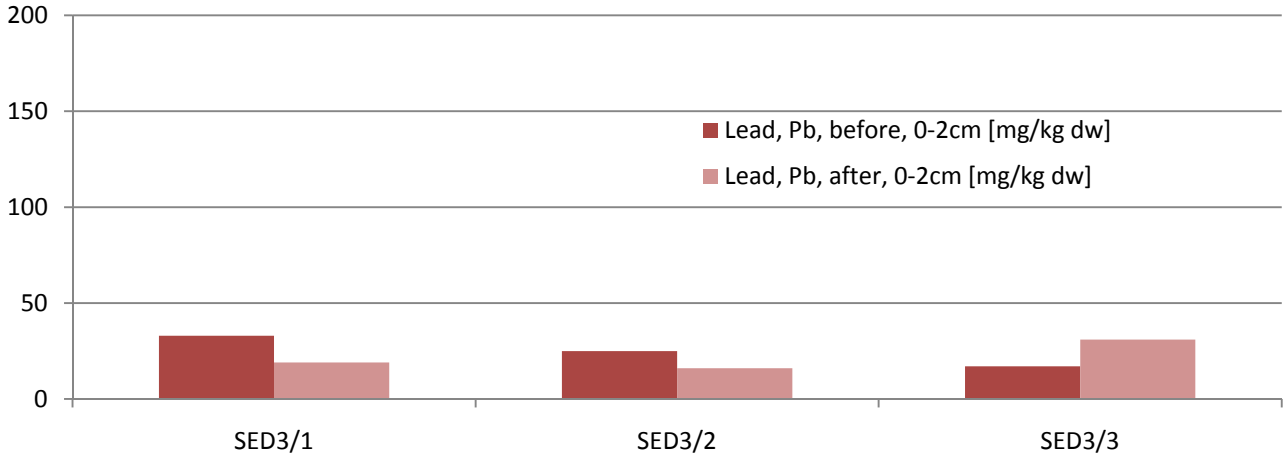


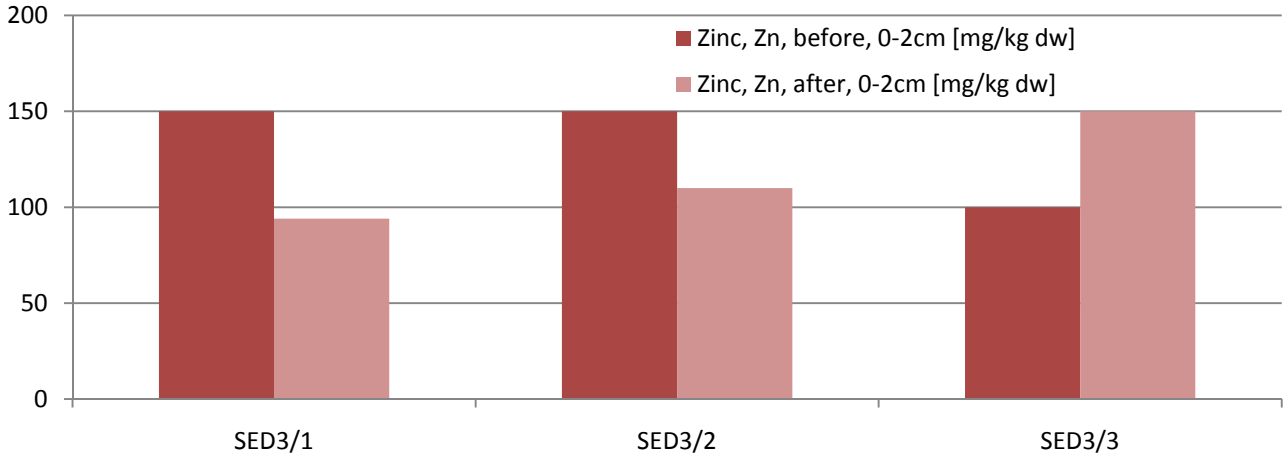

200
150
100
50
0
Cobalt, Co, before, 0-2cm [mg/kg dw]
Cobalt, Co, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

