REPORT SNO 6879-2015

Repeated environmental baseline survey at AF Miljøbase Vats in conjugation with the Ekofisk cessation EPRD project

Norwegian Institute for Water Research

REPORT

Main Office
Gaustadalléen 21
0349 Oslo
Telephone (47) 22 18 51 00
Telefax (47) 22 18 52 00
Internet: www.niva.no

Regional Office, Sørlandet
Jon Lilletuns vei 3
4879 Grimstad
Telephone (47) 22 18 51 00
Telefax (47) 37 04 45 13

Regional Office, Østlandet
Sandvikaveien 59
2312 Ottestad
Telephone (47) 22 18 51 00
Telefax (47) 62 57 66 53

Regional Office, Vestlandet
Thormøhlensgate 53 D
5006 Bergen
Telephone (47) 22 18 51 00
Telefax (47) 55 31 22 14

Title	Serial No.	Date
Repeated environmental baseline survey at AF Miljøbase Vats in conjugation with the Ekofisk cessation EPRD project	6879-2015	24.06.2015
	Project no. Sub-No. O-15236	Pages Price 29 + appendix

Author(s)	Topic group	Distribution
Jonny Beyer, Astri Kvassnes*, Jarle Håvardstun, Mats Walday, Hege Gundersen & Morten Schaanning ** present adress IRIS, Stavanger*	Overvåking	Open
	Geographical area Rogaland, Norway	Printed NIVA

Client(s)	Client ref.
AF Offshore Decom	1699

Abstract

In this study, the environmental contamination by AF Environmental Base Vats (AFEBV) was assessed before and after the facilities demolition activities in the Ekofisk cessation EPRD project. Seafloor debris and contaminant concentrations in soil, groundwater and fjord sediments were measured in 2015 and compared with similar data from the 2009 baseline study. ROV inspections found generally normal biological conditions of the algae and benthic animals but also much anthropogenic scrap at the seabed, although the amount has decreased by 2015 in comparison to 2009 as a result of clean-up operations. The survey revealed that soil in the ultimate vicinity of the base has become more contaminated with PAHs, metals and mercury in particular. The annual monitoring programme revealed peak concentrations in moss and soil samples in 2010, but subsequent actions to reduce spreading of dust from the working area have resulted in decreasing contaminant levels in both types of samples. Assessment of groundwater samples showed low levels of all contaminants, indicating that the impermeable deck at the base prevents contaminant transfer. Sediments collected in the fjord adjacent to the demolition plant showed PAH levels largely in class II, but one PAH component and TBT was in class IV. Similar findings of TBT and PAH have been reported before 2009 and no evidence was found for a consistent change in the level of these contaminant between 2009 and 2015. Levels of PCB7, mercury and other metals were generally low (class I) in sediment samples from all fjord stations.

4 keywords, Norwegian	4 keywords, English
1. AF Offshore Decom	1. AF Offshore Decom
2. Vatsfjorden	2. Vatsfjord
3. Miljøundersøkelse	3. Environmental survey
4. ROV	4. ROV

Jonny Beyer
Project manager

Morten Schaanning
Research manager

ISBN 978-82-577-6614-6

Repeated environmental baseline survey at AF Miljøbase Vats in conjugation with the Ekofisk cessation EPRD project

Preface

An environmental survey by the AF Environmental base Vats (AFEBV) was performed in 2015 to compare the current environmental status to its baseline condition in 2009, when AFEBV's work in the Ekofisk Cessation EPRD project started. Soil, groundwater, marine sediments and anthropogenic debris at the seafloor were investigated. AF Offshore Decom commissioned the investigation and organised shipment and order of chemical analyses of the sediment samples. The NIVA personnel involved in the 2015 survey have been Jonny Beyer (PL), Jarle Håvardstun, Mats Gunnar Walday, Hege Gundersen and Morten T. Schaanning (QA). In connection with the baseline report work in 2009, Astri JS Kvassnes was PL whereas Mats Walday, Hege Gundersen and Torgeir Bakke (QA) were contributors. The contact persons at AFEBV for the 2015 work have been Veslemøy Eriksen and Jøran Baann.

Oslo, 19.06.2015

Jonny Beyer

Contents

Summary

AF Offshore Decom recycles decommissioned offshore installations at the AF Environmental Base Vats, AFEBV (AF Miljøbase Vats) at Raunes in Vindafjord Municipality, Rogaland, Norway. The installations are separated into large sections at sea and towed to shore at AFEBV where they subsequently are hoisted onshore and further taken apart. All materials are sorted after value. Hazardous components and waste materials are treated separately. The AFEBV facility is equipped with a water treatment plant for surface water / processing water as well as other infrastructures targeted for minimizing release of chemical contaminants to the neighbouring environment.

The Norwegian Institute for Water Research has, on commission from AF Offshore Decom, performed a repeated environmental baseline investigation by AFEBV to compare the locations environmental status to its condition in 2009, when the previous baseline study (Kvassnes et al. 2010) was done prior to the onset of the Ekofisk Cessation EPRD project. Soil, groundwater, marine sediments and anthropogenic debris at the seafloor were investigated. The goal of the present investigation was to compare the baseline results from 2009 with similar data from 2015, i.e. to document to what degree the performance of the Ekofisk Cessation EPRD project has influenced the environmental surroundings of AFEBV. The present survey includes ROV-investigations to observe debris and visually evaluate the state of the seafloor outside the quays at Raunes, as well as sampling and chemical analysis of marine sediments near the quays. In addition, chemical analysis of soil samples from the AFEBV site and groundwater samples obtained from four wells at the quay was performed.

Several previous ROV-surveys at the Raunes location have shown that the benthic substrate outside Raunes varies from being dominated by deposited rocks and boulders containing variable degree of biotic fouling, and smothering of rock flour where the quay has been expanded, to normal soft bottom with multiple traces of marine in-fauna as well as other visible benthic fauna. The benthic community that was observed during the present ROV inspection in Raunesvika and Grønavika was generally as expected for a harbour area like the one outside AFEBV, with benthic algae, kelp, starfish, fish and crab. The substrate in Raunesvika consists of soft sediments, mixed with sand, gravel and some stones in the shallower part, but also some areas with bedrock. The present ROV survey identified and positioned a number of debris objects located at 80 individual positions within the two inspection areas Raunesvika and Grønavika. The observed debris included many different objects, such as steel ropes, floating ropes, iron-rods, metal plates, ladders, various plastic debris, parts of canvas and silt-curtains, fish-cages, boards, fish nets, trees and wooden structures, and a number of car-tires of variable sizes. Although a considerable amount of seabed debris had been removed from this location after the previous baseline survey in 2009, the present ROV survey clearly shows that there is still a considerable amount of anthropogenic material on the bottom in this area. It was approximately the same number of debris found in 2015 as in 2012. Survey conditions were very good in 2015, making it easy for the ROV to spot debris.

The soil survey revealed that the ultimate vicinity of AFEBV has become more contaminated with PAHs and metals in the period 2009-2015. For mercury, the levels had increased 20 times at the most contaminated J1 position just adjacent to the plant. Mercury, zinc and four PAH components exceeded the guideline norm value for sensitive land use in this sample. However, the tendency of soil contamination appears to be very local and patchy distributed, as the J2 soil station located just a few dozen meters away was significantly less contaminated. The annual monitoring programme revealed that mercury in particular, increased in soil and moss samples between 2009 and 2010. However, this programme has shown that in the subsequent years remedial actions against spreading of dust from the working area resulted in a decrease of contaminant levels in soil samples and moss collected close to the base. Thus both stations (J1 and J2) were less contaminated in 2015 than in 2010.

The assessment of groundwater samples from under the base demonstrates low levels of all contaminants measured, signalling a good condition of the groundwater and that the impermeable deck at the base prevents contaminant transfer to the ground beneath the demolition facility.

Both surveys showed some contamination of sediment in Raunesvika. PAH levels were largely class II, but one PAH component (benso(ghi)perylene), which was analysed in 2015 only, was in class IV at one of the three stations investigated (class I at the other three). TBT was in class IV levels at two stations in Raunesvika. Levels of PCB7, mercury and other metal contaminants were low (class I) at all stations, both years. Similar findings of TBT and PAH in Raunesvika has been reported by several studies conducted before 2009, and several more remote fjord stations investigated in 2009 revealed the occasional presence of elevated (class II) levels of PAH, TBT and lead, showing that anthropogenic and industrial activities had left some foot-prints in the area also before 2009. It was concluded that neither the baseline studies nor any other available information gave any evidence for a consistent change in contaminant levels in these fjord sediments between 2009 and 2015

Sammendrag

AF Offshore Decom resirkulerer utrangerte offshoreinstallasjoner ved AF Miljøbase Vats på Raunes i Vindafjord kommune, Rogaland. Installasjonene blir delt opp i store deler og slept til land ved miljøbasen hvor de heises på land og blir videre tatt fra hverandre. Alle metaller sorteres for resirkulering og farlige komponenter og avfall behandles separat. Miljøbasen er utstyrt med et vannbehandlingsanlegg for overvann / prosessvann samt annen infrastruktur målrettet for å minimere utslipp av kjemiske forurensninger til miljøet.

I sammenheng med Ekofisk Cessation EPRD prosjektet (2009-2015) skal AF Offshore Decom dokumentere miljøtilstanden rundt basen før og etter arbeid med disse offshore installasjonene. Norsk Institutt for Vannforskning har i den sammenheng på oppdrag fra AF Offshore Decom utført en baseline studie ved anlegget i 2009 (Kvassnes et al. 2010), og nå denne gjentatte miljøundersøkelsen i 2015. Jord, grunnvann, marine sedimenter og menneskeskapt avfall på fjordbunnen utenfor basen er blitt undersøkt. Målet var å sammenligne baseline resultatene fra 2009 med tilsvarende data fra 2015, og derigjennom å vurdere i hvilken grad arbeidet med Ekofisk installasjonene i perioden 2009-2015 har påvirket omgivelsene ved miljøbasen.

Ved hjelp av ROV-undersøkelser ble den generelle biologiske tilstand og mengden av menneskeskapt skrap på fjordbunnen ved miljøbasen vurdert både i 2009 og 2015. Videre er det begge år gjort innsamling og kjemiske analyser av jordprøver, grunnvannsprøver og fjordsedimenter nær basen for å vurdere graden av forurensning fra virksomheten. Data fra 2015 ble sammenlignet med 2009 data for å vurdere om det var skjedd vesentlige endringer i perioden.

De visuelle undersøkelsene av fjordbunnen dokumenterte bunnforhold bestående av områder med grunnfjell og myke sedimenter, blandet med sand, grus og større steiner og steinblokker i den grunnere delen der de fysiske inngrep (utfyllinger, steinblokker) er gjort i sammenheng med utvidelser av kaianlegget ved Raunes. Organismesamfunnet som kunne påvises med ROV var omtrent som forventet for denne typen kystlokalitet, med fastsittende alger, tare, sjøstjerner, fisk og krabbe. ROV undersøkelsen i 2015 identifiserte 80 enkeltposisjoner for menneskeskapt skrap innenfor de to inspeksjonsområder Raunesvika og Grønavika. Mange forskjellige objekter ble påvist, for eksempel kvaser av vaier og tau, jernstenger, metallplater, stiger, ulike plast objekter, deler av lerreter og silt-gardiner, ruser, fiskegarn, trekonstruksjoner og mange bildekk av variable størrelser. Den totale mengden av gjenstander hadde gått noe ned i 2015 i forhold til 2009 som følge av opprydding.

Undersøkelsen av jordprøver på to stasjoner (J1 og J2) lokalisert rett ved miljøbasen viste at dette umiddelbare nærområdet var mer forurenset i 2015 enn i 2009, spesielt for PAH, kvikksølv og enkelte andre metaller. For eksempel var kvikksølvnivåene på den mest forurensede J1 stasjonen 20 ganger høyere i 2015 enn i 2009. I prøven fra J1 overskred kvikksølv, sink og fire PAH komponenter normverdien for følsom arealbruk, vurdert på basis av veiledende grenseverdier. Den påviste jordforurensningen synes likevel å være svært lokal og ujevnt fordelt ettersom et betydelig lavere forurensningsnivå ble målt ved den andre jordstasjonen J2 som kun ligger noen titalls meter fra J1 stasjonen. Både jord- og mose-prøver innsamlet og analysert i det årlige overvåkingsprogrammet har imidlertid vist at det foregikk en spredning av forurensing, spesielt kvikksølv, fra området like etter oppstart i 2009. Tiltak mot støvflukt fra anlegget som ble iverksatt etter undersøkelsene i 2010 har i de etterfølgende årene gitt generelt avtagende konsentrasjoner i terrenget rundt basen selv om enkeltprøver fremdeles kan vise forhøyede nivåer sammenlignet med 2009. Konsentrasjonene av kvikksølv var således lavere i 2015 enn i 2010 både på J1 og J2.

Målingene av grunnvannsprøver samlet fra fire brønner lokalisert inne på basen viste lave nivåer av alle forurensningskomponentene som ble målt, noe som signaliserer god tilstand av grunnvannet og at den ugjennomtrengelige membranen som ligger under anleggsområdet virker etter hensikten og hindrer forurensning fra å trenge ned i bakken.

Både i 2009 og 2015 ble det påvist forurensede sedimenter på fjordbunnen rett ved miljøbasen, nærmere bestemt i form av PAH16 som viste klasse 2 på en av stasjonene i Raunesvika og TBT som viste klasse IV på begge stasjonene. En PAH-komponent (benso(ghi)perylen) som bare ble analysert i 2015 viste klasse IV på en stasjon i Raunesvika, men var under deteksjonsgrensen på den andre stasjonen i Raunesvika og på begge de to stasjonene som ble undersøkt i Grønavika. PCB7, kvikksølv og andre metaller forelå kun i lave nivåer (klasse I) på alle stasjoner begge år både i Raunesvika og Grønavika. Tilsvarende funn av forhøyede nivåer av TBT og PAH i Raunesvika er blitt rapportert før 2009 og undersøkelsen i 2009 avdekket sporadisk forhøyede konsentrasjoner (klasse II) av TBT, PAH og bly på stasjoner i Yrkesfjorden og Krossfjorden, langt unna AFOD's bedriftsområde. Undersøkelsene har ikke gitt grunnlag for å konkludere at konsentrasjonsnivået av noen av de undersøkte forbindelsene i sedimentene i fjorden utenfor basen er endret i perioden mellom 2009 og 2015.

1. Introduction

1.1 Background and aim of study

In 2009, the AF Environmental Base Vats (AFEBV) started to demolish parts of the offshore installations dismantled in conjugation with the Ekofisk Cessation EPRD Project, a project which ends in 2015. Before the Ekofisk demolition activities started in 2009, a separate "baseline survey" was performed at AFEBV location at Raunes (Kvassnes et al. 2010) targeted to measure the contamination level in various environmental matrices (fjord sediments, soil samples, and groundwater samples) collected within or close by the AFEBV facility.

In the present study from 2015 similar assessments were conducted of the same environmental matrices obtained from the same positions close to AFEBV. The key objective of the present work is to provide a *before vs. after comparison* of the environmental contamination level at the AFEBV location. Furthermore, the amount of seafloor debris close to AFEBV was assessed both in 2009 and 2015 by means of ROV inspections and these results are also compared in the present report.

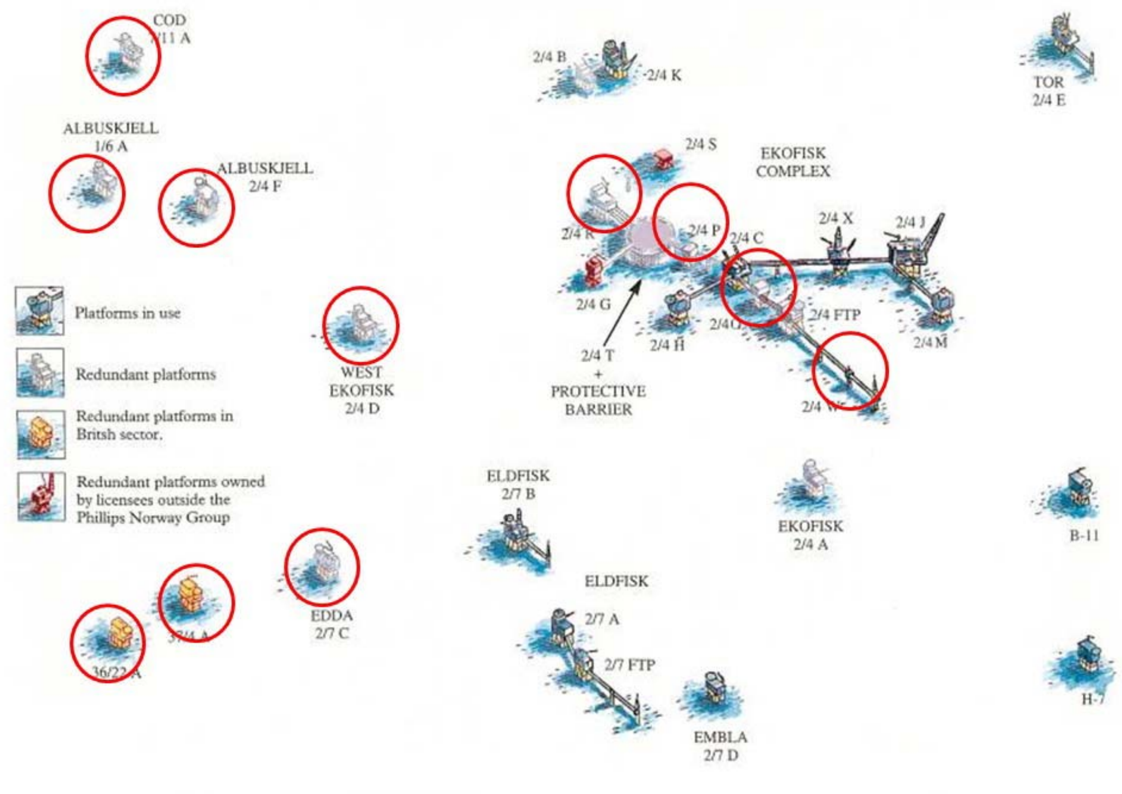

Figure 1. Platforms at the Ekofisk Field (2008). The platforms included in the EPRD project are flagged with a red circle.

1.2 Description of the AFEBV study location

AFEBV (AF Miljøbase Vats) is located at Raunes in Rogaland, on the west side of the Vatsfjord, a 5 km long fjord that meets the larger and deeper Yrkjefjord to the south (**Figure 2Figure 3**). AFEBV has expanded its quay areas over the years (**Figure 3**), presenting a deep-water quay with free access to the ocean (no sills).

The Vatsfjord has two basins that are separated by shallower glacial sills. AFEBV is located just south of the southernmost sill at Raunes. From the area close to AFEBV facility, the fjord deepens from the 30 meter deep sill to 160 meters depth where the Vatsfjord meets the Yrkjefjord (**Figure 2**).

The ground under the large quay area at AFEBV is protected against pollution by an impermeable membrane located under an inward-sloping tarmac quay deck. All rainwater that falls on the tarmac deck is collected and thoroughly cleansed in a sand-filter based water treatment system before the resulting effluent is discharged to the sea, this as a key measure for minimizing environmental release of chemical contaminates from the demolition facility.

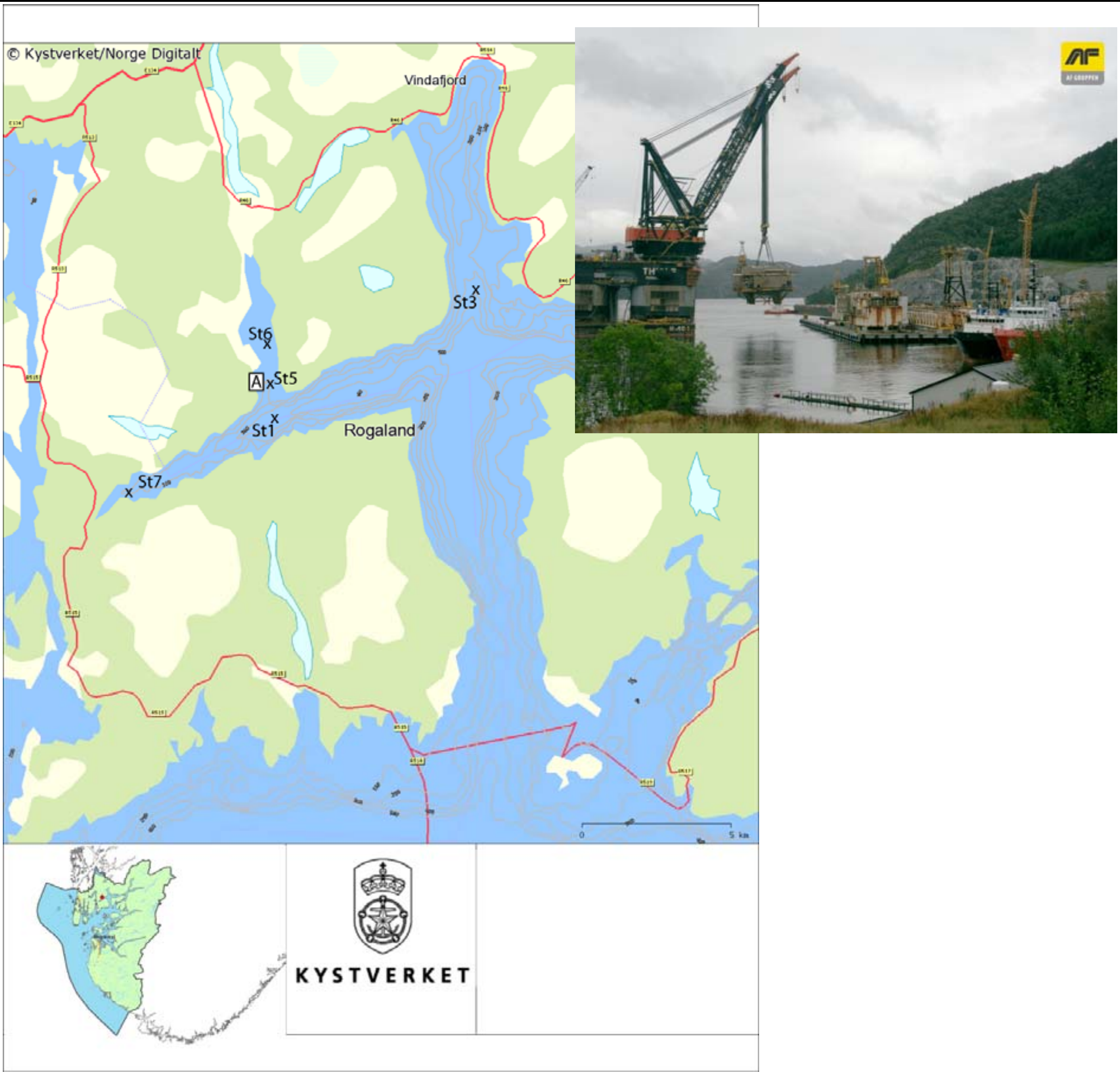

Figure 2. Sampling stations where 3-4 replicates of the fjord sediments have been collected. "A" refers to the area shown in Figure 1B, which includes the site of Miljøbase Vats (photo inserted).