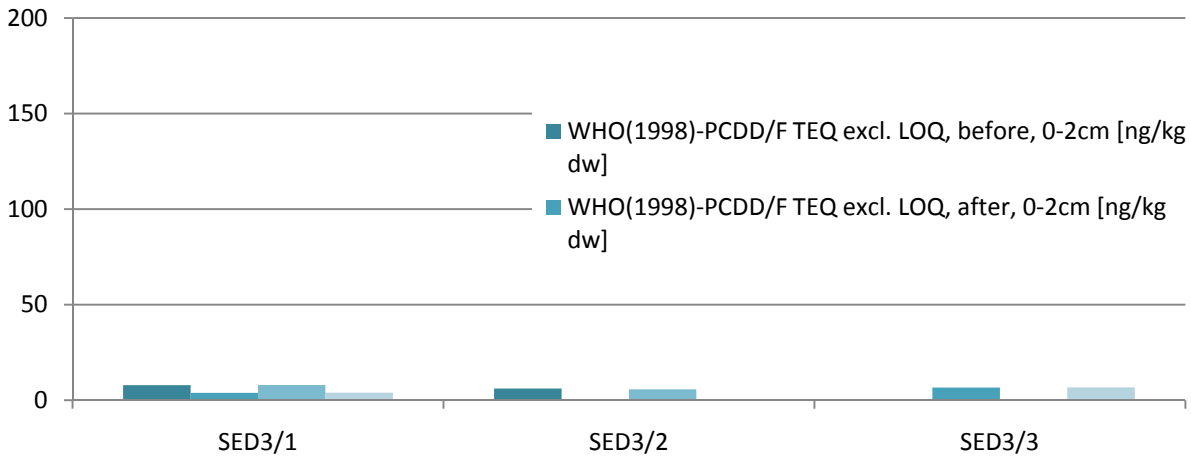

200
150
100
50
0
Copper, Cu, before, 0-2cm [mg/kg dw]
Copper, Cu, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

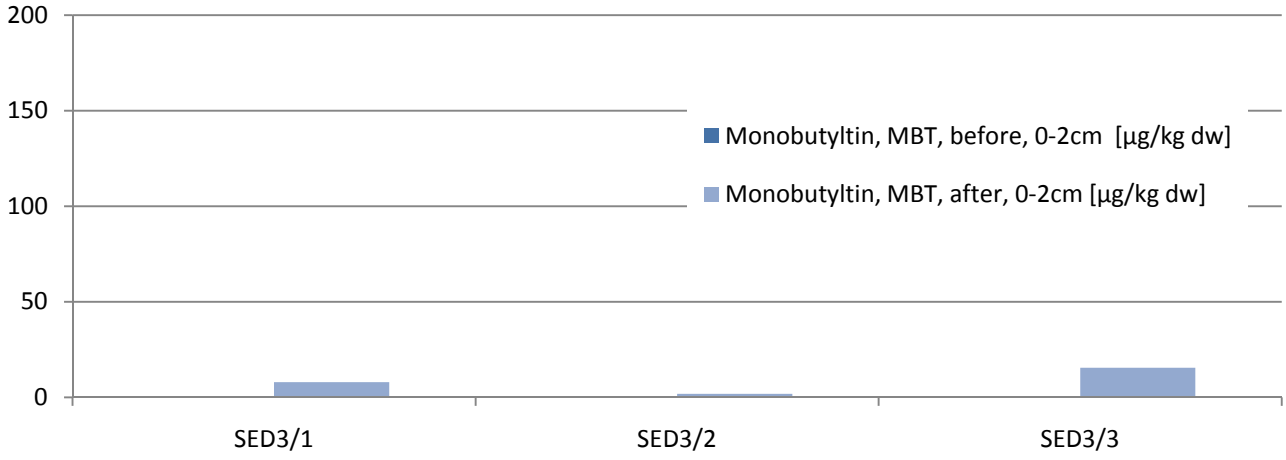

5
4
3
2
1
0
Mercury, Hg, before, 0-2cm [mg/kg dw]
Mercury, Hg, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