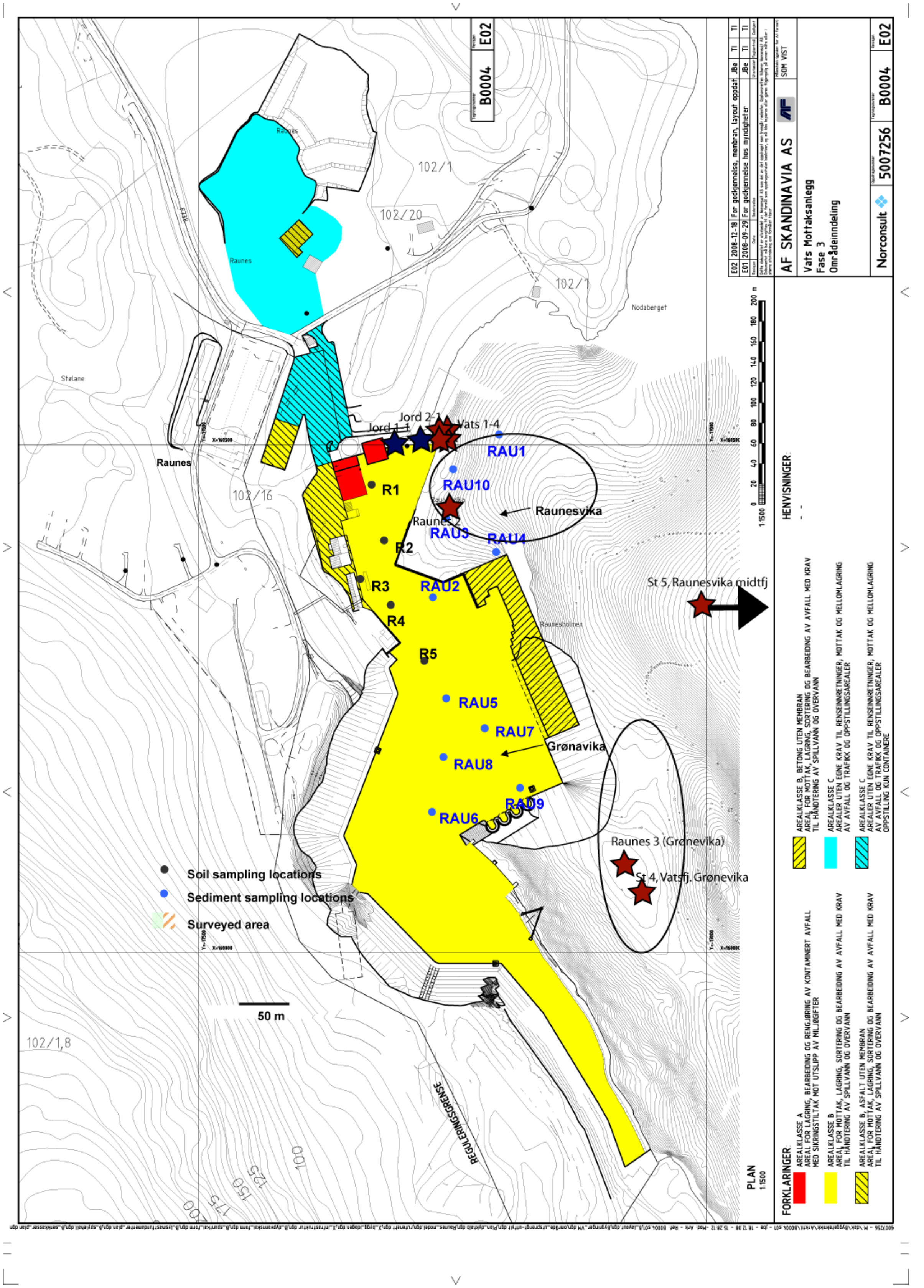

Figure 3. Sampling sites on and around AF Miljøbase Vats. Blue text (RAU#) indicates earlier sediment sampling sites. Black text (R#) indicates earlier soil sampling. Blue stars (Jord#) indicate sites for soil sampling in this study, brown stars indicate sediment sites. The ellipsoids indicate areas where sediment sampling was attempted in this study. The yellow field indicates the new quay areas.

1.3 Other studies performed at the AFEBV location

Table 1. Summary of all environmental studies performed at or near the AFEBV facility.

Year	Title / issue	By	Main conclusions
1999	Resipientundersøkelse i Vatsfjorden, Vindafjord Kommune	Rogalandsforskning (Tvedten, 1999)	The sewage discharge should be placed on the seaward side of the sill at Raunes due to the stagnant water on the inside of the sill give limited recipient capacity in the inner basins of the Vatsfjord. Thus, this mid-fjord discharge is spilled at depth in the same immediate basin as AF Miljøbase Vats.
2002	Assessment of environmental implications of mooring the Hutton TLP in Vatsfjorden	Rogalandsforskning (Kjeilen et al., 2002)	The environmental conditions along the quay in Grønavika are generally good. The site sediments and water column is considered to be little polluted and there are no differences between the stations at the quay and the reference stations. TBT was not analyzed.
2004	Environmental Baseline Report for Raunes, Vindafjord Kommune	Miljøbistand AS (Kristensen, 2004)	The soil is largely uncontaminated. For the sediments, there is TBT-contamination in Raunesvika (Class 4), and Grønavika in class 2-3; PAH Class 2-3 and 2-4 respectively. One sample detected DDT in Grønavika. Foreign debris was mapped.
2007	Miljøundersøkelse Vats-Ekofisk, avsluttende undersøkelse	COWI (Misund, 2007)	The soil is considered clean, with exception of chromium and oil-levels at a higher level than the limits for sensitive land use. Sediments in Raunesvika are still polluted with TBT (up to Class 4) but show a decreasing trend. Mercury is registered in class 2 in one sample. All other metals were in class 1. The sediments in Grønavika are still polluted with TBT (class 4 in one site, other sites class 1 and 2). PAH levels are low, and lower than in 2004. Mercury was registered in class 2 in one point (RAU7), possibly due to activities on site. DDT was not detected. Foreign objects consisted of tires, metal debris and pipes were registered.
2008	Miljøundersøkelse Vats – Ekofisk, baseline undersøkelse	COWI, (Misund, 2008b)	The soil is considered clean, with the exception of chromium and oil-levels at a higher level than the limits for sensitive land use. Mercury is not detected. Somewhat increased zinc. Sediments are still polluted with TBT up to class 4. PAH is increased but still in class 2. Mercury is in class 1 in all points and the positive effect of the new sandfilter is observed. The other metals are in class 1. Grønavika has less TBT contamination than Raunesvika. Some samples, however, show an increase. PAH is low, class 1. All measurements for mercury are in class 1 and 2. DDT was found in one sample. Foreign objects were tires and metal debris in both bays.
2008	Analyser av Blåskjell ved og rundt Vats Mottaksanlegg	NIVA, (Kvassnes, 2008)	The current heavy metal level in the mussels is low, and arsenic is the only metal that is in the lower end of environmental class 2 (SFTs veileder 97:3) and it appears that this represents a general higher level of this metal in the bay.
2008	Gjennomgang av rapporter fra undersøkelser i Vatsfjorden – Fokus på Vats Mottaksanlegg	COWI (Misund, 2008a)	A review of previous investigations at Miljøbase Vats. They find it likely that small amounts of mercury have been released into the bays of Grønavika and Raunesvika. In Raunesvika it is likely that the mercury was released before the initiation of the sandfilter was added to the process-water line in 2006. TBT was slightly increased in Raunesvika but decreased in Grønavika. The ROV investigations found metal-debris and rubber-tires in the bays but there is no significant change in the environmental state from 2007 to 2008.
2009	Undersøkelser av mulig transport av tungmetaller via Rauneselva ut i sjøen	COWI (Misund, 2009)	Norway's local branch of Green Warriors had sampled sediments 20m from the mouth of Rauneselva and the sample showed a very high level of mercury (2.3 mg/kg) and zinc (1000mg/kg). A hot-spot investigation was performed and attempts were made to reproduce the values. The hotspot was not found and no mercury-levels were at the level found by the GW. There was, however, evidence of leaky seals along a concrete wall leading to elevated levels of mercury in the soil directly outside them.
2009	Partikkelforurensing i Vatsfjorden	NIVA (Johnsen and Dale, 2009)	Increased turbidity in relation to construction of the new quay-areas at AFEBV was investigated. Small, platy mineral-grains were found in the water-masses and some layers of the water-column carried these rock-particles inward in the Vatsfjord. Particles were mostly not carried across the fjord and it was concluded that environmental impact of particles for marine fish or mussels was unlikely.
2009	AFD2-D-GEN-EG-0001: environmental baseline survey report : Ekofisk Cessation EPRD Project	NIVA (Kvassnes et al., 2010b)	Sediments at the study site is contaminated with TBT (SFT Class IV, TA-2229) and PAH (Class II), but not at a higher level than was previously shown. The remaining components (As, Ba, Cd, Co, Cr, Cu, Hg, Mo, Ni, P, Pb, V, Zn, PCBs, Pentaclorbenzene, alpha-HCH, Hexachlorbenzene, Gamma-HCH, Octachlorstyrene, 4,4-DDE, 4,4-DDD, MBT, DBT, MPT, DPT and TPT) analyzed in the samples close to the site are in SFT Class I, not classified or not detected. This includes mercury, a heavy metal, of which some material leaked into the bays between 2004 and 2006. The well-water appears to be in good condition, whereas there is a slightly elevated level of contamination in the soil samples, where zinc and arsenic are right above the SFT norm levels for sensitive land use. Large rocks and metallic debris are found along the shore, with smothering from fine rock-dust due to the recent expansion of the quay areas. The biological state is as expected in Raunesvika, an active quay area, with fish, kelp and other typical fauna and flora for the region.
2009-2014	Five annual reports and one summary report of the environmental monitoring program at EFEBV for the period 2009-2014	NIVA (Beyer et al., 2015a; Beyer et al., 2014; Beyer et al., 2015b; Kvassnes and Hobæk, 2012; Kvassnes et al., 2013; Kvassnes et al., 2011; Kvassnes et al., 2010a)	Monitoring of emissions to sea from the water treatment plant shows that AFEBV has operated within the discharge permit, assessed on the basis of annual emissions. For high priority pollutants, such as mercury, the discharge has been consistently well below the discharge permit. However, specific groups of substances in the discharge, such as PFOS, should be followed up closely in the further monitoring. Analyses of groundwater collected under the quay deck show low levels of pollutants, apart from a few single samples early in the program period. This indicates that the protection membrane positioned under the quay deck works as intended. In the first years of the monitoring program, a moderate increase of metal contamination (including mercury) was observed in samples of stream water, soil and moss collected in the ultimate vicinity of AFEBV. This local contamination was most likely due to dust spreading from the facility. Measures implemented for limiting the dust problem led to declining contamination in the latter phase of the program period. In the sea adjacent to AFEBV, bottom sediments showed broadly good environmental status, but older pollution (especially TBT) was still markedly present. The monitoring of fish (Atlantic cod, plaice and tusk) and shellfish (mussels and crab) in the fjord outside AFEBV showed generally low levels of pollutants, predominately within environmental class I or II according to the Norwegian classification system for coastal waters. Time trend analyses for all pollutants measured in fish, crabs and mussels showed several significant upward and downward trends over the five years period. However, most of these trends appear to be regional and none could be attributed to discharges from AFEBV. In summary, the results obtained within the environmental monitoring program by AFEBV indicate that emissions from the facility have had very little impact, if any, on the pollution status in the fjord environment outside the base during the period 2009-2014.
2014	Metaller og organiske miljøgifter i sjømat fra Vatsfjorden	NIFES, (Frantzen and Måge, 2014)	Results of a field survey of contaminant levels in mussels, crabs and fish in Vatsfjord and Yrkjefjord suggest that the seafood in the area is somewhat affected by mercury and PCBs, but not at levels that provide a basis for dietary advice.

2. The field surveys at AFEBV in 2009 and 2015

2.1 ROV inspection of the seabed

This underwater survey in the neighboring fjord environment by AFEBV includes the registration of scrap and waste objects at the seabed, as well as a simple biological / sedimentology evaluation of the area.

The survey was performed 26th – 27th of May 2015 using an ROV of the type Argus Mariner 1 (Figure 4) which was operated by the crew at the parent vessel MS Scuba (Amundsen Diving). Marine biologist Mats Walday from NIVA did registrations. The visibility in the water was good (> 10m) during work. The two areas that were examined in the present survey, Raunesvika and Grønavika, have been investigated several times previously; in 2004, 2009 (previous baseline) and in 2012. The survey in 2004 did not use a ROV with positioning equipment. Thus, a comparison of observations from the 2004 survey with the findings in the other ROV surveys (including the present one) is hampered with relatively large degree of uncertainty.

The ROV was run in a search patterns within the two specified areas. A depth range from 1-60 meters was covered. Although the main purpose of the survey was to identify anthropogenic material, also different biological conditions of the seabed were observed and recorded. A number of waterpipes and tubes were observed at the bottom in the area north of the main jetty. Most of these are positioned on the sea chart and was here not registered as anthropogenic material. It was recorded a log through the survey in which all other anthropogenic materials observed were position determined, characterized, and in many cases also photographed.

Some of the specified positions and depths are not 100% accurate as the ROV films down towards the bottom and since the ROV sometimes is not close to the observed object. These inaccuracies are relatively small, however, and should not have any practical significance for this study. All movies and photos from the recordings are stored by NIVA.

Figure 4: Left: The ROV from Amundsen which was used during the registrations 26.-27. May 2015. Right: The control room of parent vessel MS Scuba where the ROV pilot sits and where the recordings and records were made.

2.1.1 Results

It was during the 2015 survey registered a total of 80 positions within the surveyed area where different kinds of anthropogenic material were found (Table 2). The positions of all observed materials recorded during the 2009, 2012 and 2015 surveys are shown on the aerial images shown below (Figure 7, Figure 8, Figure 9).

Generally in both areas, the seabed was in a 'living bottom' condition status. In both areas, we encountered holes and traces of benthic animals on the sediment surface (Figure 5).

However, there was relatively little degree of fouling to be found on the rocks and boulders on the seabed. This was especially the case in the slightly deeper areas of Grønavika south of the quay where the seafloor was filled with a lot of rocks (Figure 6). In the upper 10-12 m we found scattered occurrences of sugar kelp and commonly occurring threadlike brown algae (Figure 6). A few places, dense occurrences of large hydroids were observed. And in the shallow part of this area, quite a lot of small wrasse fish were observed along the shoreline. We also saw a number of gadoid fish individuals, these were most probably saithe. It is a general challenge to estimate the actual density of fish at a location as based on ROV filming since it is likely that the same fish will be recorded several times during the filming.

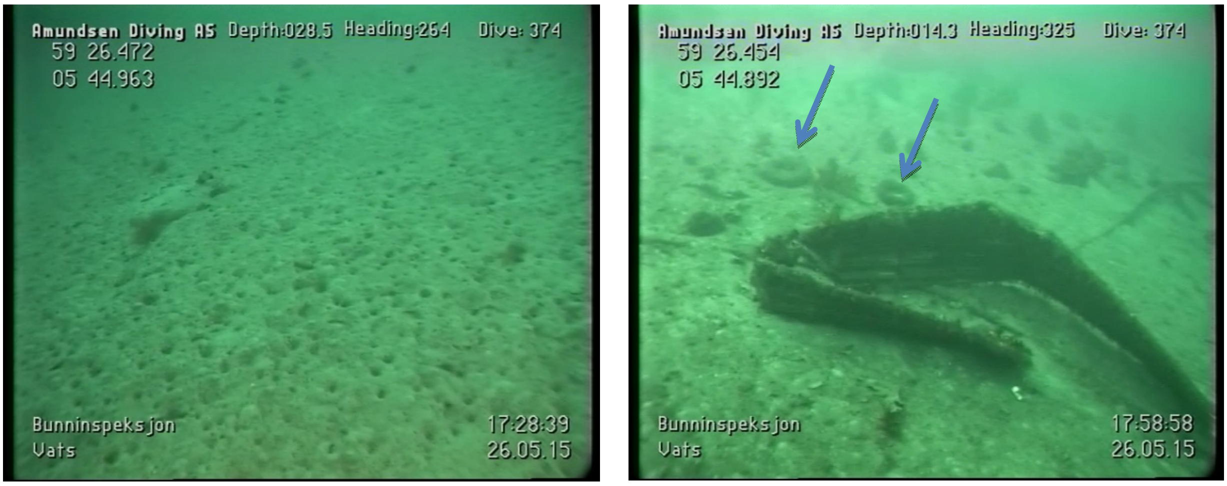

Figure 5: Left: Many holes and grooves in the bottom indicate a live bottom. Here at ca. 30 m depth in the area north of the main quay. Right: A piece of corrugated iron and in the background tires (arrow) can be seen. The picture is taken from ca. 15 m depth in the area north of the main quay. Relatively many tires were observed at approximately 10-15m depth in this area.

Figure 6: The pictures show the area south of the main quay which was scattered with large rocks and boulders. Left picture show rocks at 26 m depth with only little algal fouling. Right picture: at approx. 11 m depth there was with significantly more fouling present, in particular sugar kelp and hydroids as can be seen on the rocks in the foreground.

During the ROV surveys in 2009 and 2015, a range of miscellaneous scrap iron, plastic debris, wires, cables, piece of tube, corrugated iron sheets, scaffolding residues, fishing gear, various rubber tires, and several trees were recorded and positioned. Although a considerable amount of seabed debris had been removed from this location after the previous baseline survey in 2009, the present ROV survey clearly shows that there is still a considerable amount of anthropogenic material on the bottom in this area (Table 2). It was approximately the same number of debris found in 2015 as in 2012. Survey conditions were very good in 2015, making it easy for the ROV to spot debris.

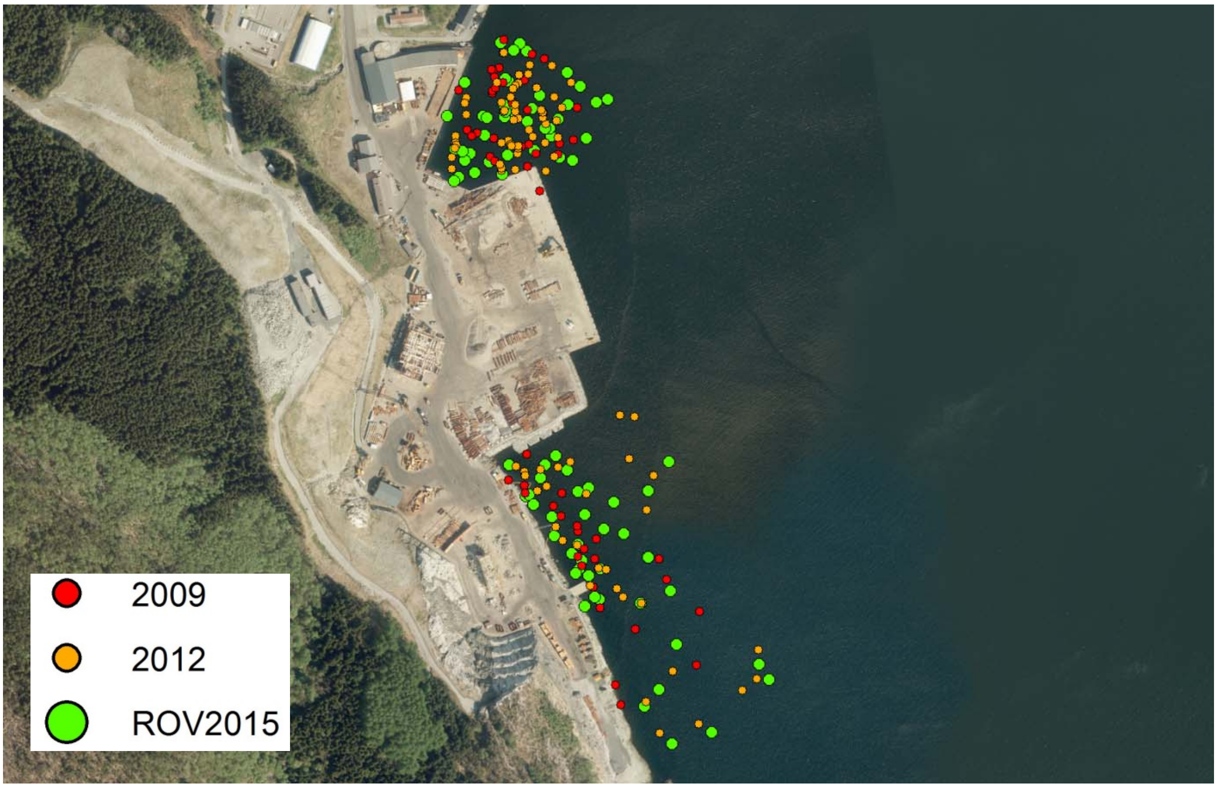

Figure 7: This overview picture shows the positions of all anthropogenic materials that have been registered and positioned during the ROV surveys conducted in 2009, 2012 and 2015.

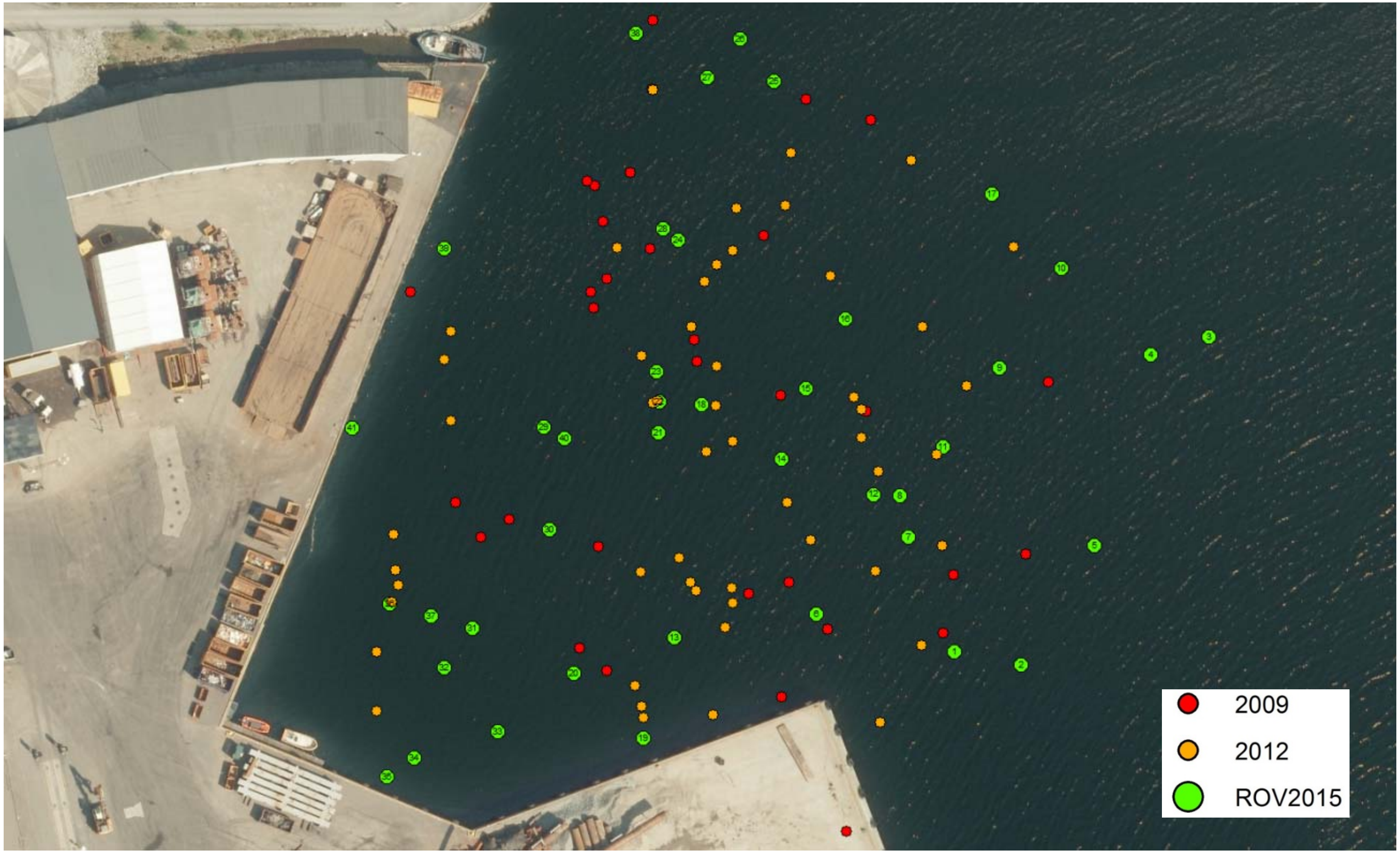

Figure 8: This picture shows the positions of all anthropogenic materials that have been registered and positioned in the area Raunesvika (north of the main quay) during the ROV surveys conducted in 2009, 2012 and 2015. For data registered in 2015, each individual debris object is given a ID number which also is referring to the observations summarised in Table 2.

Figure 9: This picture shows the positions of all anthropogenic materials that have been registered and positioned in the area Grønavika (south of the main quay) during the ROV surveys conducted in 2009, 2012 and 2015. For data registered in 2015, each individual debris object is given a ID number which also is referring to the observations summarised in Table 2.

Table 2: This table provides a summary of all anthropogenic materials that have been registered and positioned during the 2015 ROV survey. Objects with ID numbers 1-41 are located within Raunesvika in the area north of the main quay, whereas objects with ID numbers 42-80 are located in Grønavika in the area south of the main quay. Time, depths and position data for all objects registered are shown.

Object ID	Obs. Time	Depth (ca)	Object	Latitude	Longitude	Film
1	26.05.15 17:02	26	Steel rod	59.44048	5.74918	1
2	26.05.15 17:04	28	Part of construction scaffold	59.44047	5.74940	1
3	26.05.15 17:08	29	Concrete blocks, canvas, steel rope	59.44102	5.74995	1
4	26.05.15 17:14	31	Ladder and pipe section	59.44098	5.74977	1
5	26.05.15 17:16	36	Rubber mat	59.44067	5.74962	1
6	26.05.15 17:20	19	Water pipe (probably in use`?)	59.44053	5.74873	1
7	26.05.15 17:22	25	Rubber mat	59.44067	5.74902	1
8	26.05.15 17:24	24	Car tire	59.44073	5.74898	1
9	26.05.15 17:25	31	Corrugated iron plate	59.44095	5.74928	1
10	26.05.15 17:27	29	Box, canvas, loose weights for water pipe	59.44112	5.74947	1
11	26.05.15 17:30	29	Rubber mat and several tires	59.44082	5.74912	1
12	26.05.15 17:31	25	Big car tire	59.44073	5.74890	1
13	26.05.15 17:34	11	Tire with kelp on	59.44048	5.74828	1
14	26.05.15 17:37	21	Tire	59.44078	5.74860	1
15	26.05.15 17:39	25	Thin water pipe with lead rope around	59.44090	5.74867	1
16	26.05.15 17:40	25	Corrugated iron plate (with fish, ling)	59.44102	5.74878	1
17	26.05.15 17:42	27	Tire	59.44123	5.74923	1
18	26.05.15 17:46	16	Corrugated iron plate and many tires	59.44087	5.74833	2
19	26.05.15 17:52	6	Staircase	59.44032	5.74820	2
20	26.05.15 17:55	9	Tire (with fish, wrasse)	59.44042	5.74797	2
21	26.05.15 17:57	16	Corrugated iron plate	59.44082	5.74820	2
22	26.05.15 17:58	17	Ladder	59.44087	5.74820	2
23	26.05.15 17:59	16	Corrugated iron plate and several tires	59.44092	5.74818	2
24	26.05.15 18:00	16	Thin pipeline with lead rope around	59.44113	5.74823	2
25	26.05.15 18:02	17	Plate	59.44140	5.74852	2
26	26.05.15 18:03	16	Rope	59.44147	5.74840	2
27	26.05.15 18:05	14	One big and one small tire	59.44140	5.74830	2
28	26.05.15 18:09	15	2 tires	59.44115	5.74818	2
29	26.05.15 18:12	14	2 tires	59.44082	5.74783	2
30	26.05.15 18:13	14	4 tires	59.44065	5.74787	2
31	26.05.15 18:14	9	9 tires	59.44048	5.74763	2
32	26.05.15 18:16	8	Unknown object and tire	59.44042	5.74755	2
33	26.05.15 18:17	6	Silt curtain (SILTDUK)	59.44032	5.74773	2
34	26.05.15 18:19	5	Tire	59.44027	5.74747	2
35	26.05.15 18:32	5	Crab trap	59.44023	5.74738	3
36	26.05.15 18:36	5	Rope, floating upwards	59.44052	5.74737	3
37	26.05.15 18:36	6	Big tire	59.44050	5.74750	3
38	26.05.15 18:43	7	Several tubes	59.44147	5.74807	3
39	26.05.15 18:47	5	Parts of pipes	59.44110	5.74748	3
40	26.05.15 18:48	5	Plastic grid	59.44080	5.74790	3
41	26.05.15 18:50	5	Grid	59.44080	5.74722	3
42	26.05.15 19:18	38	Plastic debris	59.43787	5.75132	4
43	26.05.15 19:35	52	Scrap	59.43600	5.75322	4
44	26.05.15 19:37	49	Pipe parts	59.43613	5.75303	4
45	26.05.15 20:03	41	Small part of a ventilation pipe	59.43760	5.75098	5
46	26.05.15 20:29	37	Tire	59.43673	5.75145	5
47	26.05.15 20:32	35	Traffic obstruction objects	59.43702	5.75103	5
49	27.05.15 8:59	27	Big part of a Tree	59.43760	5.74995	7
50	27.05.15 9:00	35	Rod	59.43748	5.75040	7
51	27.05.15 9:02	34	Rope/band	59.43722	5.75060	7

Object ID	Obs. Time	Depth (ca)	Object	Latitude	Longitude	Film
52	27.05.15 9:06	31	Rope / tube	59.43627	5.75160	7
53	27.05.15 9:28	31	Steel rope	59.43552	5.75227	8
54	27.05.15 9:34	26	Plastic debris/big box?	59.43662	5.75095	8
55	27.05.15 9:37	29	'Rod'-like structure	59.43725	5.75025	8
56	27.05.15 9:38	28	Part of a tube	59.43737	5.74992	8
57	27.05.15 9:39	30	Big tire and steel rope	59.43757	5.74977	8
58	27.05.15 9:42	18	Steel rope	59.43775	5.74957	8
59	27.05.15 9:46	12	Steel rope	59.43787	5.74937	8
60	27.05.15 9:49	17	Tire	59.43778	5.74918	8
61	27.05.15 9:53	19	Steel ring, steel rope, water pipe(?)	59.43710	5.74982	8
62	27.05.15 9:55	22	Parts of a construction scaffold	59.43690	5.75022	8
63	27.05.15 10:04	10	Tree	59.43540	5.75160	8
64	27.05.15 10:07	14	Tree	59.43587	5.75133	8
65	27.05.15 10:13	15	Plastic tube	59.43697	5.74990	9
66	27.05.15 10:17	14	Reinforcing rods (?)	59.43767	5.74912	9
67	27.05.15 10:24	10	Scrap by a column	59.43733	5.74935	9
68	27.05.15 10:26	11	Rod-like structure	59.43702	5.74972	9
69	27.05.15 10:27	14	Long iron chain	59.43688	5.74985	9
70	27.05.15 10:28	13	Fish trap	59.43683	5.75003	9
71	27.05.15 10:36	7	Tree	59.43572	5.75110	9
72	27.05.15 10:44	9	Unknown object	59.43663	5.75023	9
73	27.05.15 10:45	8	Thin floating rope	59.43665	5.75015	9
74	27.05.15 10:48	7	Wooden pole	59.43717	5.74940	9
75	27.05.15 10:52	7	White plastic scrap and pipe part	59.43750	5.74888	9
76	27.05.15 10:53	7	Bended metal scrap, grids, tires	59.43752	5.74893	10
77	27.05.15 10:57	6	Tree	59.43777	5.74857	10
78	27.05.15 11:01	8	Metal and pipe parts	59.43743	5.74902	10
79	27.05.15 11:08	6	Fish net	59.43685	5.74980	10
80	27.05.15 11:12	5	White electric cable	59.43657	5.74998	10

2.2 Contaminant concentrations in groundwater

The demolition area of AFEBV has an impermeable membrane / tarmac deck which have the purpose of preventing contaminated surface water from penetrating into the ground. All surface water is collected and treated in the water treatment facility. Samples of the groundwater under demolition area can be collected from four sealed wells which all are going through the impermeable membrane under the tarmac of the quays (Figure 10). Each of these wells is approximately 5 m deep and the locations of the four wells are shown in **Figure 11**.

The main purpose of the sampling of the groundwater wells is to investigate whether the membrane functions properly, and is successful in preventing leaks to the subsoil area. The water sample is obtained by use of a 5-meter long water-hose and a sub-surface pump. Each well is sampled with its individual and clean pump and hose. The water was siphoned directly into the sample bottles, sealed and sent to the laboratory.

The results of the analyses for the 2009 and 2015 samples are shown in Table 3.

Figure 10: Groundwater samples from four wells in the quay deck are collected for analysis of contaminant levels.

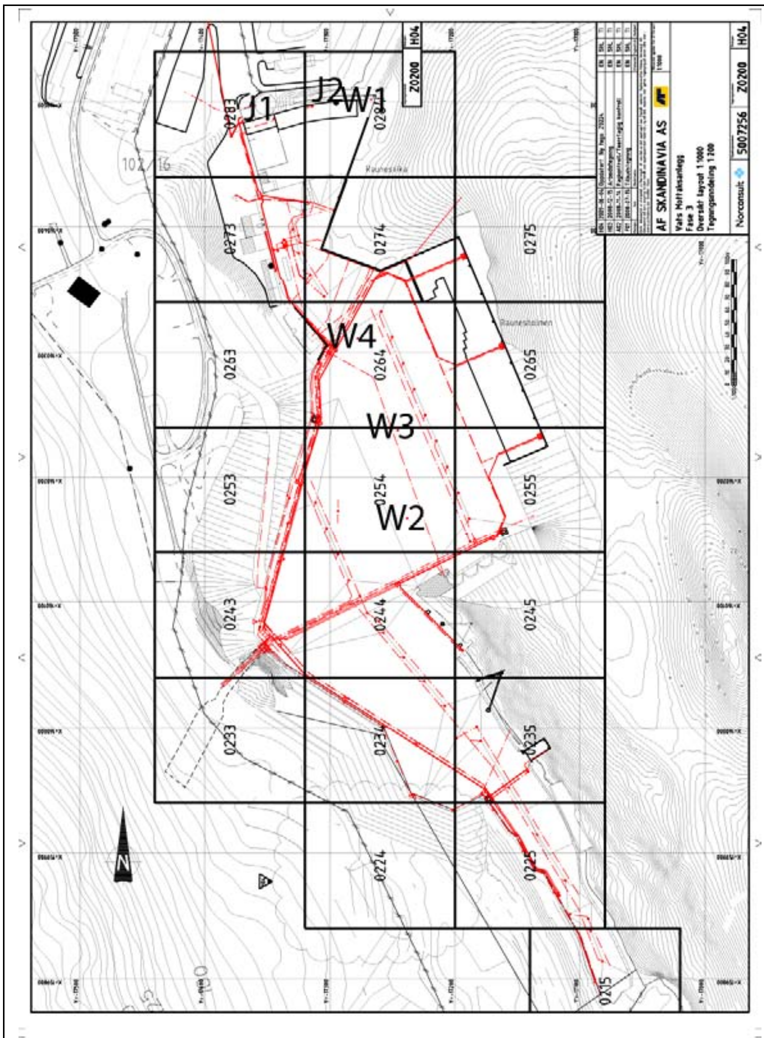

Figure 11. Location of wells (W1-W4) and soil samples (J1, J2) at AF Miljøbase Vats

2.2.1 Results

As can be seen from the results, the concentration-levels of contaminants are generally low. In 2009, many values were below the level of detection for most parameters (Cd, Hg and Pb), but this could partly be due to an unsatisfactory poor analytical quantification levels for these analyses at that rime. For the 2015 analyses, the levels of analytical quantification for the Cd, Hg and Pb analyses were significantly improved. However, as can be seen from the numbers given in Table 3, the observed contamination values for these parameters in the 2015 samples were consistently low. The observed iron-levels indicate a decrease in three of four wells between 2009 and 2015. The recorded pH values is as expected for groundwater and if there is seawater in the subsurface (groundwater ranges from pH 7-8.2 (source NGU), whereas seawater has a general pH around 8.15.

Table 3: Analysis results for 2009 and 2015 for contaminant levels detected in groundwater samples from the four wells located within the demolition area of AFEBV.

Date	Sample	pH	Cadmium µg/l	Iron mg/l	Mercury µg/l	Lead µg/l	Oils µg/l
20090706	Well 1	7,95	<2	0,188	<0.05	<20	<50
20090706	Well 2	7,71	<2	0,121	<0.05	<20	<50
20090706	Well 3	8,02	<2	0,755	<0.05	<20	<50
20090706	Well 4	7,93	<2	0,744	<0.05	<20	<50
20150527	Well 1	7,65	<0,06	0,059	0,003	0,10	<50
20150527	Well 2	7,76	<0,03	0,13	0,002	0,16	<50
20150527	Well 3	7,78	0,08	0,259	0,002	0,45	<50
20150527	Well 4	7,86	<0,03	0,177	0,004	0,23	<50

Water samples from the four wells at AFEBV have also been analyzed twice a year throughout the period 2009 – 2014, in connection with the environmental monitoring program of the facility. A relevant finding from those analyses was a few observations of temporarily increased contamination level early in the monitoring program, e.g. for mercury (Figure 12). These results indicated that there were occasional leakages of contamination into the well water early in the monitoring program, and this was explained as most likely being caused by with improper sealing at the wells were the contamination was found. For example, some insulating plates from the lids of the wells were observed to have fallen into the wells. After better sealing of the wells was implemented, only low levels have been found after 2012, as can be seen in Figure 12.

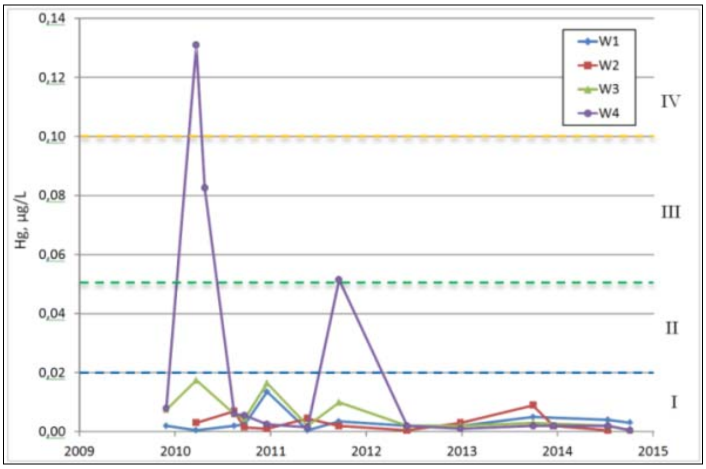

Figure 12: Time trend of Hg levels in water samples from the groundwater wells at AFEBV during the period 2010 – 2014 (data from the environmental monitoring program at AFEBV).

2.3 Contaminant concentrations in soil samples

There is currently not any natural soil areas left inside the facility area of AF EBV, and soil samples were therefore obtained from two positions (J1 and J2) located just outside the plant, in the narrow brim between the Raunes River and the wall at the north end of the AFEBV area (Figure 13). The positions of the two soil stations (J1 and J2) are shown in the area map in Figure 11. Both soil stations J1 and J2 were used in the 2009 and the 2015 soil collection.

The J1 station was located close to seals in the northern wall where a study performed by COWI had found elevated levels of mercury and zinc and is taken at the same site as the R11 sample in the COWI report (Misund, 2009).

In 2009, each soil sample was taken from the top 10 cm of soil material and scooped up into burnt glass-jars and submitted to the analytical laboratory for determination of heavy metals and a selection of other contaminants. In the 2015 soil sample collection, the 10-15 cm top layer of the ground was removed and the soil was sampled into Rilsan plastic bags, which are particularly suitable for collection and transport of samples, including soil samples.

A larger number of contaminants were determined in 2015 as compared to 2009 when the Eurofins SFTJ analytical package was used, an analytical package that satisfied the regulatory norms for sensitive land use at that time (Aquateam 2009).

Figure 13: Collection of soil samples was done from two positions within the narrow brim located between the Raunes River and the wall at the north end of the AFEBV area.

2.3.1 Results

The results of the soil analyses for the 2009 and 2015 samples from the J1 and J2 stations are shown in Table 4. The table also includes estimates of relative difference (fold change) between 2009 and 2015 for both sample positions. Results from both years show that the J1 position was in general more contaminated than the J2 position (Table 4). Furthermore, the fold change comparison between 2009 and 2015 values reveals quite clearly that both J1 and J2 positions have become more contaminated during this six years period. The largest difference is seen for mercury at the J1 position with 20 times higher values quantified in the 2015 sample in comparison to the 2009 sample. The increasing trend is also illustrated by the larger number of parameters in the 2015 sample that fail the norm value for sensitive land use (norm according to the TA-1629 guideline). In 2009, only the benzo(b)fluoranthene concentrations in the J1 sample exceeded the norm value, whereas the Zn concentration in the J1 sample was at the borderline. In comparison, six parameters in the J1 sample and one parameter in the J2 sample failed the norm level based on the 2015 data (Table 4).