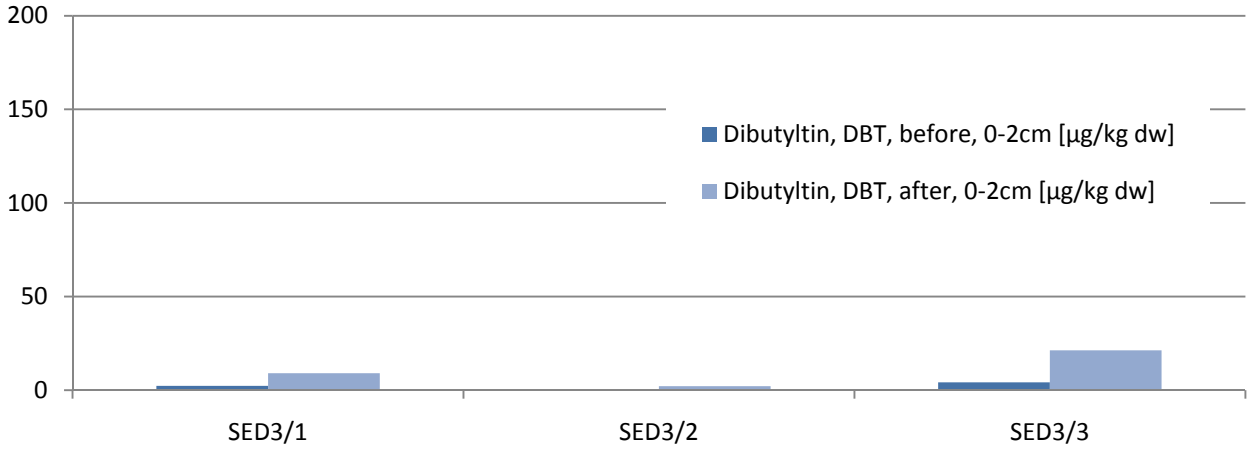

200
150
100
50
0
Nickel, Ni, before, 0-2cm [mg/kg dw]
Nickel, Ni, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

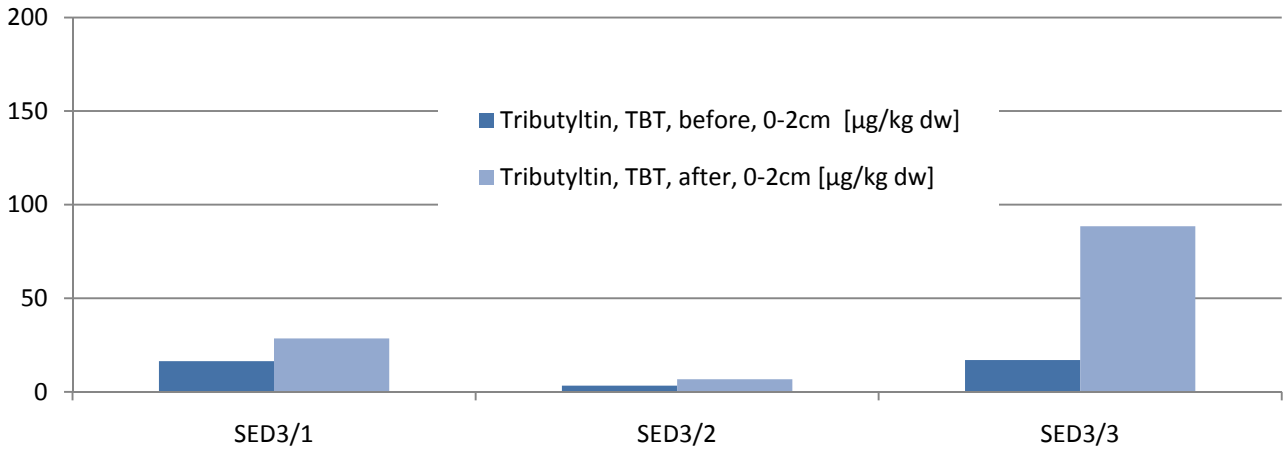

200
150
100
50
0
Lead, Pb, before, 0-2cm [mg/kg dw]
Lead, Pb, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