Table 4: Comparison of soil contamination data from 2009 and 2015 for samples obtained at the two soil stations J1 and J2, which both are situated very close to the AFEBV facility. Also the norm values for sensitive land use according to SFT guideline TA-1629 are shown, and values exceeding the norm are marked with solid box lines. The fold change between 2009 and 2015 are calculated when both data values are above the limits for analytical determination.

		NORM	J1 position			J2 position		
Parameter	Unit	TA-1629	2009	2015	Fold change	2009	2015	Fold change
Dry matter (E)	%		98	89,4	0,91	99	88,9	0,90
As (Arsen)	mg/kg TS	8	3,3	2,42	0,73	1,9	1,92	1,01
Cd (Kadmium)	mg/kg TS	1,5	0,28	<0.10	-	0,44	<0.10	-
Cr (Krom)	mg/kg TS	50	16	25,20	1,58	7	18,4	2,63
Cu (Kopper)	mg/kg TS	100	12	32,6	2,72	8,4	19,8	2,36
Hg (Kvikksølv)	mg/kg TS	1	0,14	2,84	20,29	0,014	<0.20	-
Ni (Nikkel)	mg/kg TS	60	14	23	1,64	5,6	16,5	2,95
Pb (Bly)	mg/kg TS	60	13	18,7	1,44	6,2	10,4	1,68
Zn (Sink)	mg/kg TS	200	200	428	2,14	100	96	0,96
Cr6+	mg/kg TS			0,364	-		0,22	-
Cyanid-fri	mg/kg TS	1	n.d.	<0.10	-	n.d.	<0.10	-
THC	mg/kg TS		n.d.		-	n.d.		-
Sum PCB-7	mg/kg TS	0,01	n.d.	n.d.	-	n.d.	n.d.	-
g-HCH (Lindan)	mg/kg TS		n.d.	<0.0010	-	n.d.	<0.0010	-
o,p'-DDT	mg/kg TS	0,04	n.d.	<0.010	-	n.d.	<0.010	-
p,p'-DDT	mg/kg TS			<0.010	-		<0.010	-
o,p'-DDD	mg/kg TS		n.d.	<0.010	-	n.d.	<0.010	-
p,p'-DDD	mg/kg TS		n.d.	<0.010	-	n.d.	<0.010	-
o,p'-DDE	mg/kg TS			<0.010	-		<0.010	-
p,p'-DDE	mg/kg TS		n.d.	<0.010	-	n.d.	<0.010	-
1,2,3,5+1,2,4,5-Tetraklorbensen	mg/kg TS	0,05	n.d.	<0.020	-	n.d.	<0.020	-
Heksaklorbensen	mg/kg TS	0,03	n.d.	<0.0050	-	n.d.	<0.0050	-
Naftalen	mg/kg TS	0,8	0,0019	<0.010	-	n.d.	<0.010	-
Acenaftylen	mg/kg TS		n.d.	<0.010	-	n.d.	<0.010	-
Acenaften	mg/kg TS	0,8	0,0023	0,011	4,78	n.d.	<0.010	-
Fluoren	mg/kg TS	0,8	0,056	<0.010	-	n.d.	<0.010	-
Fenantren	mg/kg TS	0,8	0,013	0,049	3,77	0,001	<0.010	-
Antracen	mg/kg TS	0,8	0,034	<0.010	-	n.d.	<0.010	-
Fluoranten	mg/kg TS	1	0,025	0,114	4,56	0,0038	0,037	9,74
Pyren	mg/kg TS	1	0,022	0,094	4,27	0,0038	0,032	8,42
Benso(a)antracen	mg/kg TS	0,03	0,015	0,055	3,67	0,0041	0,023	5,61
Krysen	mg/kg TS	0,03	0,022	0,056	2,55	0,0066	0,026	3,94
Benso(b)fluoranten	mg/kg TS	0,01	0,026	0,092	3,54	0,0044	0,044	10,00
Benso(k)fluoranten	mg/kg TS	0,09	0,019	0,028	1,47	0,0038	0,015	3,95
Benso(a)pyren	mg/kg TS	0,2	0,022	0,052	2,36	0,0036	0,025	6,94
Dibenso(ah)antracen	mg/kg TS	0,05	0,0045	0,012	2,67	n.d.	<0.010	-
Benso(ghi)perylen	mg/kg TS	0,1	0,024	0,049	2,04	0,003	0,023	7,67
Indeno(123cd)pyren	mg/kg TS	0,05	0,027	0,051	1,89	0,0027	0,024	8,89
Sum PAH-16	mg/kg TS	2	0,26	0,66	2,54	0,036	0,25	6,94
Xylener	mg/kg TS	1	0,021	<0.0150	-	n.d.	<0.0150	-
Pentaklorfenol	mg/kg TS	0,005	n.d.	<0.006	-	n.d.	<0.006	-

2.4 Contaminant concentrations in fjord sediments

The field work in 2009 included sediment sampling also at several reference stations in Yrkjefjorden, relatively far from AFEBV, this was done in order to provide information about the typical background level of contamination in this region. It was considered to be unnecessary to repeat the sampling at these far-away stations for the 2015 sediment sampling, as it was the stations close to AFEBV that were relevant for the before-after comparison that is addressed in this study.

The variable conditions of the seafloor within Vatsfjorden suggest a need for using varied sampling-approach to obtain good quality samples. In particular, in the area close to AFEBV the seafloor is largely consisting of rocks and hard-bottom which makes it difficult to find positions that allow van Veen sediment grabbing. At these stations, several repeated grab shots will often be required to provide enough sediment material.

In 2009, NIVA performed the sampling of the soft-bottom sediments from the 5^{th} to the 8^{th} of May 2009 using the vessel MS Solvik, in varying weather conditions ranging from calm to gale. "St4, Vatsfj. Grønavika" and "St6 Indre Vatsfjorden" was sampled with a van Veen grab and the top 2 cm of sediments was sub-sampled from undisturbed sediments.

In 2015, the sediment samples were taken from the boat «Scallop» operated by Kvitsøy Sjøtjenester AS and with Bjarte Espevik as crew. Responsible for field work from NIVA was Jarle Håvardstun and Lise Tveiten. Since geographical coordinates of sediment stations were not given in the earlier baseline report (NIVA report 5915-2010), the localization of the sediment stations close to AFEBV was based on the station maps (**Figure 3**). The exact sampling points used in 2015 can therefore differ slightly from the 2009 sampling. The geographical coordinates for the sediment stations used in 2015 were registered and are given in Table 5, whereas the sampling depths, and a visual description of each sediment sample collected for analysis is given in Table 6. For the 2015 sediment sampling we used a van-Veen bottom sampler collecting a surface area of $0{,}1 m^2$. All replicate samples had a clear water surface on top of the sediment layer. This water was removed with a siphon before taking out a surface sample of approximately 0-2 cm of the surface layer.

Figure 14: Drone picture from the sediment collection in Raunesvika in 2015, with the boat located approximately over the Raunes 2 sediment station.

Table 5: Station names and geographical coordinates for the sediment stations close to AFEBV used in the 2015 sediment survey.

Station name	N	E
St. 4 Vatsfjord	59°26,252	5°45,057
St. Raunes 3	59°26,268	5°45,043
St. Raunes 2	59°26,437	5°44,866
St. Vats 1	59°26,485	5°44,867
St. Vats 2	59°26,485	5°44,878
St. Vats 3	59°26,485	5°44,890
St. Vats 4	59°26,485	5°44,902

Table 6: Station names, sampling depth, and a visual description of the sediments collected in the 2015 sediment survey.

Station	Depth (m)	Sample nr	Sediment description
St. 4 Vatsfjord	41	I	Brown fine particulated and sandy sediment. No H_2S smell. Sand worms.
	42	II	Brown fine particulated and sandy sediment. No H_2S smell. Sand worms.
	42	III	Brown fine particulated and sandy sediment. No H_2S smell. Sand worms.
	41	IV	Brown fine particulated and sandy sediment. No H_2S smell.
St. Raunes 3	40	I	Brown fine particulated and sandy sediment. Some gravel and smaller stones no H_2S smell sea urchins and sand worms.
	40	II	Brown fine particulated and sandy sediment. Some gravel and smaller stones No H_2S smell sand worms.
	41	III	Brown fine sediment. No H_2S smell
	40	IV	Brown fine sediment. No H_2S smell
St. Raunes 2	16	I	Sandy sediment with smaller stones and fine particulated material.
	16	II	Sandy sediment with smaller stones and fine particulated material.
	16	III	Sandy sediment with smaller stones and fine particulated material.
	16	IV	Sandy sediment with smaller stones and fine particulated material.
Vats 1	6	I	Fine sand and smaller stones with fine particulated materials
Vats 2	6,3	I	Fine sand and smaller stones with fine particulated materials
Vats 3	11	I	Fine sand and smaller stones with fine particulated materials
Vats 4	14,5	I	Brown fine particulated sediment. No H_2S smell. Sand worms.
Vats 4	14,5	II	Brown fine particulated sediment. No H_2S smell. Sand worms
Vats 4	14,5	III	Brown fine particulated sediment. No H_2S smell. Sand worms

In 2009, in all the sampling methods we collected approximately 25cc of sediments from the upper 2 cm from each sample and mixed them together thus representing a pooled average of 3 samples from each site. When the sediments were recovered on deck, the sediments were covered with clear water, indicating the undisturbed surface. The water was then siphoned off. The remaining four stations were sampled with a box-corer, also achieving sediment samples of the same, or better, quality. In addition, four individual samples (Vats 1-4) were sampled by an ROV at the outlet of Raunes River in order to investigate a possible mercury problem at this specific location. One of our four samples (Vats 4) was analyzed for all the variables in the study. In sites “Raunes 2” and “Raunes 3 (Grønavika)” a small grab was used from a small boat due to the occurrence of rocks on the marine sediments potentially harming the box-corer. The sediments were kept cool and sent to the laboratories at NIVA in Oslo and analyzed at NIVAs accredited laboratories.

In the 2015 sediment collection survey, the seafloor condition was rather challenging at the stations: St. 4 Vatsfjord, St Raunes 3 and St Raunes 2, and it was necessary to take four replicate samples to get enough sediment material of good sample quality. These four replicate samples were mixed to make a composite sediment sample from each station. From the station Vats 4 there were taken three replicate samples to make the composite sample, whereas from the stations Vats 1, Vats 2 and Vats 3 there was taken only 1 sample, as the seafloor condition at these locations was better and more suitable for sediment collection when using the van Veen grab equipment.

Most of the sediment parameters analyzed in the 2009 and 2015 samples were determined and quantified with use of accredited analyses. Whenever possible, the contaminant data were used to classify the sediment samples according to the Norwegian guidelines for classification of marine sediments after their contaminant content (TA-1467/1997, TA-2229/2007 and TA-2230/2007).

2.4.1 Results

Chemical contaminants were measured in marine sediments collected close to AFEBV in 2009 and 2015 (**Figure 3**). The results of these analyses are shown in Table 7. Sediment contaminant data from a selection of reference sites (data from 2009 only) are shown in Table 8 (station map in **Figure 2**). The number of sediment parameters was somewhat expanded in 2015 in comparison to 2009.

Most analyses from Raunesvika was performed on samples collected at Vats 4 and Raunes 2(**Figure 3**). In Raunesvika as well as in Grønavika (st. 4 Vatsfjorden and Raunes 3) the measured levels of PCB7, mercury and other heavy metals were consistently low (Class I levels) both in 2009 and 2015.

In Raunesvika, some PAH components reached Class II whereas TBT reached Class IV both in 2009 and 2015. Also the PAH-component benso(ghi)perylene, which was not analysed in 2009, reached class IV in 2015. The concentrations of TBT (tributyltin) were slightly higher than in 2009, whereas the levels of MBT (monobutyltin) and DBT (dibutyltin) were slightly lower. Slightly elevated levels of PAH and TBT contaminants in Raunesvika correspond with data reported in other studies done prior to 2009.

In Grønavika, MBT, DBT and TBT was not detected in 2009 but present in Class II in 2015 (classification valid for TBT only). All other contaminants analyzed were present in low concentrations (Class I) in this area.

From the reference stations investigated in 2009 (**Figure 2**, Table 8), it can be noted that several compounds showed elevated (Class II) levels of lead (St. 1 and 3), PAH16 (St. 1, 3 and 6), benso(a)pyren (all stations) and TBT (St. 5 and 6)). These observations clearly revealed occasional presence of traces of anthropogenic and industrial activities from before 2009.

Table 7: Concentrations of contaminants in samples of marine sediment collected close to AFEBV in 2009 and 2015. When possible, the sediment contamination data are used to classify the sediment according to Norwegian guidelines for classification of marine sediment (TA-1467/1997 or TA-2229), with the colour codes as follows: Blue, green, yellow, orange and red representing the condition classes I, II, III, IV and V, respectively.

Parameter	Unit	Vats 1 Raunesvika		Vats 2 Raunesvika		Vats 3 Raunesvika		Vats 4 Raunesvika		Raunes 2 Raunesvika		Raunes 3 Grønavika		St 4 Vatsfj Grønavika	
		2009	2015	2009	2015	2009	2015	2009	2015	2009	2015	2009	2015	2009	2015
Dry matter (E)	%	-	76	-	72,5	-	72,2	-	70,3	-	63,0	-	58,3	-	85,2
Dry matter (G)	%	-	-	-	-	-	-	-	71,9	-	59	-	68,1	-	70,5
Water content	%	-	-	-	-	-	-	-	29,7	-	37	-	41,7	-	14,8
Grains <63 µm	% TS	-	-	-	-	-	-	19	-	65	-	69	-	43	-
Grains >63 µm	%	-	-	-	-	-	-	-	80,6	-	70,1	-	79,2	-	62,9
Grains <2 µm	%	-	-	-	-	-	-	-	0,6	-	0,7	-	0,6	-	1
TOC	% TS	-	-	-	-	-	-	1,71	1,05	2,19	1,16	0,35	0,539	0,27	0,648
As (Arsen)	mg/kg TS	-	-	-	-	-	-	7,4	2,99	9,2	3,3	3	3,1	3	3,86
Cd (Kadmium)	mg/kg TS	-	-	-	-	-	-	n.d.	<0.10	n.d.	<0.10	n.d.	<0.10	n.d.	<0.10
Cr (Krom)	mg/kg TS	-	-	-	-	-	-	18	11,8	27,8	14,0	23,8	21,4	23,1	22,6
Cu (Kopper)	mg/kg TS	-	-	-	-	-	-	17,4	14,8	27,9	15,7	17,3	14,6	15	16,6
Hg	mg/kg TS	0,081	<0.20	0,034	<0.20	0,031	<0.20	0,04	<0.20	0,133	<0.20	0,059	<0.20	0,016	<0.20
Ni (Nikkel)	mg/kg TS	-	-	-	-	-	-	9,9	8,1	16,3	8,9	12	10,3	11	11,3
Pb (Bly)	mg/kg TS	-	-	-	-	-	-	14	10,3	17	13,8	13	11,3	8,3	13,2
Zn (Sink)	mg/kg TS	-	-	-	-	-	-	53,7	58,3	105	75,8	135	120	88	104
Ba (Barium)	mg/kg TS	-	-	-	-	-	-	45,4	34,5	92,3	42,7	191	110	128	121
Co (Kobolt)	mg/kg TS	-	-	-	-	-	-	5,3	6,52	9,3	5,91	9,4	10,8	8	11,8
Mo (Molybden)	mg/kg TS	-	-	-	-	-	-	2	0,79	3	1,47	2	0,67	2	0,87
V (Vanadium)	mg/kg TS	-	-	-	-	-	-	20,1	18,5	38,8	18,8	37,8	29,2	30,4	32,3
P (Fosfor)	mg/kg TS	-	-	-	-	-	-	539	644	702	613	717	669	626	685
N-total	mg/kg TS	-	-	-	-	-	-	1300	659	n.d.	933	n.d.	787	n.d.	801
Sum NPD	µg/kg TS	-	-	-	-	-	-	n.d.	-	90,5	-	n.d.	-	n.d.	-
Naftalen	µg/kg TS	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	<10
Acenaftylen	µg/kg TS	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	<10
Acenaften	µg/kg TS	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	<10
Fluoren	µg/kg TS	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	<10
Fenantren	µg/kg TS	-	-	-	-	-	-	-	<10	-	74	-	<10	-	<10
Antracen	µg/kg TS	-	-	-	-	-	-	-	<10	-	16	-	<10	-	<10
Fluoranten	µg/kg TS	-	-	-	-	-	-	-	11	-	122	-	<10	-	<10
Pyren	µg/kg TS	-	-	-	-	-	-	-	10	-	86	-	<10	-	<10
Benso(a)antracen	µg/kg TS	-	-	-	-	-	-	-	<10	-	41	-	<10	-	<10
Krysen	µg/kg TS	-	-	-	-	-	-	-	<10	-	48	-	<10	-	<10
Benso(b)fluoranten	µg/kg TS	-	-	-	-	-	-	-	10	-	47	-	<10	-	<10
Benso(k)fluoranten	µg/kg TS	-	-	-	-	-	-	-	<10	-	27	-	<10	-	<10
Benso(a)pyren	µg/kg TS	-	-	-	-	-	-	3,4	<10	21	44	n.d.	<10	n.d.	<10
Dibenso(ah)antracen	µg/kg TS	-	-	-	-	-	-	-	<10	-	<10	-	<10	-	<10
Benso(ghi)perylen	µg/kg TS	-	-	-	-	-	-	-	<10	-	39	-	11	-	10
Indeno(123cd)pyren	µg/kg TS	-	-	-	-	-	-	-	<10	-	35	-	<10	-	<10
Sum PAH-16	µg/kg TS	-	-	-	-	-	-	66	31	323	580	166	11	40	10
Sum PAH carcinogene	µg/kg TS	-	-	-	-	-	-	n.d.	10	132	240	n.d.	n.d.	n.d.	n.d.
Sum PCB-7	µg/kg TS	-	-	-	-	-	-	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Monobutyltinnkation	µg/kg TS	-	-	-	-	-	-	9,6	4,5	7,2	5,1	n.d.	1,2	n.d.	1,2
Dibutyltinnkation	µg/kg TS	-	-	-	-	-	-	23	8,7	12	7,7	n.d.	1,4	n.d.	1,2
Tributyltinnkation	µg/kg TS	-	-	-	-	-	-	21	40	20	27	n.d.	1,4	n.d.	1
Monofenyltinnkation	µg/kg TS	-	-	-	-	-	-	n.d.	<1.0	n.d.	<1.0	n.d.	<1.0	n.d.	<1.0
Difenyltinnkation	µg/kg TS	-	-	-	-	-	-	n.d.	<1.0	5,6	<1.0	n.d.	<1.0	n.d.	<1.0
Trifenyltinnkation	µg/kg TS	-	-	-	-	-	-	n.d.	<1.0	4	1,2	1,4	<1.0	n.d.	<1.0

< Concentration values that are below the method's detection limit.
n.d. Concentration values are not determined
(-) Not analysed

Table 8: Contaminant concentrations in reference sediment samples collected in the 2009 field work. These stations are all located relatively far from AFEBV in comparison to the stations shown in Table 7. The colour codes referring to the classes of pollution state are the same as for Table 7.

Analytic Variable	Unit	St 1, Yrkesfj/Vatsfj	St 3, Krossfjorden	St 5, Raunesvika midtfj.	St 6 Indre Vatsfjorden	St 7 Indre Yrkesfjorden
Grains<63µm	% dry weight	87	91	36	88	60
TN/F	µg N/mg TS	1.7	1.0	n.d.	2.0	1.5
TOC/F	µg C/mg TS	19.0	13.5	11.3	26.7	11.3
As/ICP-Sm	µg/g	15	10	6	7.9	5
Ba/ICP-Sm	µg/g	79.1	66.8	44.8	44.5	23.9
Cd/ICP-Sm	µg/g	n.d.	n.d.	n.d.	n.d.	n.d.
Co/ICP-Sm	µg/g	16.9	16.3	4.8	7.9	4.5
Cr/ICP-Sm	µg/g	33.8	33.2	14	25.9	11
Cu/ICP-Sm	µg/g	22.2	20.1	9.97	18.5	8.34
Hg-Sm	µg/g	0.047	0.043	0.028	0.076	0.028
Mo/ICP-Sm	µg/g	3.5	3.6	0.7	2	0.9
Ni/ICP-Sm	µg/g	29	29.8	9.6	19.7	9.7
P/ICP-Sm	µg/g	883	798	653	871	772
Pb/ICP-Sm	µg/g	44	39	13	29	14
V/ICP-Sm	µg/g	63	56.4	21.9	39.7	18.9
Zn/ICP-Sm	µg/g	108	98.4	49.9	91.8	43.7
TBT-Sm	µg/kg t.v.	n.d.	n.d.	1.1	4.7	n.d.
Sum PAH16	µg/kg t.v.	668	760.3	137.3	565	256.6
Sum PCB_7	µg/kg t.v.	0.61	n.d.	n.d.	n.d.	n.d.
BAP-Sm	µg/kg t.v.	24	15	8.2	30	11
Sum KPAH	µg/kg t.v.	415	475.1	n.d.	359.6	170.7
Sum NPD	µg/kg t.v.	50.4	n.d.	n.d.	n.d.	n.d.
MBT-Sm	µg MBT/kg	n.d.	4.2	n.d.	14	5.3
DBT-Sm	µg/kg t.v.	n.d.	n.d.	n.d.	6.2	n.d.
MPhT-Sm	µg/kg t.v.	n.d.	n.d.	n.d.	n.d.	n.d.
DPhT-Sm	µg/kg t.v.	n.d.	n.d.	n.d.	n.d.	n.d.
TPhT-Sm	µg/kg t.v.	<1	n.d.	n.d.	n.d.	n.d.