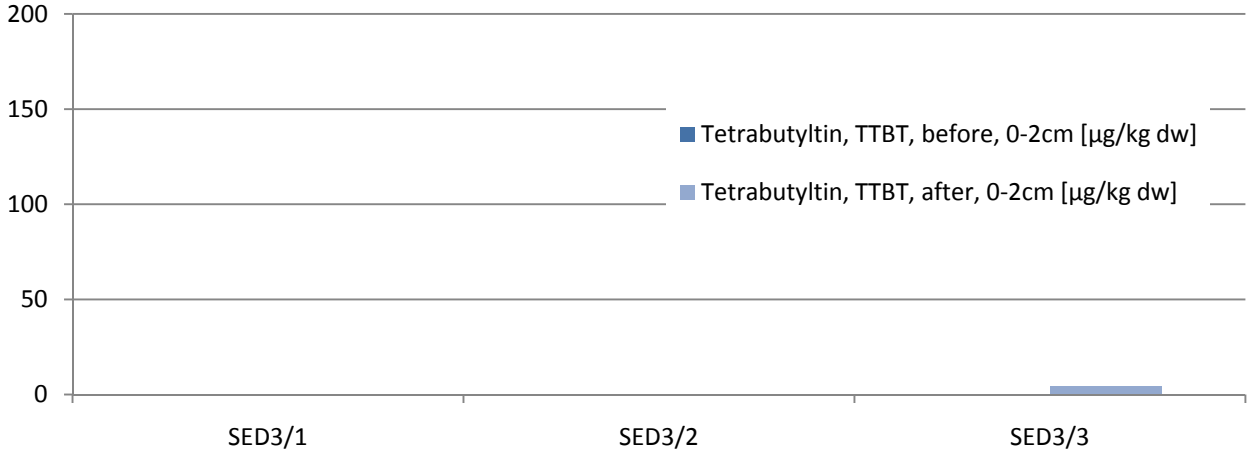

200
150
100
50
0
Zinc, Zn, before, 0-2cm [mg/kg dw]
Zinc, Zn, after, 0-2cm [mg/kg dw]
SED3/1
SED3/2
SED3/3