3. Discussion and conclusion

NIVAs Baseline Survey in 2009 showed that the environmental status of the AFEBV location was generally good, possibly apart from the older contamination of TBT and PAH found in fjord sediments in Raunesvika and a large amount of scrap objects located at the seafloor. Both these observations were corroborated by the present repetition survey at the AFEBV location in 2015, although the amount of debris at the bottom had been decreased as a result of a clean-up campaign.

The surveys both in 2009 and 2015 found a level of PAHs at one of the stations in Raunesvika (Raunes 2 station) corresponding to class II, according to the Norwegian sediment classification system. One PAH component (benso(ghi)perylen), which was not analysed in 2009, were present in class IV in 2015. TBT was present in class IV levels at both stations in Raunesvika both in 2009 and 2015, whereas the levels of PCB7, mercury and other metal contaminants were generally low (class I) at all stations. Similar findings of TBT and PAH in Raunesvika has been reported by several studies conducted before 2009.

At the two stations Vats 4 and Raunes 2 (both in Raunesvika) the concentrations of TBT were slightly higher in 2015 than in 2009, but within the same class (Class IV). Sum PAH16 was lower at one of the two stations investigated and higher at the other, but the classification had remained the same (class I and class II, respectively). At both stations TOC and metals frequently associated with TOC (Cu, Pb), was lower in 2015 than in 2009. The fact that TBT and PAH (at one of the two stations) does not follow the same pattern might indicate a specific source for these contaminants, but the signal is very weak and the present data material is too sparse, to determine for sure if the difference is coincidental or represent a real increase.

The assessment of groundwater samples from under the base demonstrates low levels of all contaminants measured, signalling a good condition of the groundwater and that the impermeable deck at the base prevents contaminant transfer to the ground beneath the demolition facility.

The soil contamination survey clearly revealed that the ultimate vicinity of AFEBV has become moderately contaminated with PAHs and metals in the period 2009-2015. For mercury the levels have increased 20 times at the most contaminated position (J1) just adjacent to the plant. Mercury, zinc and four PAH components exceeded the guideline norm value for sensitive land use in this sample. However, the observed soil contamination appears to be local and patchy, as the soil station located just a few dozen meters away (J2) was much less contaminated. Furthermore, both soil stations were located at the narrow brim lying between the Raunes River and the fence that borders the AFEBV area. In other words, it is only a very short distance (a few meters only) between the northern part of the demolition area of AFEBV and the location where the soil samples were obtained. Hence, the observed increase in soil contamination seen in 2015 represents an impact in the ultimate vicinity of the operation area where the large scale demolition activities have been performed.

The annual monitoring programme revealed that the increase of particularly mercury in soil- and moss-samples occurred from 2009 to 2010. The programme has also shown that in the subsequent years remedial actions against spreading of dust from the working area resulted in a decrease of contaminant levels in both sample types

4. References

Bakke, T, Oen, A, Kibsgaard, A, Breedveld, G, Eek, E, Helland, A, Källqvist, T, Ruus, A, Hylland, Kfl. 2007: Revidering av klassifisering av metaller og organiske ,miljøgifter i vann og sedimenter. TA2229/2007. 12s.

Beyer, J., Hobæk, A., Beylich, B., Johnsen, T., 2015a. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2014, Norsk Institutt for Vannforskning (NIVA), p. 105.

Beyer, J., Kvassnes, A., Hobæk, A., Beylich, B., Johnsen, T., 2014. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2013, Norsk Institutt for Vannforskning, p. 137.

Beyer, J., Kvassnes, A., Hobæk, A., Johnsen, T., Beylich, B., Schaanning, M., 2015b. Sammendrag av miljøovervåkingen ved AF Miljøbase Vats for perioden 2009-2014, Norsk Institutt for Vannforskning, p. 50.

Frantzen, S., Måge, A., 2014. Metaller og organiske miljøgifter i sjømat fra Vatsfjorden. Nasjonalt institutt for ernærings- og sjømatforskning (NIFES), p. 28.

Johnsen, TM, Dale, T, 2009: Partikkelforurensing i Vatsfjorden. NIVA report LNR 5823-2009.

Kjeilen, G., Westerlund, S., Torgrimsen, S., Bjørnstad, A., Aas, E., 2002. Assessment of environmental implications of Hutton TLP mooring in the Vats fjord / FINAL REPORT. IRIS, Stavanger.

Kristensen, M.S., 2004. Environmental Baseline Report for Raunes, Vindafjord Kommune. Miljøbistand AS.

Kvassnes, AJS, 2008: Analyser av Blåskjell ved og rundt Vats Mottaksanlegg. NIVA Notat.

Kvassnes, AJS, Walday, MG, Gundersen, H, 2010: AFD2-D-GEN-EG-0001. Environmental Baseline Survey Report. Ekofisk Cessation EPRD Project. NIVA report 5915-2010. .

Kvassnes, A., Hobæk, A., 2012. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2011. NIVA.

Kvassnes, A., Hobæk, A., Borgersen, G., Gitmark, J., Johnsen, T., 2013. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2012. NIVA, p. 101 + vedlegg.

Kvassnes, A., Hobæk, A., Johnsen, T., 2011. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2010. NIVA, p. 67 + vedlegg.

Kvassnes, A., Hobæk, A., Johnsen, T., Walday, M., Sweetman, A., Gundersen, H., Rygg, B., Brkljacic, M., Borgersen, G., 2010a. Årsrapport for miljøovervåking rundt AF Miljøbase Vats for 2009. NIVA, p. 159.

Kvassnes, A.J., 2008. Analyser av Blåskjell ved og rundt Vats Mottaksanlegg. NIVA.

Kvassnes, A.J., Walday, M., Gundersen, H., 2010b. AFD2-D-GEN-EG-0001: environmental baseline survey report : Ekofisk Cessation EPRD Project. Norsk institutt for vannforskning, Oslo.

Misund, A., 2007. Miljøundersøkelse Vats-Ekofisk, avsluttende undersøkelse. COWI.

Misund, A., 2008a. Gjennomgang av rapporter fra undersøkelser i Vatsfjorden - Fokus på Vats Mottaksanlegg. COWI

Misund, A., 2008b. Miljøundersøkelse Vats – Ekofisk, baseline undersøkelse. COWI.

Misund, A., 2009. Undersøkelser av mulig transport av tungmetaller via Rauneselva ut i sjøen. COWI

Tvedten, Ø.F., 1999. Resipientundersøkelse i Vatsfjorden, Vindafjord kommue. Rogalandsforskning, p. 61.

Vik, Eilen A. m.fl. 1999. Risikovurdering av forurenset grunn. SFT veiledning 99:01A. Statens forurensningstilsyn.

Weideborg, 2007: Oppdatering av bakgrunnsdata og forslag til nye normverdier for forurenset grunn. Aquateam - Norsk vannteknologisk senter A/S Rapport nr: 06-039.

4.1 Appendix 1 – Technical description of ROV survey in 2009

We had more difficult conditions for registrations in Grønavika than in Raunesvika, due to more turbid waters and less light. The inaccuracy in the positioning of the ROV is fairly wide in the shallower waters but narrows at depth. This was particularly obvious in Raunesvika where some positions were registered to be on land

We received a total of 10 electronic log-files from the ROV, although half of these were from a different project not pertaining to this one. Our data contained one file from the 7th of May and four files from the 8th of May 2009 (Table 6). The files were in an npd-format and were treated in Excel before exported to ArcGIS (ver. 9.3). The first 73 lines in 080509_000 lacked positions and were therefore deleted. Some of the positions are incorrect or insecure, particularly those taken in shallow water. This pertains particularly to those from the 7th of May. The outliers were removed and the following procedure was followed to define these: positions more than 10 meters from the previous and consecutive position were removed using an Excel algorithm based on Pythagoras'. In addition, we inspected the positions visually in ArcGIS to remove obvious outliers not eliminated using the algorithm. In total 2541 outliers were removed.

Some positions are still uncertain, particularly in the areas of Grønavika closest to shore (070509_000). Here, some positions are still on shore, but as this pertains to so many positions, we would remove a substantial part of the material if we remove all of these. Thus one should be aware of the potential position errors in the inner parts of Grønavika. The remaining positions are better, but there is still an insecurity of up to 10 meters, or more in the shallow areas. The positions of anthropogenic remains found in these outliers have been moved to the nearest correct position. This pertains to 8 out of 59 registered remains and the points have been moved up to 24 meters.

Table 9. Overview over the removal of outliers from 5 logfiles

Place	***Date***	***Fliename***	***Number of positions***	*Number of outliers removed*
Grønavika	7. mai 2009	070509_000	7456	1610
Grønavika	8. mai 2009	080509_000	5972	271
Raunesvika	8. mai 2009	080509_001	42	0
Raunesvika	8. mai 2009	080509_002	3363	420
Raunesvika	8. mai 2009	080509_003	2088	240

We have used the UTM/WGS1894/Zone32N coordinate system. The background-picture in the map is from http://www.norgeibilder.no from Statens Kartverk from 2004, and may deviate from the conditions of today, due to the recent constructions. Red markers in Figure 2.3 indicate anthropogenic remains and the numbers refers to the ID in table 2.2.

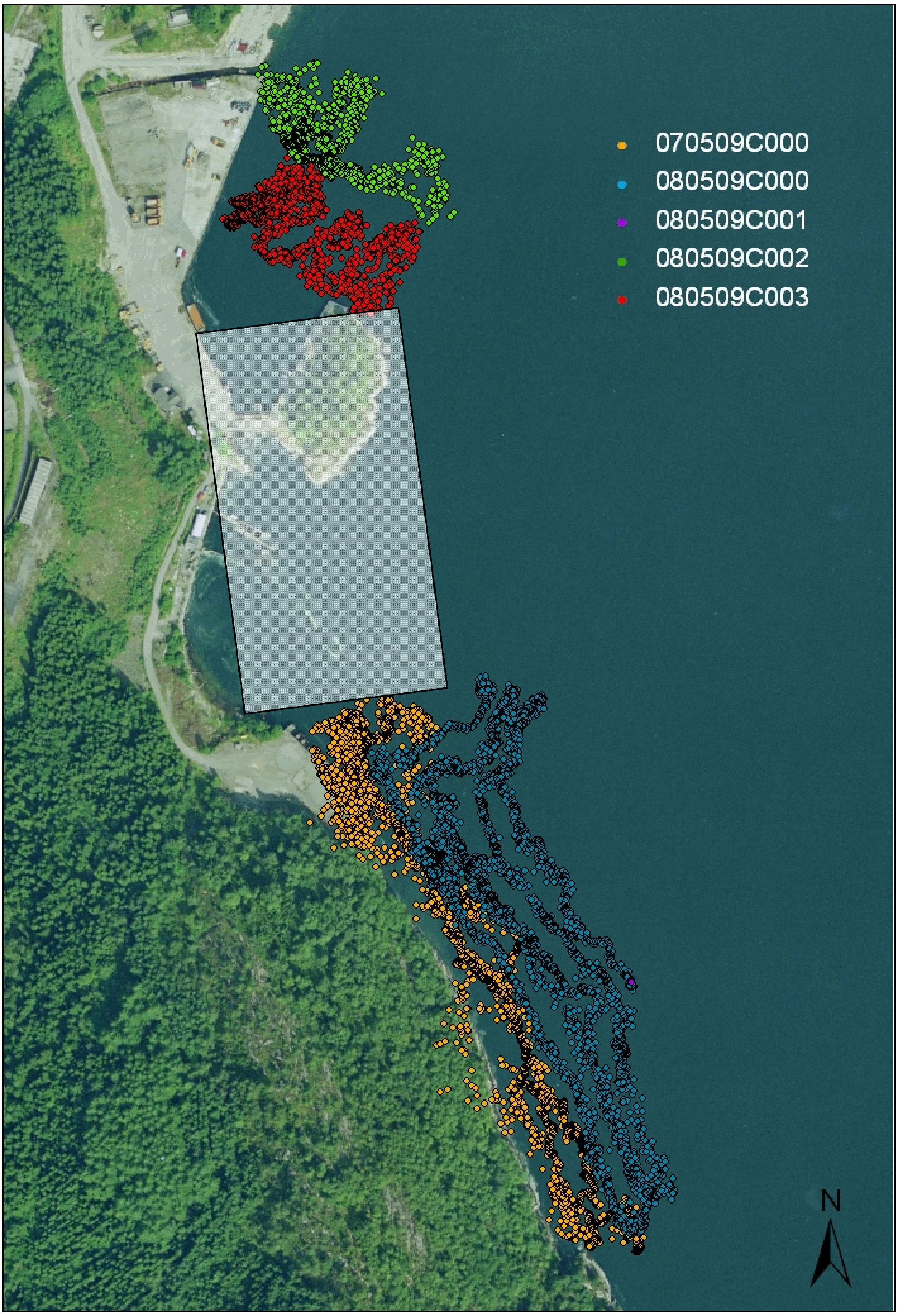

Figure 15.'Tracking' of the movements of the ROV at AF Miljøbase Vats the 7th and 8th of May 2009. The areal photo is taken before the recent constructions were performed. The gray area indicates a coarse indications of the newly filled-in areas.

Table 10. Registrations of antropogenic materials from the ROV-recordings in Grønavika and Raunesvika the 7th and 8th of May 2009. The ROV-depth is the depth at which the ROV was at the time of registration, not the depth at which the debris rests.

ID	Registrering	ROV-dyp	Ø	N	Dato	Klokke-slett	Flyttet (m)	Ø	N
	Grønavika								
1	trestamme/jernstang overgrodd	4	315760	6593034	07.05.2009	21:58:06	9	315731	6593072
2	trestamme/jernstang overgrodd	5	315743	6593049	07.05.2009	21:59:56	7	315726	6593091
3	trestamme/jernstang overgrodd	4,9	315715	6593096	07.05.2009	22:05:41			
4	trestamme/jernstang overgrodd	1,8	315667	6593204	07.05.2009	22:24:38			
5	siltduk (?)	5,2	315637	6593279	07.05.2009	22:40:40			
6	siltduk (fungerende)	5,2	315644	6593269	07.05.2009	22:43:52			
7	tauverk	9,8	315630	6593304	07.05.2009	22:55:08	15	315634	6593284
8	armeringsjern, 'sprenghylser'	10,3	315639	6593302	07.05.2009	22:55:34			
9	betongsøyle	10	315650	6593259	07.05.2009	23:01:05			
10	duk fungerende (?)	9,6	315644	6593245	07.05.2009	23:01:47			
11	armeringsjern	14,7	315644	6593303	07.05.2009	23:10:28	11	315678	6593243
12	sammenfiltret duk	14,6	315670	6593249	07.05.2009	23:13:03			
13	duk	14,7	315684	6593246	07.05.2009	23:19:08			
14	søyle 'no.4'	9,8	315699	6593193	07.05.2009	23:40:53			
15	garn	9,5	315686	6593209	07.05.2009	23:42:44			
16	duk	9,7	315693	6593208	07.05.2009	23:44:02			
17	betongring, rør ca Ø 10cm, tauver, duk	19,7	315696	6593221	08.05.2009	08:01:42			
18	rør eller vaier som vi fastnet i	22	315694	6593229	08.05.2009	08:05:55			
19	rør	20,8	315692	6593230	08.05.2009	08:18:22			
20	dekk	29,5	315691	6593289	08.05.2009	08:48:33			
21	2 tau m oppdrift	34	315831	6593037	08.05.2009	09:04:54			
22	'tau/vaier m oppdrift'	40,1	315709	6593251	08.05.2009	09:26:41			
23	betongblokk/moring	39,9	315749	6593248	08.05.2009	09:27:34			
24	dekk m tauverk	36,5	315775	6593195	08.05.2009	09:30:50			
	Raunesvika								
25	stålrør, tau	6,2	315590	6593677	08.05.2009	10:30:26			
26	metallskrap	6	315573	6593672	08.05.2009	10:17:41			
27	lang rørledning	9,7	315598	6593714	08.05.2009	10:38:20			
28	fiskeruse, tau	9,7	315611	6593698	08.05.2009	10:40:42			
29	2 bildekk	8	315606	6593686	08.05.2009	10:45:16	24	315617	6593721
30	stålrør, tau	11,3	315606	6593680	08.05.2009	10:55:53	24	315617	6593709
31	stor 'plate'	11,2	315617	6593673	08.05.2009	10:56:03	20	315605	6593692
32	3 dekk, det ene stort	12	315576	6593710	08.05.2009	10:57:09			
33	vajer, rørledning	15,2	315615	6593721	08.05.2009	10:58:36			
34	stort dekk	13,9	315610	6593686	08.05.2009	10:59:52			
35	nedgrodde 'jernstenger'	12,3	315598	6593696	08.05.2009	11:00:20			
36	langt smalt 'rør'	11,5	315600	6593700	08.05.2009	11:01:10	3	315657	6593703
37	dekk + noen jernstenger	13,5	315612	6593676	08.05.2009	11:04:00			
38	rørledning (også synlig på 20m dyp)	17,3	315621	6593693	08.05.2009	11:04:41			
39	duk som ligger delvis på stor rørledning	18,8	315636	6593708	08.05.2009	11:06:18			
40	duk, hanske	22,3	315643	6593696	08.05.2009	11:08:18			

ID	Registrering	ROV-dyp	Ø	N	Dato	Klokke-slett	Flyttet (m)	Ø	N
41	2 takplater, hjelm	18,6	315617	6593664	08.05.2009	11:13:30			
42	takplate	23	315640	6593657	08.05.2009	11:15:20			
43	stor rørledning	23	315652	6593647	08.05.2009	11:16:27			
44	stor rørledning	33,6	315682	6593648	08.05.2009	11:18:46			
45	stor rørledning	31,9	315683	6593663	08.05.2009	11:19:59			
46	litt skrot	7,1	315589	6593643	08.05.2009	12:01:10			
47	div skrap	7,7	315588	6593638	08.05.2009	12:04:45			
48	jernstang	7	315610	6593643	08.05.2009	12:07:04			
49	traktordekk - nedgrodd	9,6	315579	6593624	08.05.2009	12:09:46			
50	jernstang/rør/tau	12,4	315609	6593629	08.05.2009	12:12:45			
51	bøtte, tau	13,4	315589	6593600	08.05.2009	12:14:45			
52	2 dekk	15,2	315595	6593606	08.05.2009	12:15:10			
53	rør + rørledning, tau	17,6	315615	6593612	08.05.2009	12:16:22			
54	rør eller jernstang, hjelm	21,1	315641	6593605	08.05.2009	12:18:30			
55	duk	19	315624	6593600	08.05.2009	12:19:24			
56	dekk, rørledning, kjetting opp til duk?	19,3	315614	6593588	08.05.2009	12:20:45			
57	takplate	22,2	315643	6593593	08.05.2009	12:21:26			
58	søppel, rørledning/kabel	24,6	315662	659360	08.05.2009	12:22:58			
59	rørledning, 'tykk duk'	28,2	315651	6593594	08.05.2009	12:26:05			

4.2 Appendix 2: Analysis report of marine sediments in 2009

ANALYSE RAPPORT

NORSK AKKREDITERING
Nr. TEST009

Norsk Institutt for Vannforskning
Gaustadalléen 21
0349 Oslo
Tel: 22 18 51 00
Fax: 22 18 52 00

Navn **Vats Sediment**
Adresse

Deres referanse:

Vår referanse:
Rekv.nr. 2009-952
O.nr. O 28440BBK

Dato
29/06/2015

Prøvene ble levert ved NIVAs laboratorium av forsker, og merket slik som gjengitt i tabellen nedenfor. Prøvene ble analysert med følgende resultater (analyseusikkerhet kan fås ved henvendelse til laboratoriet):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
1	Vats 1	2009.05.08	2009.05.19	2009.06.17-2009.06.17
2	Vats 2	2009.05.08	2009.05.19	2009.06.17-2009.06.17
3	Vats 3	2009.05.08	2009.05.19	2009.06.17-2009.06.17
4	Vats 4	2009.05.08	2009.05.19	2009.05.25-2010.01.13
5	Raunes 2	2009.05.08	2009.05.19	2009.05.25-2010.01.13
6	Raunes 3 (Grønevika)	2009.05.08	2009.05.19	2009.05.25-2010.01.13
7	St 1, Yrkesfj/Vatsfj	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Prøvenr Analysevariabel Metode	Enhet	1	2	3	4	5	6	7
Kornfordeling <63µm Intern*	% t.v.				19	65	69	87
Nitrogen, total 6	µg N/mg TS G				1,3	<1,0	<1,0	1,7
Karbon, org. total 6	µg C/mg TS G				17,1	21,9	3,5	19,0
Arsen 9-5	µg/g E				7,4	9,2	3	15
Barium 9-5	µg/g E				45,4	92,3	191	79,1
Kadmium 9-5	µg/g E				<0,2	<0,2	<0,2	<0,2
Kobolt 9-5	µg/g E				5,3	9,3	9,4	16,9
Krom 9-5	µg/g E				18,0	27,8	23,8	33,8
Kobber 9-5	µg/g E				17,4	27,9	17,3	22,2
Kvikksølv 4-3	µg/g E	0,081	0,034	0,031	0,040	0,133	0,059	0,047
Molybden 9-5	µg/g E				2	3,0	2	3,5

Nikkel 9-5	µg/g	E				9,9	16,3	12	29,0
Fosfor 9-5	µg/g	E				539	702	717	883
Bly 9-5	µg/g	E				14	17	13	44,0
Vanadium 9-5	µg/g	E				20,1	38,8	37,8	63,0
Sink 9-5	µg/g	E				53,7	105	135	108
PCB-28 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
PCB-52 3-3	µg/kg t.v.	H				i	i	i	i
PCB-101 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
PCB-118 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
PCB-105 3-3	µg/kg t.v.	H				<0,5	i	<0,5	<0,5
PCB-153 3-3	µg/kg t.v.	H				<0,5	i	i	i
PCB-138 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
PCB-156 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
PCB-180 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	0,61
PCB-209 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5
Sum PCB Beregnet	µg/kg t.v.					<4,5	<3,5	<4	<4,11
Seven Dutch Beregnet	µg/kg t.v.					<3	<2,5	<2,5	<2,61
Pentaklorbenzen 3-3	µg/kg t.v.	H				<0,3	<0,3	<0,3	<0,3
Alfa-HCH 3-3	µg/kg t.v.	H				<0,5	<0,5	<0,5	<0,5

i : Forbindelsen er dekket av en interferens i kromatogrammet.
* : Metoden er ikke akkreditert.