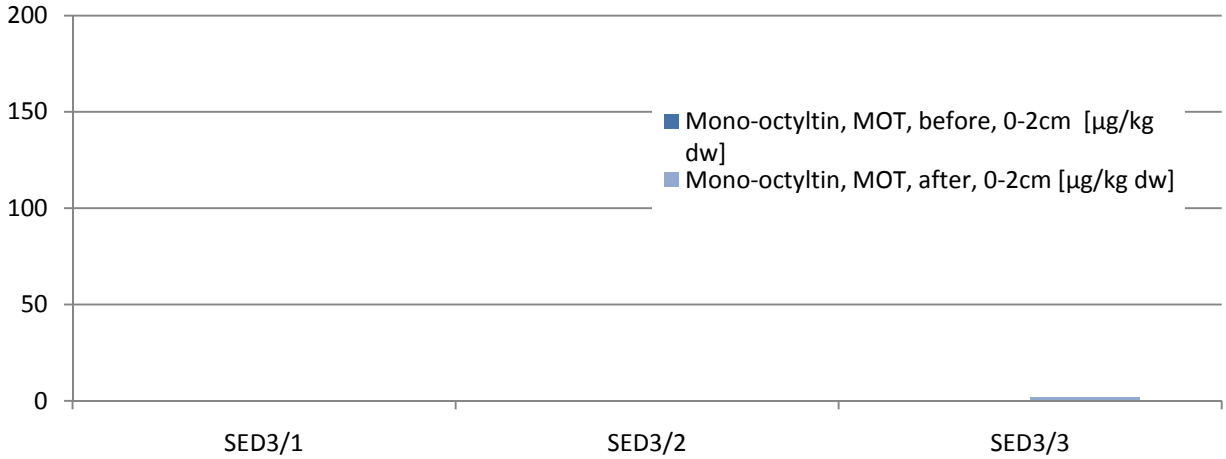

200
150
100
50
0
WHO(1998)-PCDD/F TEQ excl. LOQ, before, 0-2cm [ng/kg dw]
WHO(1998)-PCDD/F TEQ excl. LOQ, after, 0-2cm [ng/kg dw]
SED3/1
SED3/2
SED3/3

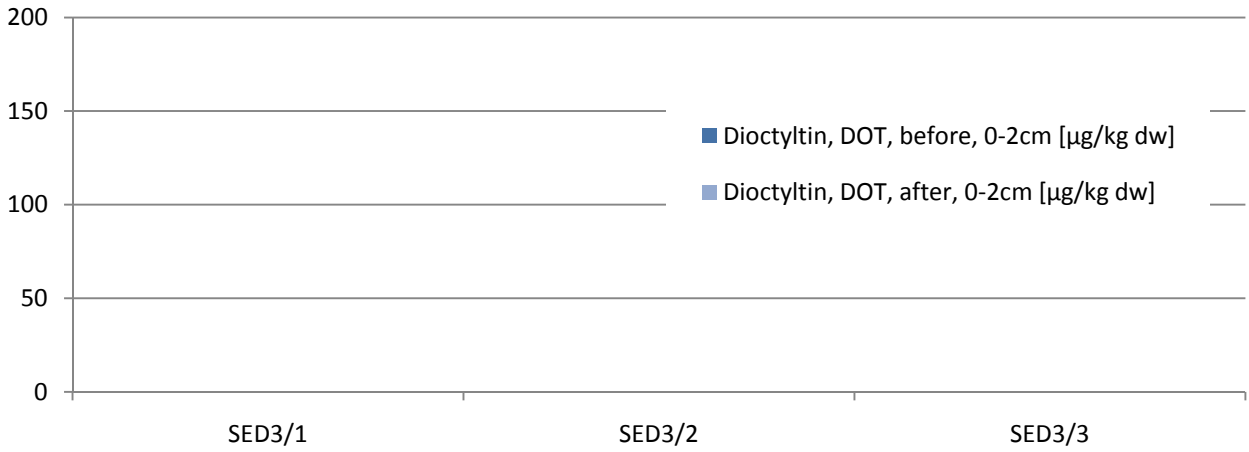

200
150
100
50
0
Monobutyltin, MBT, before, 0-2cm [µg/kg dw]
Monobutyltin, MBT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3

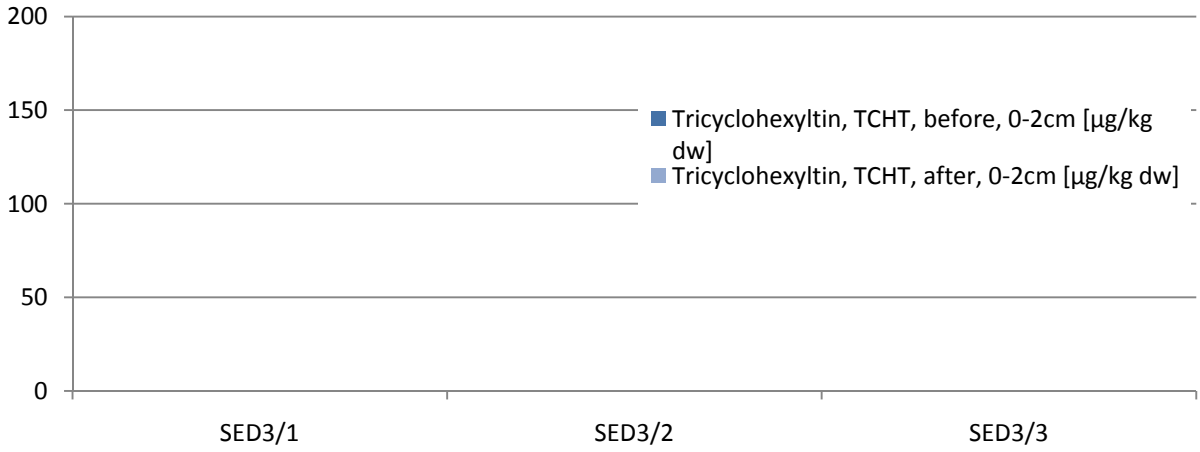

200
150
100
50
0
Dibutyltin, DBT, before, 0-2cm [µg/kg dw]
Dibutyltin, DBT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3

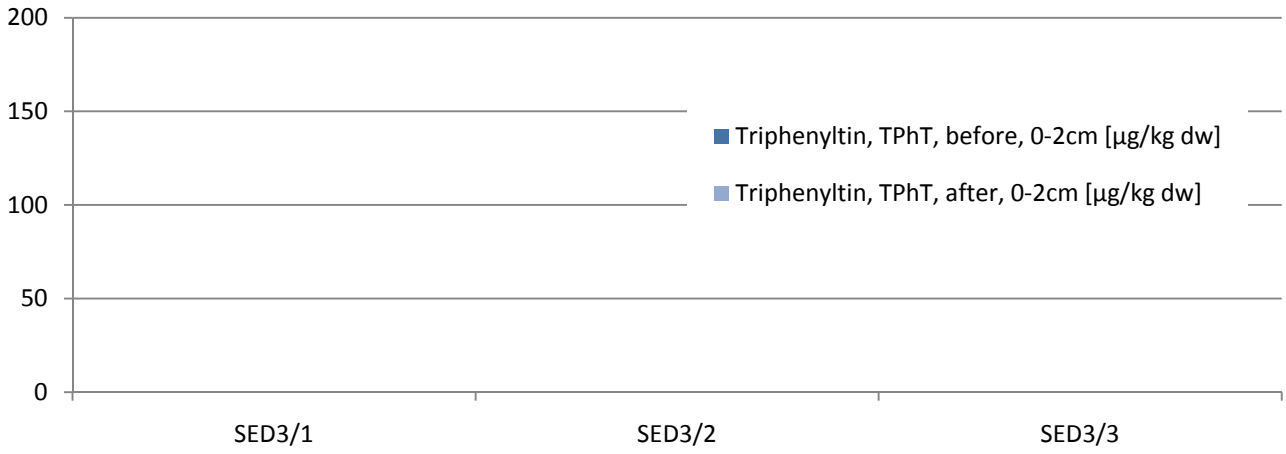

200
150
100
50
0
Tributyltin, TBT, before, 0-2cm [µg/kg dw]
Tributyltin, TBT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3