Kommentarer

1 Metallresultatene er oppgitt på tørrvekt.

4 PCB: CB52, CB105 og CB153 er dekket av en interferens i kromatogrammet av en eller flere av prøvene. Siden konsentrasjonen av de øvrige PCB-kongenerene er under deteksjonsgrensen (0.5µg/kg) og med kjennskap til kongenersammensetningen i kommersielle PCB-oljer, er det usannsynlig at konsentrasjonen av de nevnte kongenerene er høyere enn 0.5 µg/kg.
Et referansemateriale ble analysert parallelt med prøvene. Resultatet for cb156 var høyere enn øvre aksjonsgrense.
SnOrg: Prøven er analysert sammen med et sertifisert referansemateriale. Verdiene for TBT lå under nedre aksjonsgrense. Det finnes ikke noen sertifisert verdi for fenylkomponentene og vi rapporterer derfor ikke disse verdiene siden de ikke viser tilfredsstillende stabilitet.

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-Dato	Mottatt NIVA	Analyseperiode
1	Vats 1	2009.05.08	2009.05.19	2009.06.17-2009.06.17
2	Vats 2	2009.05.08	2009.05.19	2009.06.17-2009.06.17
3	Vats 3	2009.05.08	2009.05.19	2009.06.17-2009.06.17
4	Vats 4	2009.05.08	2009.05.19	2009.05.25-2010.01.13
5	Raunes 2	2009.05.08	2009.05.19	2009.05.25-2010.01.13
6	Raunes 3 (Grønevika)	2009.05.08	2009.05.19	2009.05.25-2010.01.13
7	St 1, Yrkesfj/Vatsfj	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Analysevariabel	Enhet	Prøvenr Metode	1	2	3	4	5	6	7
Hexaklorbenzen	µg/kg t.v.	H 3-3				<0,3	<0,3	<0,3	<0,3
Gamma-HCH	µg/kg t.v.	H 3-3				<0,5	<0,5	<0,5	<0,5
Oktaklorstyren	µg/kg t.v.	H 3-3				<0,5	<0,5	<0,5	<0,5
4,4-DDE	µg/kg t.v.	H 3-3				<0,5	<0,5	<0,5	<0,5
4,4-DDD	µg/kg t.v.	H 3-3				<1	<1	<1	<1
Naftalen i sediment	µg/kg t.v.	H 2-3				3,3	3,0	<2	13
Acenaftylen	µg/kg t.v.	H 2-3				<2	<2	<2	<2
Acenaften	µg/kg t.v.	H 2-3				<2	<2	<2	<2
Fluoren	µg/kg t.v.	H 2-3				<2	<2	<2	3,3
Dibenzotiofen	µg/kg t.v.	H 2-3				<2	2,5	2,7	2,4
Fenantren	µg/kg t.v.	H 2-3				6,2	85	120	35
Antracen	µg/kg t.v.	H 2-3				<2	2,7	<2	5,7
Fluoranten	µg/kg t.v.	H 2-3				6,0	38	9,8	40
Pyren	µg/kg t.v.	H 2-3				6,3	34	4,5	35
Benz(a)antracen	µg/kg t.v.	H 2-3				2,8	15	<2	21
Chrysen	µg/kg t.v.	H 2-3				4,9	16	<2	25
Benzo(b+j)fluoranten	µg/kg t.v.	H 2-3				10	36	4,2	100
Benzo(k)fluoranten	µg/kg t.v.	H 2-3				2,9	13	<2	35
Benzo(e)pyren	µg/kg t.v.	H 2-3				8,3	22	3,2	54
Benzo(a)pyren	µg/kg t.v.	H 2-3				3,4	21	<2	24
Perylen	µg/kg t.v.	H 2-3				15	16	2,2	13
Indeno(1,2,3cd)pyren	µg/kg t.v.	H 2-3				4,3	24	3,4	170
Dibenz(ac+ah)antrac.	µg/kg t.v.	H 2-3				<2	4,0	<2	27
Benzo(ghi)perylen	µg/kg t.v.	H 2-3				5,5	25	4,3	130
Sum PAH	µg/kg t.v.	Beregnet				<90,9	<363,2	<174,3	<737,4
Sum PAH16	µg/kg t.v.	Beregnet				<65,6	<322,7	<166,2	<668
Sum KPAH	µg/kg t.v.	Beregnet				<33,6	132	<19,6	415
Monobutyltinn	µg MBT/kg	H 14-1*				9,6	7,2	<2	<1
Dibutyltinn	µg/kg t.v.	H 14-1*				23	12	<2	<2
Tributyltinn	µg/kg t.v.	H 14-1*				21	20	<1	<1

* : Metoden er ikke akkreditert.

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
1	Vats 1	2009.05.08	2009.05.19	2009.06.17-2009.06.17
2	Vats 2	2009.05.08	2009.05.19	2009.06.17-2009.06.17
3	Vats 3	2009.05.08	2009.05.19	2009.06.17-2009.06.17
4	Vats 4	2009.05.08	2009.05.19	2009.05.25-2010.01.13
5	Raunes 2	2009.05.08	2009.05.19	2009.05.25-2010.01.13
6	Raunes 3 (Grønevika)	2009.05.08	2009.05.19	2009.05.25-2010.01.13
7	St 1, Yrkesfj/Vatsfj	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Analysevariabel	Enhet	Prøvenr Metode	1	2	3	4	5	6	7
Monophenyltinn	µg/kg t.v.	H 14-1*				n.d	n.d	n.d	n.d
Diphenyltinn	µg/kg t.v.	H 14-1*				n.d	n.d	n.d	n.d
Triphenyltinn	µg/kg t.v.	H 14-1*				n.d	n.d	n.d	n.d

* : Metoden er ikke akkreditert.

ANALYSE RAPPORT

NORSK
AKKREDITERING
Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
8	St 3, Krossfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
9	St 4, Vatsfj. Grønevika	2009.05.08	2009.05.19	2009.05.25-2010.01.13
10	St 5, Raunesvika midtfj.	2009.05.08	2009.05.19	2009.05.25-2010.01.13
11	St 6 Indre Vatsfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
12	St 7 Indre Yrkesfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Analysevariabel	Enhet	Prøvenr Metode	8	9	10	11	12
Kornfordeling <63µm	% t.v.	Intern*	91	43	36	88	60
Nitrogen, total	µg N/mg TS	G 6	1,0	<1,0	<1,0	2,0	1,5
Karbon, org. total	µg C/mg TS	G 6	13,5	2,7	11,3	26,7	11,3
Arsen	µg/g	E 9-5	10	3	6	7,9	5
Barium	µg/g	E 9-5	66,8	128	44,8	44,5	23,9
Kadmium	µg/g	E 9-5	<0,3	<0,2	<0,2	<0,2	<0,2
Kobolt	µg/g	E 9-5	16,3	8,0	4,8	7,9	4,5
Krom	µg/g	E 9-5	33,2	23,1	14,0	25,9	11,0
Kobber	µg/g	E 9-5	20,1	15,0	9,97	18,5	8,34
Kvikksølv	µg/g	E 4-3	0,043	0,016	0,028	0,076	0,028
Molybden	µg/g	E 9-5	3,6	2	0,7	2,0	0,9
Nikkel	µg/g	E 9-5	29,8	11	9,6	19,7	9,7
Fosfor	µg/g	E 9-5	798	629	653	871	772
Bly	µg/g	E 9-5	39	8,3	13	29	14
Vanadium	µg/g	E 9-5	56,4	30,4	21,9	39,7	18,9
Sink	µg/g	E 9-5	98,4	88,0	49,9	91,8	43,7
PCB-28	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-52	µg/kg t.v.	H 3-3	i	i	i	i	i
PCB-101	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-118	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-105	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-153	µg/kg t.v.	H 3-3	i	i	i	<0,5	<0,5
PCB-138	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-156	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-180	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
PCB-209	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
Sum PCB	µg/kg t.v.	Beregnet	<4	<4	<4	<4,5	<4,5
Seven Dutch	µg/kg t.v.	Beregnet	<2,5	<2,5	<2,5	<3	<3
Pentaklorbenzen	µg/kg t.v.	H 3-3	<0,3	<0,3	<0,3	<0,3	<0,3
Alfa-HCH	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5

i : Forbindelsen er dekket av en interferens i kromatogrammet.
* : Metoden er ikke akkreditert.

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
8	St 3, Krossfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
9	St 4, Vatsfj. Grønevika	2009.05.08	2009.05.19	2009.05.25-2010.01.13
10	St 5, Raunesvika midtfj.	2009.05.08	2009.05.19	2009.05.25-2010.01.13
11	St 6 Indre Vatsfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
12	St 7 Indre Yrkesfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Analysevariabel	Enhet	Prøvenr Metode	8	9	10	11	12
Hexaklorbenzen	µg/kg t.v.	H 3-3	<0,3	<0,3	<0,3	<0,3	<0,3
Gamma-HCH	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
Oktaklorstyren	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
4,4-DDE	µg/kg t.v.	H 3-3	<0,5	<0,5	<0,5	<0,5	<0,5
4,4-DDD	µg/kg t.v.	H 3-3	<1	<1	<1	<1	<1
Naftalen i sediment	µg/kg t.v.	H 2-3	9,1	<2	<2	9,6	36
Acenaftylen	µg/kg t.v.	H 2-3	<2	<2	<2	<2	<2
Acenaften	µg/kg t.v.	H 2-3	<2	<2	<2	<2	<2
Fluoren	µg/kg t.v.	H 2-3	2,1	<2	<2	<2	<2
Dibenzotiofen	µg/kg t.v.	H 2-3	<2	<2	<2	<2	<2
Fenantren	µg/kg t.v.	H 2-3	22	3,5	6,0	14	6,2
Antracen	µg/kg t.v.	H 2-3	2,1	<2	<2	2,4	<2
Fluoranten	µg/kg t.v.	H 2-3	23	<2	8,9	28	9,8
Pyren	µg/kg t.v.	H 2-3	22	2,1	8,8	25	8,9
Benz(a)antracen	µg/kg t.v.	H 2-3	13	<2	5,3	15	6,3
Chrysen	µg/kg t.v.	H 2-3	19	<2	5,3	16	7,1
Benzo(b+j)fluoranten	µg/kg t.v.	H 2-3	82	4,1	22	100	39
Benzo(k)fluoranten	µg/kg t.v.	H 2-3	27	<2	8,4	40	14
Benzo(e)pyren	µg/kg t.v.	H 2-3	42	2,7	13	66	24
Benzo(a)pyren	µg/kg t.v.	H 2-3	15	<2	8,2	30	11
Perylen	µg/kg t.v.	H 2-3	16	<2	5,3	23	8,8
Indeno(1,2,3cd)pyren	µg/kg t.v.	H 2-3	270	3,8	25	130	50
Dibenz(ac+ah)antrac.	µg/kg t.v.	H 2-3	40	<2	3,4	19	7,3
Benzo(ghi)perylen	µg/kg t.v.	H 2-3	210	4,2	26	130	53
Sum PAH	µg/kg t.v.	Beregnet	<820,3	<46,4	<157,6	<656	<291,4
Sum PAH16	µg/kg t.v.	Beregnet	<760,3	<39,7	<137,3	<565	<256,6
Sum KPAH	µg/kg t.v.	Beregnet	475,1	<19,9	<79,6	359,6	170,7
Monobutyltinn	µg MBT/kg	H 14-1*	4,2	<2	<2	14	5,3
Dibutyltinn	µg/kg t.v.	H 14-1*	<2	<2	<4	6,2	<3
Tributyltinn	µg/kg t.v.	H 14-1*	<1	<1	1,1	4,7	<1

* : Metoden er ikke akkreditert.

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

Prøvenr	Prøve merket	Prøvetakings-dato	Mottatt NIVA	Analyseperiode
8	St 3, Krossfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
9	St 4, Vatsfj. Grønevika	2009.05.08	2009.05.19	2009.05.25-2010.01.13
10	St 5, Raunesvika midtfj.	2009.05.08	2009.05.19	2009.05.25-2010.01.13
11	St 6 Indre Vatsfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13
12	St 7 Indre Yrkesfjorden	2009.05.08	2009.05.19	2009.05.25-2010.01.13

Analysevariabel	Enhet	Prøvenr Metode	8	9	10	11	12
Monophenyltinn	µg/kg t.v.	H 14-1*	<1	<1	<1	<1	<1
Diphenyltinn	µg/kg t.v.	H 14-1*	<9	<8	<8	<9	<6
Triphenyltinn	µg/kg t.v.	H 14-1*	<1	<1	<1	<1	<1

* : Metoden er ikke akkreditert.

Norsk institutt for vannforskning

Astri JS Kvassnes
Forsker

ANALYSE RAPPORT

NORSK AKKREDITERING Nr. TEST009

Rekv.nr. 2009-952

(fortsettelse av tabellen):

VEDLEGG

SUM PCB er summen av polyklorerte bifenyler som inngår i denne rapporten.

Seven dutch er summen av polyklorerte bifenyler 28,52,101,118,138,153 og 180.

SUM PAH16 omfatter flg forbindelser: naftalen, acenaftylen, acenaften, fluoren, fenantren, antracen, fluoranten, pyren, benz(a)antracen, chrysen, benzo(b+j)fluoranten, benzo(k)fluoranten, benzo(a)pyren, indeno(1,2,3-cd)pyren, dibenz(a,c+a,h)antracen, benzo(ghi)perylen.

SUM KPAH er summen av benz(a)antracen, benzo(b+j+k)fluoranten, benzo(a)pyren, indeno(1,2,3-cd)pyren, dibenz(a,c+a,h)antracen, chrysen og naftalen[1]. Disse har potensielt kreftfremkallende egenskaper i mennesker i flg International Agency for Research on Cancer, IARC (1987, Chrysen og naftalen fra 2007). De tilhører IARC's kategorier 2A + 2B (sannsynlig + trolig carcinogene). Chysen og naftalen ble inkludert i våre rapporter f.o.m. 18.09.2008.

SUM PAH er summen av alle PAH-forbindelser som inngår i denne rapporten.

[1] Bare a,h-isomeren har potensielt kreftfremkallende egenskaper

4.3 Appendix 3: Analysis report of soil and marine sediments in 2015

Rapport

N1507677

Side 1 (18)

Y42X1DMI2G

Registrert **2015-06-09 13:19**
Utstedt **2015-06-18**

AF Offshore Decom - Ekofisk EPRD
AF Environment. base VATS
Project 1699
Postboks 6272 Etterstad
N-0603 Oslo
Norge

Prosjekt **EkofiskEPRD/1699**
Bestnr **AFD2-ALS-C-0213-GENERAL-Analyses of sediments/soil**

Analysis of soil

Deres prøvenavn **J1**
Soil

Labnummer N00368075

Analyse	Resultater	Usikkerhet (±)	Enhet	Metode	Utført	Sign
Tørrstoff (E)	**89.4**	5.39	%	1	1	HABO
As (Arsen)	**2.42**	0.48	mg/kg TS	1	1	HABO
Cd (Kadmium)	**<0.10**		mg/kg TS	1	1	HABO
Cr (Krom)	**25.2**	5.04	mg/kg TS	1	1	HABO
Cu (Kopper)	**32.6**	6.52	mg/kg TS	1	1	HABO
Hg (Kvikksølv)	**2.84**	0.57	mg/kg TS	1	1	HABO
Ni (Nikkel)	**23.0**	4.6	mg/kg TS	1	1	HABO
Pb (Bly)	**18.7**	3.7	mg/kg TS	1	1	HABO
Zn (Sink)	**428**	85.6	mg/kg TS	1	1	HABO
Cr6+	**0.364**	0.073	mg/kg TS	1	1	HABO
Cyanid-fri	**<0.10**		mg/kg TS	1	1	HABO
PCB 28	**<0.0030**		mg/kg TS	1	1	HABO
PCB 52	**<0.0030**		mg/kg TS	1	1	HABO
PCB 101	**<0.0030**		mg/kg TS	1	1	HABO
PCB 118	**<0.0030**		mg/kg TS	1	1	HABO
PCB 138	**<0.0030**		mg/kg TS	1	1	HABO
PCB 153	**<0.0030**		mg/kg TS	1	1	HABO
PCB 180	**<0.0030**		mg/kg TS	1	1	HABO
Sum PCB-7*	**n.d.**		mg/kg TS	1	1	HABO
g-HCH (Lindan)	**<0.0010**		mg/kg TS	1	1	HABO
o,p'-DDT	**<0.010**		mg/kg TS	1	1	HABO
p,p'-DDT	**<0.010**		mg/kg TS	1	1	HABO
o,p'-DDD	**<0.010**		mg/kg TS	1	1	HABO
p,p'-DDD	**<0.010**		mg/kg TS	1	1	HABO
o,p'-DDE	**<0.010**		mg/kg TS	1	1	HABO
p,p'-DDE	**<0.010**		mg/kg TS	1	1	HABO
Monoklorbensen	**<0.010**		mg/kg TS	1	1	HABO
1,2-Diklorbensen	**<0.020**		mg/kg TS	1	1	HABO
1,4-Diklorbensen	**<0.020**		mg/kg TS	1	1	HABO
1,2,3-Triklorbensen	**<0.010**		mg/kg TS	1	1	HABO
1,2,4-Triklorbensen	**<0.030**		mg/kg TS	1	1	HABO
1,3,5-Triklorbensen	**<0.010**		mg/kg TS	1	1	HABO
1,2,3,5+1,2,4,5-Tetraklorbense	**<0.020**		mg/kg TS	1	1	HABO
Pentaklorbensen	**<0.010**		mg/kg TS	1	1	HABO
Heksaklorbensen	**<0.0050**		mg/kg TS	1	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent
og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Rapport

Side 2 (18)

N1507677

Y42X1DMI2G

Deres prøvenavn	**J1** **Soil**					
Labnummer	N00368075					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Diklormetan	**<0.060**		mg/kg TS	1	1	HABO
Triklormetan (kloroform)	**<0.020**		mg/kg TS	1	1	HABO
Trikloreten	**<0.010**		mg/kg TS	1	1	HABO
Tetraklormetan	**<0.010**		mg/kg TS	1	1	HABO
Tetrakloreten	**<0.010**		mg/kg TS	1	1	HABO
1,2-Dikloretan	**<0.0030**		mg/kg TS	1	1	HABO
1,1,1-Trikloretan	**<0.010**		mg/kg TS	1	1	HABO
1,2-Dibrometan	**<0.0040**		mg/kg TS	1	1	HABO
1,1,2-Trikloretan	**<0.010**		mg/kg TS	1	1	HABO
Naftalen	**<0.010**		mg/kg TS	2	1	HABO
Acenaftylen	**<0.010**		mg/kg TS	2	1	HABO
Acenaften	**0.011**	0.003	mg/kg TS	2	1	HABO
Fluoren	**<0.010**		mg/kg TS	2	1	HABO
Fenantren	**0.049**	0.015	mg/kg TS	2	1	HABO
Antracen	**<0.010**		mg/kg TS	2	1	HABO
Fluoranten	**0.114**	0.034	mg/kg TS	2	1	HABO
Pyren	**0.094**	0.028	mg/kg TS	2	1	HABO
Benso(a)antracen^	**0.055**	0.016	mg/kg TS	2	1	HABO
Krysen^	**0.056**	0.017	mg/kg TS	2	1	HABO
Benso(b)fluoranten^	**0.092**	0.028	mg/kg TS	2	1	HABO
Benso(k)fluoranten^	**0.028**	0.008	mg/kg TS	2	1	HABO
Benso(a)pyren^	**0.052**	0.016	mg/kg TS	2	1	HABO
Dibenso(ah)antracen^	**0.012**	0.003	mg/kg TS	2	1	HABO
Benso(ghi)perylen	**0.049**	0.015	mg/kg TS	2	1	HABO
Indeno(123cd)pyren^	**0.051**	0.015	mg/kg TS	2	1	HABO
Sum PAH-16*	**0.66**		mg/kg TS	2	1	HABO
Bensen	**<0.0050**		mg/kg TS	2	1	HABO
Toluen	**<0.10**		mg/kg TS	2	1	HABO
Etylbensen	**<0.020**		mg/kg TS	2	1	HABO
Xylener	**<0.0150**		mg/kg TS	2	1	HABO
Sum BTEX*	**n.d.**		mg/kg TS	2	1	HABO
Fraksjon C5-C6	**<7.0**		mg/kg TS	2	1	HABO
Fraksjon >C6-C8	**<7.0**		mg/kg TS	2	1	HABO
Fraksjon >C8-C10	**<10**		mg/kg TS	2	1	HABO
Fraksjon >C10-C12	**<2.0**		mg/kg TS	2	1	HABO
Fraksjon >C12-C16	**<3.0**		mg/kg TS	2	1	HABO
Fraksjon >C16-C35	**53**	16	mg/kg TS	2	1	HABO
Sum >C12-C35*	**53.0**		mg/kg TS	2	1	HABO
2-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
4-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4+2,5-Diklorfenol	**<0.040**		mg/kg TS	2	1	HABO
2,6-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3,4-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3,5-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,6-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4,6-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	J1 **Soil**					
Labnummer	N00368075					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
3,4,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4,5-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4,6-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,5,6-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
Pentaklorfenol	**<0.006**		mg/kg TS	2	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	J2 Soil					
Labnummer	N00368076					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**88.9**	5.37	%	1	1	HABO
As (Arsen)	**1.92**	0.38	mg/kg TS	1	1	HABO
Cd (Kadmium)	**<0.10**		mg/kg TS	1	1	HABO
Cr (Krom)	**18.4**	3.68	mg/kg TS	1	1	HABO
Cu (Kopper)	**19.8**	3.96	mg/kg TS	1	1	HABO
Hg (Kvikksølv)	**<0.20**		mg/kg TS	1	1	HABO
Ni (Nikkel)	**16.5**	3.3	mg/kg TS	1	1	HABO
Pb (Bly)	**10.4**	2.1	mg/kg TS	1	1	HABO
Zn (Sink)	**96.0**	19.2	mg/kg TS	1	1	HABO
Cr6+	**0.220**	0.045	mg/kg TS	1	1	HABO
Cyanid-fri	<0.10		mg/kg TS	1	1	HABO
PCB 28	<0.0030		mg/kg TS	1	1	HABO
PCB 52	<0.0030		mg/kg TS	1	1	HABO
PCB 101	<0.0030		mg/kg TS	1	1	HABO
PCB 118	<0.0030		mg/kg TS	1	1	HABO
PCB 138	<0.0030		mg/kg TS	1	1	HABO
PCB 153	<0.0030		mg/kg TS	1	1	HABO
PCB 180	<0.0030		mg/kg TS	1	1	HABO
Sum PCB-7*	**n.d.**		mg/kg TS	1	1	HABO
g-HCH (Lindan)	<0.0010		mg/kg TS	1	1	HABO
o,p'-DDT	<0.010		mg/kg TS	1	1	HABO
p,p'-DDT	<0.010		mg/kg TS	1	1	HABO
o,p'-DDD	<0.010		mg/kg TS	1	1	HABO
p,p'-DDD	<0.010		mg/kg TS	1	1	HABO
o,p'-DDE	<0.010		mg/kg TS	1	1	HABO
p,p'-DDE	<0.010		mg/kg TS	1	1	HABO
Monoklorbensen	<0.010		mg/kg TS	1	1	HABO
1,2-Diklorbensen	<0.020		mg/kg TS	1	1	HABO
1,4-Diklorbensen	<0.020		mg/kg TS	1	1	HABO
1,2,3-Triklorbensen	<0.010		mg/kg TS	1	1	HABO
1,2,4-Triklorbensen	<0.030		mg/kg TS	1	1	HABO
1,3,5-Triklorbensen	<0.010		mg/kg TS	1	1	HABO
1,2,3,5+1,2,4,5-Tetraklorbense	<0.020		mg/kg TS	1	1	HABO
Pentaklorbensen	<0.010		mg/kg TS	1	1	HABO
Heksaklorbensen	<0.0050		mg/kg TS	1	1	HABO
Diklormetan	<0.060		mg/kg TS	1	1	HABO
Triklormetan (kloroform)	<0.020		mg/kg TS	1	1	HABO
Trikloreten	<0.010		mg/kg TS	1	1	HABO
Tetraklormetan	<0.010		mg/kg TS	1	1	HABO
Tetrakloreten	<0.010		mg/kg TS	1	1	HABO
1,2-Dikloretan	<0.0030		mg/kg TS	1	1	HABO
1,1,1-Trikloretan	<0.010		mg/kg TS	1	1	HABO
1,2-Dibrometan	<0.0040		mg/kg TS	1	1	HABO
1,1,2-Trikloretan	<0.010		mg/kg TS	1	1	HABO
Naftalen	<0.010		mg/kg TS	2	1	HABO
Acenaftylen	<0.010		mg/kg TS	2	1	HABO
Acenaften	<0.010		mg/kg TS	2	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	J2 Soil						
Labnummer	N00368076						
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Fluoren	**<0.010**		mg/kg TS	2	1	HABO
Fenantren	**<0.010**		mg/kg TS	2	1	HABO
Antracen	**<0.010**		mg/kg TS	2	1	HABO
Fluoranten	**0.037**	0.011	mg/kg TS	2	1	HABO
Pyren	**0.032**	0.010	mg/kg TS	2	1	HABO
Benso(a)antracen^	**0.023**	0.007	mg/kg TS	2	1	HABO
Krysen^	**0.026**	0.008	mg/kg TS	2	1	HABO
Benso(b)fluoranten^	**0.044**	0.013	mg/kg TS	2	1	HABO
Benso(k)fluoranten^	**0.015**	0.005	mg/kg TS	2	1	HABO
Benso(a)pyren^	**0.025**	0.008	mg/kg TS	2	1	HABO
Dibenso(ah)antracen^	**<0.010**		mg/kg TS	2	1	HABO
Benso(ghi)perylen	**0.023**	0.007	mg/kg TS	2	1	HABO
Indeno(123cd)pyren^	**0.024**	0.007	mg/kg TS	2	1	HABO
Sum PAH-16*	**0.25**		mg/kg TS	2	1	HABO
Bensen	**<0.0050**		mg/kg TS	2	1	HABO
Toluen	**<0.10**		mg/kg TS	2	1	HABO
Etylbensen	**<0.020**		mg/kg TS	2	1	HABO
Xylener	**<0.0150**		mg/kg TS	2	1	HABO
Sum BTEX*	**n.d.**		mg/kg TS	2	1	HABO
Fraksjon C5-C6	**<7.0**		mg/kg TS	2	1	HABO
Fraksjon >C6-C8	**<7.0**		mg/kg TS	2	1	HABO
Fraksjon >C8-C10	**<10**		mg/kg TS	2	1	HABO
Fraksjon >C10-C12	**<2.0**		mg/kg TS	2	1	HABO
Fraksjon >C12-C16	**<3.0**		mg/kg TS	2	1	HABO
Fraksjon >C16-C35	**30**	9	mg/kg TS	2	1	HABO
Sum >C12-C35*	**30.0**		mg/kg TS	2	1	HABO
2-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
4-Monoklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4+2,5-Diklorfenol	**<0.040**		mg/kg TS	2	1	HABO
2,6-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3,4-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3,5-Diklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,6-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,4,6-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
3,4,5-Triklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4,5-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,4,6-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
2,3,5,6-Tetraklorfenol	**<0.020**		mg/kg TS	2	1	HABO
Pentaklorfenol	**<0.006**		mg/kg TS	2	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent
og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	Raunes 2 Marine sediment					
Labnummer	N00368077					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**63.0**	3.81	%	3	1	HABO
Vanninnhold	**37.0**	2.25	%	3	1	HABO
Kornstørrelse >63 µm	**70.1**	7.0	%	3	1	HABO
Kornstørrelse <2 µm	**0.7**	0.07	%	3	1	HABO
Kornfordeling	**----------**		se vedl.	3	1	HABO
TOC	**1.16**		% TS	3	1	HABO
Naftalen	**<10**		µg/kg TS	3	1	HABO
Acenaftylen	**<10**		µg/kg TS	3	1	HABO
Acenaften	**<10**		µg/kg TS	3	1	HABO
Fluoren	**<10**		µg/kg TS	3	1	HABO
Fenantren	**74**	22.3	µg/kg TS	3	1	HABO
Antracen	**16**	4.66	µg/kg TS	3	1	HABO
Fluoranten	**122**	36.6	µg/kg TS	3	1	HABO
Pyren	**86**	25.8	µg/kg TS	3	1	HABO
Benso(a)antracen^	**41**	12.3	µg/kg TS	3	1	HABO
Krysen^	**48**	14.3	µg/kg TS	3	1	HABO
Benso(b)fluoranten^	**47**	14.2	µg/kg TS	3	1	HABO
Benso(k)fluoranten^	**27**	8.07	µg/kg TS	3	1	HABO
Benso(a)pyren^	**44**	13.0	µg/kg TS	3	1	HABO
Dibenso(ah)antracen^	**<10**		µg/kg TS	3	1	HABO
Benso(ghi)perylen	**39**	11.7	µg/kg TS	3	1	HABO
Indeno(123cd)pyren^	**35**	10.6	µg/kg TS	3	1	HABO
Sum PAH-16*	**580**		µg/kg TS	3	1	HABO
Sum PAH carcinogene^*	**240**		µg/kg TS	3	1	HABO
PCB 28	**<0.70**		µg/kg TS	3	1	HABO
PCB 52	**<0.70**		µg/kg TS	3	1	HABO
PCB 101	**<0.70**		µg/kg TS	3	1	HABO
PCB 118	**<0.70**		µg/kg TS	3	1	HABO
PCB 138	**<0.70**		µg/kg TS	3	1	HABO
PCB 153	**<0.70**		µg/kg TS	3	1	HABO
PCB 180	**<0.70**		µg/kg TS	3	1	HABO
Sum PCB-7*	**n.d.**		µg/kg TS	3	1	HABO
As (Arsen)	**3.28**	0.66	mg/kg TS	3	1	JIBJ
Pb (Bly)	**13.8**	2.8	mg/kg TS	3	1	JIBJ
Cu (Kopper)	**15.7**	3.15	mg/kg TS	3	1	JIBJ
Cr (Krom)	**14.0**	2.79	mg/kg TS	3	1	JIBJ
Cd (Kadmium)	**<0.10**		mg/kg TS	3	1	JIBJ
Hg (Kvikksølv)	**<0.20**		mg/kg TS	3	1	JIBJ
Ni (Nikkel)	**8.9**	1.8	mg/kg TS	3	1	JIBJ
Zn (Sink)	**75.8**	15.2	mg/kg TS	3	1	JIBJ
Tørrstoff (G)	**59.0**		%	4	2	HABO
Monobutyltinnkation	**5.1**	0.66	µg/kg TS	4	2	HABO
Dibutyltinnkation	**7.7**	1.0	µg/kg TS	4	2	HABO
Tributyltinnkation	**27**	3.5	µg/kg TS	4	2	HABO
Tetrabutyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Monooktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Dioktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trisykloheksyltinnkation	**<1.0**		µg/kg TS	4	2	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	**Raunes 2** **Marine sediment**					
Labnummer	N00368077					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Monofenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Difenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trifenyltinnkation	**1.2**	0.16	µg/kg TS	4	2	HABO
Tørrstoff (E)	**63.0**	3.81	%	5	1	HABO
Ba (Barium)	**42.7**	8.55	mg/kg TS	5	1	HABO
Co (Kobolt)	**5.91**	1.18	mg/kg TS	5	1	HABO
Mo (Molybden)	**1.47**	0.29	mg/kg TS	5	1	HABO
P (Fosfor)	**613**	123	mg/kg TS	5	1	HABO
V (Vanadium)	**18.8**	3.76	mg/kg TS	5	1	HABO
Tørrstoff (G)	**59.0**		%	6	2	HABO
C1-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C2-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C3-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C1-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
C2-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
Dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C1-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C2-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C3-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
N-total	**933**	190	mg/kg TS	7	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	Raunes 3 Marine sediment					
Labnummer	N00368078					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**58.3**	3.53	%	3	1	HABO
Vanninnhold	**41.7**	2.53	%	3	1	HABO
Kornstørrelse >63 µm	**79.2**	7.9	%	3	1	HABO
Kornstørrelse <2 µm	**0.6**	0.06	%	3	1	HABO
Kornfordeling	**----------**		se vedl.	3	1	HABO
TOC	**0.539**		% TS	3	1	HABO
Naftalen	**<10**		µg/kg TS	3	1	HABO
Acenaftylen	**<10**		µg/kg TS	3	1	HABO
Acenaften	**<10**		µg/kg TS	3	1	HABO
Fluoren	**<10**		µg/kg TS	3	1	HABO
Fenantren	**<10**		µg/kg TS	3	1	HABO
Antracen	**<10**		µg/kg TS	3	1	HABO
Fluoranten	**<10**		µg/kg TS	3	1	HABO
Pyren	**<10**		µg/kg TS	3	1	HABO
Benso(a)antracen^	**<10**		µg/kg TS	3	1	HABO
Krysen^	**<10**		µg/kg TS	3	1	HABO
Benso(b)fluoranten^	**<10**		µg/kg TS	3	1	HABO
Benso(k)fluoranten^	**<10**		µg/kg TS	3	1	HABO
Benso(a)pyren^	**<10**		µg/kg TS	3	1	HABO
Dibenso(ah)antracen^	**<10**		µg/kg TS	3	1	HABO
Benso(ghi)perylen	**11**	3.38	µg/kg TS	3	1	HABO
Indeno(123cd)pyren^	**<10**		µg/kg TS	3	1	HABO
Sum PAH-16*	**11**		µg/kg TS	3	1	HABO
Sum PAH carcinogene^*	**n.d.**		µg/kg TS	3	1	HABO
PCB 28	**<0.70**		µg/kg TS	3	1	HABO
PCB 52	**<0.70**		µg/kg TS	3	1	HABO
PCB 101	**<0.70**		µg/kg TS	3	1	HABO
PCB 118	**<0.70**		µg/kg TS	3	1	HABO
PCB 138	**<0.70**		µg/kg TS	3	1	HABO
PCB 153	**<0.70**		µg/kg TS	3	1	HABO
PCB 180	**<0.70**		µg/kg TS	3	1	HABO
Sum PCB-7*	**n.d.**		µg/kg TS	3	1	HABO
As (Arsen)	**3.10**	0.62	mg/kg TS	3	1	JIBJ
Pb (Bly)	**11.3**	2.3	mg/kg TS	3	1	JIBJ
Cu (Kopper)	**14.6**	2.92	mg/kg TS	3	1	JIBJ
Cr (Krom)	**21.4**	4.27	mg/kg TS	3	1	JIBJ
Cd (Kadmium)	**<0.10**		mg/kg TS	3	1	JIBJ
Hg (Kvikksølv)	**<0.20**		mg/kg TS	3	1	JIBJ
Ni (Nikkel)	**10.3**	2.1	mg/kg TS	3	1	JIBJ
Zn (Sink)	**120**	24.1	mg/kg TS	3	1	JIBJ
Tørrstoff (G)	**68.1**		%	4	2	HABO
Monobutyltinnkation	**1.2**	0.16	µg/kg TS	4	2	HABO
Dibutyltinnkation	**1.4**	0.18	µg/kg TS	4	2	HABO
Tributyltinnkation	**1.4**	0.18	µg/kg TS	4	2	HABO
Tetrabutyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Monooktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Dioktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trisykloheksyltinnkation	**<1.0**		µg/kg TS	4	2	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	Raunes 3 Marine sediment					
Labnummer	N00368078					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Monofenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Difenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trifenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Tørrstoff (E)	**58.3**	3.53	%	5	1	HABO
Ba (Barium)	**110**	22.0	mg/kg TS	5	1	HABO
Co (Kobolt)	**10.8**	2.16	mg/kg TS	5	1	HABO
Mo (Molybden)	**0.67**	0.13	mg/kg TS	5	1	HABO
P (Fosfor)	**669**	134	mg/kg TS	5	1	HABO
V (Vanadium)	**29.2**	5.83	mg/kg TS	5	1	HABO
Tørrstoff (G)	**68.1**		%	6	2	HABO
C1-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C2-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C3-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C1-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
C2-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
Dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C1-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C2-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C3-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
N-total	**787**	161	mg/kg TS	7	1	HABO

Rapport

N1507677

Side 10 (18)

Y42X1DMI2G

Deres prøvenavn	**Vatsfjord Grønnevik St 4** **Marine sediment**					
Labnummer	N00368079					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**85.2**	5.14	%	3	1	HABO
Vanninnhold	**14.8**	0.92	%	3	1	HABO
Kornstørrelse >63 µm	**62.9**	6.3	%	3	1	HABO
Kornstørrelse <2 µm	**1.0**	0.1	%	3	1	HABO
Kornfordeling	**----------**		se vedl.	3	1	HABO
TOC	**0.648**		% TS	3	1	HABO
Naftalen	**<10**		µg/kg TS	3	1	HABO
Acenaftylen	**<10**		µg/kg TS	3	1	HABO
Acenaften	**<10**		µg/kg TS	3	1	HABO
Fluoren	**<10**		µg/kg TS	3	1	HABO
Fenantren	**<10**		µg/kg TS	3	1	HABO
Antracen	**<10**		µg/kg TS	3	1	HABO
Fluoranten	**<10**		µg/kg TS	3	1	HABO
Pyren	**<10**		µg/kg TS	3	1	HABO
Benso(a)antracen^	**<10**		µg/kg TS	3	1	HABO
Krysen^	**<10**		µg/kg TS	3	1	HABO
Benso(b)fluoranten^	**<10**		µg/kg TS	3	1	HABO
Benso(k)fluoranten^	**<10**		µg/kg TS	3	1	HABO
Benso(a)pyren^	**<10**		µg/kg TS	3	1	HABO
Dibenso(ah)antracen^	**<10**		µg/kg TS	3	1	HABO
Benso(ghi)perylen	**10**	3.02	µg/kg TS	3	1	HABO
Indeno(123cd)pyren^	**<10**		µg/kg TS	3	1	HABO
Sum PAH-16*	**10**		µg/kg TS	3	1	HABO
Sum PAH carcinogene^*	**n.d.**		µg/kg TS	3	1	HABO
PCB 28	**<0.70**		µg/kg TS	3	1	HABO
PCB 52	**<0.70**		µg/kg TS	3	1	HABO
PCB 101	**<0.70**		µg/kg TS	3	1	HABO
PCB 118	**<0.70**		µg/kg TS	3	1	HABO
PCB 138	**<0.70**		µg/kg TS	3	1	HABO
PCB 153	**<0.70**		µg/kg TS	3	1	HABO
PCB 180	**<0.70**		µg/kg TS	3	1	HABO
Sum PCB-7*	**n.d.**		µg/kg TS	3	1	HABO
As (Arsen)	**3.86**	0.77	mg/kg TS	3	1	JIBJ
Pb (Bly)	**13.2**	2.6	mg/kg TS	3	1	JIBJ
Cu (Kopper)	**16.6**	3.32	mg/kg TS	3	1	JIBJ
Cr (Krom)	**22.6**	4.53	mg/kg TS	3	1	JIBJ
Cd (Kadmium)	**<0.10**		mg/kg TS	3	1	JIBJ
Hg (Kvikksølv)	**<0.20**		mg/kg TS	3	1	JIBJ
Ni (Nikkel)	**11.3**	2.3	mg/kg TS	3	1	JIBJ
Zn (Sink)	**104**	20.9	mg/kg TS	3	1	JIBJ
Tørrstoff (G)	**70.5**		%	4	2	HABO
Monobutyltinnkation	**1.2**	0.16	µg/kg TS	4	2	HABO
Dibutyltinnkation	**1.2**	0.16	µg/kg TS	4	2	HABO
Tributyltinnkation	**1.0**	0.13	µg/kg TS	4	2	HABO
Tetrabutyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Monooktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Dioktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trisykloheksyltinnkation	**<1.0**		µg/kg TS	4	2	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	**Vatsfjord Grønnevik St 4** **Marine sediment**					
Labnummer	N00368079					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Monofenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Difenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trifenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Tørrstoff (E)	**85.2**	5.14	%	5	1	HABO
Ba (Barium)	**121**	24.2	mg/kg TS	5	1	HABO
Co (Kobolt)	**11.8**	2.37	mg/kg TS	5	1	HABO
Mo (Molybden)	**0.87**	0.17	mg/kg TS	5	1	HABO
P (Fosfor)	**685**	137	mg/kg TS	5	1	HABO
V (Vanadium)	**32.3**	6.46	mg/kg TS	5	1	HABO
Tørrstoff (G)	**70.5**		%	6	2	HABO
C1-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C2-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C3-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C1-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
C2-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
Dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C1-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C2-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C3-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
N-total	**801**	164	mg/kg TS	7	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	Vats 4 Marine sediment					
Labnummer	N00368080					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**70.3**	4.25	%	3	1	HABO
Vanninnhold	**29.7**	1.81	%	3	1	HABO
Kornstørrelse >63 µm	**80.6**	8.1	%	3	1	HABO
Kornstørrelse <2 µm	**0.6**	0.06	%	3	1	HABO
Kornfordeling	**----------**		se vedl.	3	1	HABO
TOC	**1.05**		% TS	3	1	HABO
Naftalen	**<10**		µg/kg TS	3	1	HABO
Acenaftylen	**<10**		µg/kg TS	3	1	HABO
Acenaften	**<10**		µg/kg TS	3	1	HABO
Fluoren	**<10**		µg/kg TS	3	1	HABO
Fenantren	**<10**		µg/kg TS	3	1	HABO
Antracen	**<10**		µg/kg TS	3	1	HABO
Fluoranten	**11**	3.36	µg/kg TS	3	1	HABO
Pyren	**10**	3.13	µg/kg TS	3	1	HABO
Benso(a)antracen^	**<10**		µg/kg TS	3	1	HABO
Krysen^	**<10**		µg/kg TS	3	1	HABO
Benso(b)fluoranten^	**10**	3.13	µg/kg TS	3	1	HABO
Benso(k)fluoranten^	**<10**		µg/kg TS	3	1	HABO
Benso(a)pyren^	**<10**		µg/kg TS	3	1	HABO
Dibenso(ah)antracen^	**<10**		µg/kg TS	3	1	HABO
Benso(ghi)perylen	**<10**		µg/kg TS	3	1	HABO
Indeno(123cd)pyren^	**<10**		µg/kg TS	3	1	HABO
Sum PAH-16*	**31**		µg/kg TS	3	1	HABO
Sum PAH carcinogene^*	**10**		µg/kg TS	3	1	HABO
PCB 28	**<0.70**		µg/kg TS	3	1	HABO
PCB 52	**<0.70**		µg/kg TS	3	1	HABO
PCB 101	**<0.70**		µg/kg TS	3	1	HABO
PCB 118	**<0.70**		µg/kg TS	3	1	HABO
PCB 138	**<0.70**		µg/kg TS	3	1	HABO
PCB 153	**<0.70**		µg/kg TS	3	1	HABO
PCB 180	**<0.70**		µg/kg TS	3	1	HABO
Sum PCB-7*	**n.d.**		µg/kg TS	3	1	HABO
As (Arsen)	**2.99**	0.60	mg/kg TS	3	1	JIBJ
Pb (Bly)	**10.3**	2.0	mg/kg TS	3	1	JIBJ
Cu (Kopper)	**14.8**	2.97	mg/kg TS	3	1	JIBJ
Cr (Krom)	**11.8**	2.36	mg/kg TS	3	1	JIBJ
Cd (Kadmium)	**<0.10**		mg/kg TS	3	1	JIBJ
Hg (Kvikksølv)	**<0.20**		mg/kg TS	3	1	JIBJ
Ni (Nikkel)	**8.1**	1.6	mg/kg TS	3	1	JIBJ
Zn (Sink)	**58.3**	11.7	mg/kg TS	3	1	JIBJ
Tørrstoff (G)	**71.9**		%	4	2	HABO
Monobutyltinnkation	**4.5**	0.59	µg/kg TS	4	2	HABO
Dibutyltinnkation	**8.7**	1.1	µg/kg TS	4	2	HABO
Tributyltinnkation	**40**	5.2	µg/kg TS	4	2	HABO
Tetrabutyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Monooktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Dioktyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trisykloheksyltinnkation	**<1.0**		µg/kg TS	4	2	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Deres prøvenavn	Vats 4 Marine sediment					
Labnummer	N00368080					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Monofenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Difenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Trifenyltinnkation	**<1.0**		µg/kg TS	4	2	HABO
Tørrstoff (E)	**70.3**	4.25	%	5	1	HABO
Ba (Barium)	**34.5**	6.91	mg/kg TS	5	1	HABO
Co (Kobolt)	**6.52**	1.30	mg/kg TS	5	1	HABO
Mo (Molybden)	**0.79**	0.16	mg/kg TS	5	1	HABO
P (Fosfor)	**644**	129	mg/kg TS	5	1	HABO
V (Vanadium)	**18.5**	3.70	mg/kg TS	5	1	HABO
Tørrstoff (G)	**71.9**		%	6	2	HABO
C1-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C2-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C3-naftalen*	**<0.050**		mg/kg TS	6	2	HABO
C1-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
C2-fenantren/antracen*	**<0.050**		mg/kg TS	6	2	HABO
Dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C1-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C2-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
C3-dibensotiofen*	**<0.050**		mg/kg TS	6	2	HABO
N-total	**659**	136	mg/kg TS	7	1	HABO