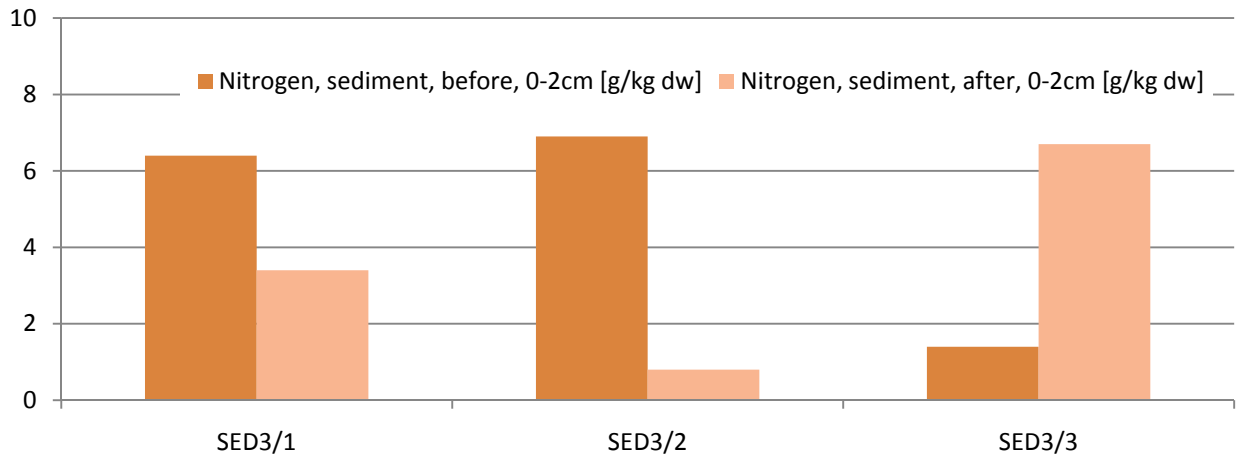

200
150
100
50
0
Tetrabutyltin, TTBT, before, 0-2cm [µg/kg dw]
Tetrabutyltin, TTBT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3

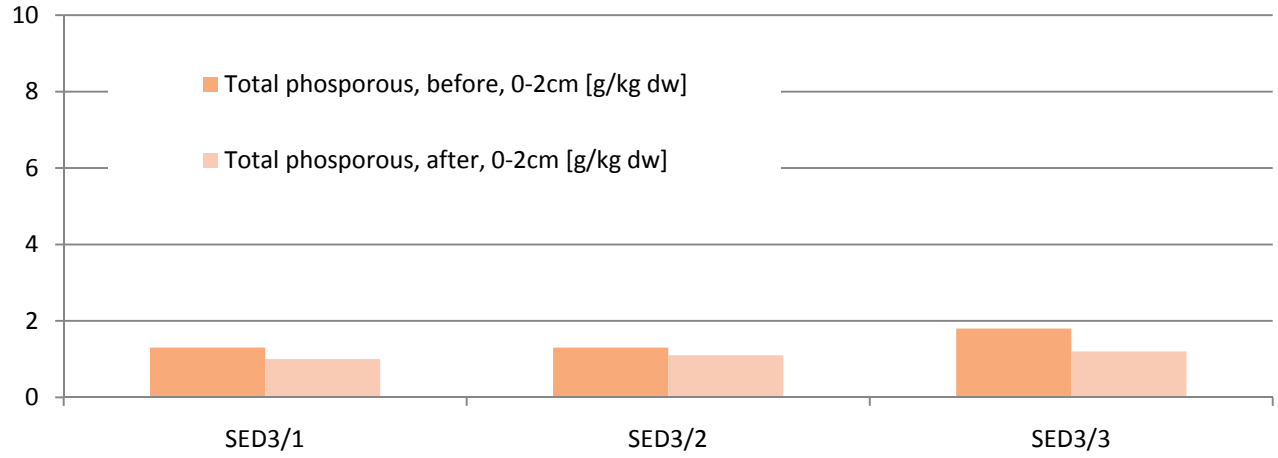

200
150
100
50
0
Mono-octyltin, MOT, before, 0-2cm [µg/kg dw]
Mono-octyltin, MOT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3


200
150
100
50
0
Dioctyltin, DOT, before, 0-2cm [µg/kg dw]
Dioctyltin, DOT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3


200
150
100
50
0
Tricyclohexyltin, TCHT, before, 0-2cm [µg/kg dw]
Tricyclohexyltin, TCHT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3


200
150
100
50
0
Triphenyltin, TPhT, before, 0-2cm [µg/kg dw]
Triphenyltin, TPhT, after, 0-2cm [µg/kg dw]
SED3/1
SED3/2
SED3/3


10
8
6
4
2
0
Nitrogen, sediment, before, 0-2cm [g/kg dw]
Nitrogen, sediment, after, 0-2cm [g/kg dw]
SED3/1
SED3/2
SED3/3


10
8
6
4
2
0
Total phosporous, before, 0-2cm [g/kg dw]
Total phosporous, after, 0-2cm [g/kg dw]
SED3/1
SED3/2
SED3/3