Deres prøvenavn	Vats 1 Marine sediment					
Labnummer	N00368081					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**76.0**	4.59	%	5	1	HABO
Hg (Kvikksølv)	**<0.20**		mg/kg TS	5	1	HABO

Deres prøvenavn	Vats 2 Marine sediment					
Labnummer	N00368082					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**72.5**	4.38	%	5	1	HABO
Hg (Kvikksølv)	**<0.20**		mg/kg TS	5	1	HABO

Deres prøvenavn	Vats 3 Marine sediment					
Labnummer	N00368083					
Analyse	**Resultater**	**Usikkerhet (±)**	**Enhet**	**Metode**	**Utført**	**Sign**
Tørrstoff (E)	**72.2**	4.36	%	5	1	HABO
Hg (Kvikksølv)	**<0.20**		mg/kg TS	5	1	HABO

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

* etter parameternavn indikerer uakkreditert analyse.
n.d. betyr ikke påvist.
n/a betyr ikke analyserbart.
< betyr mindre enn.
> betyr større enn.

	Metodespesifikasjon		
1	**Bestemmelse av Normpakke, normverdier for følsom arealbruk, del 1 (2).**		
	Metode:	Metaller:	ISO 11885, EPA 200.7, EPA 6010, SM 3120
		Tørrstoff:	ISO 11465
		Cr6+:	EN 15192, EPA 3060A
		Cyanid-fri:	ISO 6703-2
		PCB-7:	EPA 8082, ISO 10382
		Klorpesticider:	EPA 8081
		Klorbensener:	ISO 15009, EPA 8260, EPA 5021A, EPA 5021, EPA 8015, MADEP 2004, rev.1.1.
		Klorerte løsemidler:	ISO 15009, EPA 8260, EPA 5021A, EPA 5021, EPA 8015, MADEP 2004, rev.1.1.
	Måleprinsipp:	Metaller:	ICP-AES
		Cr6+:	IC-SPC
		Cyanid-fri:	Spektrofotometri
		PCB-7:	GC-ECD
		Klorpesticider:	GC-ECD
		Klorbensener:	GC-FID/MS
		Klorerte løsemidler:	GC-FID/MS
	Rapporteringsgrenser:	Metaller:	0,10-5,0 mg/kg TS
		Cr6+:	0,060 mg/kg TS
		Cyanid-fri:	0,10 mg/kg TS
		PCB-7:	0,0030 mg/kg TS
		Klorpesticider:	0,010 mg/kg TS
		g-HCH (Lindan):	0,0010 mg/kg TS
		Klorbensener:	0,010-0,030 mg/kg TS
		Heksaklorbensen:	0,0050 mg/kg TS
		Klorerte løsemidler:	0,0030-0,060 mg/kg TS
	Relativ måleusikkerhet:	Metaller:	20 %
		Tørrstoff:	10 %
		Cr6+:	20 %
		Cyanid-fri:	40 %
		PCB-7:	40 %
		Klorpesticider:	40 %
		Klorbensener:	40 %
		Klorerte løsemidler:	40 %
	Note:	Resultater rapportert som < betyr ikke påvist	
2	**Bestemmelse av Normpakke, normverdier for følsom arealbruk, del 2 (2).**		
	Metode:	PAH:	EPA 8270, ISO 18287
		BTEX:	ISO 15009, EPA 8260, EPA 5021A, EPA 5021, EPA 8015, MADEP 2004 rev. 1.1
		Klorfenoler:	ISO 14154, EPA 8041, EPA 3500
		Hydrokarboner:	
		>C5-C10	ISO 15009, EPA 8260, EPA 8015, RBCA Petroleum Hydrocarbon Methods
		>C10-C35	EN 14039

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

	Metodespesifikasjon		
	Måleprinsipp:	PAH: BTEX: Klorfenoler: Hydrokarboner: >C5-C10 >C10-C35	GC-MS GC-FID/MS GC-MS/ECD GC-FID/ECD GC-FID
	Rapporteringsgrenser:	PAH-16: Benzen: BTEX: Klorfenoler: Pentaklorfenol: C5-C6: >C6-C8: >C8-C10: >C10-C12: >C12-C16: >C16-C35:	0,010 mg/kg TS 0,0050 mg/kg TS 0.01-0.10 mg/kg TS 0,020 mg/kg TS 0,006 mg/kg TS 7,0 mg/kg TS 7,0 mg/kg TS 10 mg/kg TS 2,0 mg/kg TS 3,0 mg/kg TS 10 mg/kg TS
	Måleusikkerhet:	PAH: BTEX Klorfenoler: >C5-C10 >C10-C35	relativ usikkerhet 30 % relativ usikkerhet 40 % relativ usikkerhet 25 % relativ usikkerhet 40 % relativ usikkerhet 30 %
	Note:	Resultater rapportert som < betyr ikke påvist	
3	**«Sediment basispakke»**	**Risikovurdering av sediment**	

Bestemmelse av vanninnhold og tørrstoff

Metode:	ISO 11465
Måleprinsipp:	Tørrstoff bestemmes gravimetrisk og vanninnhold beregnes utfra målte verdier.
Rapporteringsgrense:	0,10 %
Måleusikkerhet:	5 %

Bestemmelse av Kornfordeling (<63 µm, >63 µm og <2 µm)

Metode:	ISO 11277:2009
Måleprinsipp:	Laserdiffraksjon
Rapporteringsgrense:	0,10 %

Bestemmelse av TOC

Metode:	ISO 10694, EN 13137, EN 15936
Måleprinsipp:	Coulometrisk bestemmelse
Rapporteringsgrense:	0,010 %TS

Bestemmelse av polysykliske aromatiske hydrokarboner, PAH-16

Metode:	EPA 429, EPA 1668, EPA 3550
Måleprinsipp:	GC/MSD
Rapporteringsgrenser:	10 µg/kg TS
Måleusikkerhet:	30 %

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

	Metodespesifikasjon
	Bestemmelse av polyklorerte bifenyler, PCB-7 Metode: EPA 429, EPA 1668, EPA 3550 Måleprinsipp: GC/MSD Rapporteringsgrenser: 0,7 µg/kg TS Måleusikkerhet: 30 % **Bestemmelse av metaller, M-1C** Metode: EPA 200.7, ISO 11885, EPA 6010, SM 3120 Måleprinsipp: ICP-AES Rapporteringsgrenser: As(0.50), Cd(0.10), Cr(0.25), Cu(0.10), Pb(1.0), Hg(0.20), Ni(5.0), Zn(1.0) alle enheter i mg/kg TS Måleusikkerhet: 20 %
4	Bestemmelse av tinnorganiske forbindelser. Metode: DIN ISO 23161 Ekstraksjon: KOH/Heksan Rensing: Alumina Derivatisering: Na tetraetyl borat (NaBEt4) Deteksjon og kvantifisering: GC-FPD Kvantifikasjonsgrenser: 1 µg/kg TS Usikkerhet (2*RSD): 13 - 15% (basert på gjentatte analyser av kontrollprøve)
5	Analyse av tungmetaller (M-1C) (enkelt elementer) Metode: EPA metoder 200.7, ISO 11885 Forbehandling: Sikting 2 mm. Oppslutning jordprøver: HNO3 og 0,5 ml H2O2 i mikrobølgeovn. Oppslutning slam- og sedimentprøver: HNO3/vann (1:1) i mikrobølgeovn.
6	Bestemmelse av PAH-16 og C1-C3 alkylhomologer (NPD). Metode: GC/MSD Ekstraksjon: Sykloheksan Deteksjon og kvantifisering: GC/MSD Note: NPD er ikke akkreditert. Det finnes ikke standarder for alle alkylerte homologer av naftalen, fenantren, antracen og dibenzothiofen. NPD er derfor bestemt ved analysere de NPD standarder som er tilgjengelige og søke etter de karakteristiske massene i de forskjellige NPD gruppene. Alle forbindelser ble således identifisert ved hjelp av fire karakteristiske masser og kvantifisert gjennom en karakteristisk masse (target ion) ved en bestemt retensjonstid i hver gruppe. Følgende grupper og forbindelser er med i analysen: C1-Naftalener: 1-metylnaftalen og 2-metylnaftalen C2-Naftalener: 1-etylnaftalen, 2-etylnaftalen, dimetylnaftalen (5 av 12 mulige homologer var tilgjengelige som standard. Kvantifisering av forbindelser med karakteristisk masse 156 og retensjonstid 2,2 minutter). C3-Naftalener: kun metylerte forbindelser. Ingen etyl- eller propylstandarder tilgjengelige. 2,3,5-trimetylnaftalen benyttet som standard. Kvantifisering av forbindelser med karakteristisk masse 128 og retensjonstid 2 min.

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen 2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

	Metodespesifikasjon
	Fenantren, antracen og alkylerte homologer kan ikke skilles kvalitativt i massespektumet og er derfor slått sammen i en gruppe. Følgende inndeling av gruppen er utført: C1-fenantren/antracen: 1-metylantracen tilgjengelig som standard. Kvantifisering av forbindelser med karakteristisk masse 192, retensjonstid 1 minutt. C2-fenantren/antracen: kun metylerte forbindelser(9,10-dimetylnaftalen) som standarder, ingen etylstandarder tilgjengelig. Kvantifisering av forbindelser med karakteristisk masse 192 og retensjonstid 1,5 minutter. C1-dibensotiofen: 1- og 3-metyldibensotiofen tilgjengelig som standarder. Kvantifisering av forbindelser med karakteristisk masse 198 og retensjonstid 0,65 minutter. C2-dibensotiofen: 4-etyldibensotiofen og 3,6-dimetyldibensotiofen tilgjengelig som standarder. Kvantifisering av forbindelser med karakteristisk masse 212 og retensjonstid 1 minutter. C3-dibensotiofen: 4-propyldibensotiofen og 2,4,7-trimetyldibensotiofen tilgjengelig som standarder. Kvantifisering av forbindelser med karakteristisk masse 226 og retensjonstid 2,1 minutter.
7	**Bestemmelse av total Nitrogen i jord** Metode: ISO 11261 Måleprinsipp: Spektrofotometri Rapporteringsgrenser: LOR 50 mg/kg TS Andre opplysninger: Modifisert Kjeldahl-metode

	Godkjenner
HABO	Hanne Boklund
JIBJ	Jan Inge Bjørnengen

	Underleverandør[1]
1	Ansvarlig laboratorium: ALS Laboratory Group, ALS Czech Republic s.r.o, Na Harfě 9/336, Praha, Tsjekkia Lokalisering av andre ALS laboratorier: Ceska Lipa: Bendlova 1687/7, 470 03 Ceska Lipa Pardubice: V Raji 906, 530 02 Pardubice Akkreditering: Czech Accreditation Institute, labnr. 1163. Kontakt ALS Laboratory Group Norge, for ytterligere informasjon
2	Ansvarlig laboratorium: GBA, Flensburger Straße 15, 25421 Pinneberg, Tyskland Lokalisering av andre GBA laboratorier: Hildesheim: Daimlerring 37, 31135 Hildesheim Gelsenkirchen: Wiedehopfstraße 30, 45892 Gelsenkirchen Freiberg: Meißner Ring 3, 09599 Freiberg Hameln: Brekelbaumstraße 1, 31789 Hameln Hamburg: Goldschmidstraße 5, 21073 Hamburg Akkreditering: DAkks, registreringsnr. D-PL-14170-01-00 Kontakt ALS Laboratory Group Norge, for ytterligere informasjon

[1] Utførende teknisk enhet (innen ALS Laboratory Group) eller eksternt laboratorium (underleverandør).

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen 2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

Måleusikkerheten angis som en utvidet måleusikkerhet (etter definisjon i "Evaluation of measurement data – Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beregnet med en dekningsfaktor på 2 noe som gir et konfidensinterval på om lag 95%.

Måleusikkerhet fra underleverandører angis ofte som en utvidet usikkerhet beregnet med dekningsfaktor 2. For ytterligere informasjon, kontakt laboratoriet.

Denne rapporten får kun gjengis i sin helhet, om ikke utførende laboratorium på forhånd har skriftlig godkjent annet.

Angående laboratoriets ansvar i forbindelse med oppdrag, se aktuell produktkatalog eller vår webside www.alsglobal.no

Den digitalt signert PDF-fil representerer den opprinnelige rapporten. Eventuelle utskrifter er å anse som kopier.

ALS Laboratory Group Norway AS
PB 643 Skøyen
N-0214 Oslo
Norway

Web: www.alsglobal.no
E-post: info.on@alsglobal.com
Tel: + 47 22 13 18 00
Fax: + 47 22 52 51 77

Dokumentet er godkjent og digitalt signert av

Jan-Inge Bjornengen
2015.06.18 18:41:38
Client Service
jan-inge.bjornengen@alsglobal.com

4.4 Appendix 3: Analysis report of groundwater samples in 2015

NIVA
Gaustadalléen 21
0349 Oslo
Tel: 22 18 51 00
Fax: 22 18 52 00

NORSK AKKREDITERING TEST 009

ANALYSERAPPORT

RapportID: 367

Kommentar til analyseoppdraget:
Denne versjonen erstatter tidligere versjon(er). Vennligst makuler tidligere versjon(er).

Analyseoppdrag: 116-660
Versjon: 2
Dato: 26.05.2015

Provenr.: NR-2015-03274
Provetype: FERSKVANN
Provemerking: W1 27.04.15
Kommentar:

Provetakningsdato: 27.04.2015
Prove mottatt dato: 04.05.2015
Analyseperiode: 05.05.2015 (- 21.05.2015

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
Kond_Temp	NS ISO 7888:1993	23,6	°C			
Konduktivitet	NS ISO 7888:1993	3270	mS/m	20%	100,0	
Kvikksolv	NS-EN ISO 12846	0,003	µg/l	40%	0,001	Eurofins a)
Bly	NS-EN ISO 17294	0,1	µg/l	20%	0,005	
Jern	NS-EN ISO 17294	59	µg/l	20%	0,30	
Kadmium	NS-EN ISO 17294	<0,060	µg/l		0,0030	
Totalt organisk karbon	NS-EN ISO 1484;1:1997	2,2	mg C/l	20%		
pH	NS-EN ISO 10523:2012	7,65	pH units	±0,2	3,5	
pH_Temp	NS-EN ISO 10523:2012	23,2	°C			
STS	NS-EN ISO 4733;1983 NS-EN ISO 872:2005	3,6	mg/l	20%		
>C10-C12	Intern metode (EKSTERN_EF)	<5,0	µg/l		5	Eurofins c)
>C12-C16	Intern metode (EKSTERN_EF)	<5,0	µg/l		5	Eurofins c)
>C16-C35	Intern metode (EKSTERN_EF)	<20	µg/l		20	Eurofins c)
>C5-C8	Intern metode (EKSTERN_EF)	<5,0	µg/l		5	Eurofins c)
>C8-C10	Intern metode (EKSTERN_EF)	<5,0	µg/l		5	Eurofins c)
Sum THC (>C5-C35)	Intern metode (EKSTERN_EF)	nd	µg/l			Eurofins c)
Turbiditet	NS-EN ISO 7027:2000	0,31	FNU	32%	0,3	

a) Eurofins Environment Testing Norway AS, NS/EN ISO/IEC 17025:2005 NA TEST 003
c) Eurofins Environment Testing Sweden AB, ISO/IEC 17025 SWEDAC 1125

Provenr.: NR-2015-03275
Provetype: FERSKVANN
Provemerking: W2 27.04.15
Kommentar:

Provetakningsdato: 27.05.2015
Prove mottatt dato: 04.05.2015
Analyseperiode: 05.05.2015 (- 21.05.2015

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
Kond_Temp	NS ISO 7888:1993	23,6	°C			
Konduktivitet	NS ISO 7888:1993	545	mS/m	20%	10,0	
Kvikksolv	NS-EN ISO 12846	0,002	µg/l	40%	0,001	Eurofins a)
Bly	NS-EN ISO 17294	0,16	µg/l	20%	0,005	
Jern	NS-EN ISO 17294	130	µg/l	20%	0,30	
Kadmium	NS-EN ISO 17294	<0,030	µg/l		0,0030	
Totalt organisk karbon	NS-EN ISO 1484;1:1997	0,76	mg C/l	20%		
pH	NS-EN ISO 10523:2012	7,88	pH units	±0,2	3,5	
pH_Temp	NS-EN ISO 10523:2012	23,2	°C			
STS	NS-EN ISO 4733;1983 NS-EN ISO 872:2005	1,6	mg/l	20%		
>C10-C12	Intern metode (EKSTERN_EF)	<5,0	µg/l		5	Eurofins c)

Tegnforklaring:
* : Ikke omfattet av akkrediteringen
<: Mindre enn, >: Storre enn, MU: Måleusikkerhet, LOQ: Kvantifiseringsgrense
Analyserapporten må kun gjengis i sin helhet og uten noen form for endringer. Analyseresultatet gjelder kun for den proven som er testet.

Side 1 av 3

Prøvenr.:	NR-2015-03275	Prøvetakningsdato:	27.05.2015
Prøvetype:	FERSKVANN	Prøve mottatt dato:	04.05.2015
Prøvemerking:	W2 27.04.15	Analyseperiode:	05.05.2015 (- 21.05.2015
Kommentar:			

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
>C12-C16	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C16-C35	Intern metode (EKSTERN_EF)	**<20**	µg/l		20	Eurofins c)
>C5-C8	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C8-C10	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
Sum THC (>C5-C35)	Intern metode (EKSTERN_EF)	**nd**	µg/l			Eurofins c)
Turbiditet	NS-EN ISO 7027:2000	**0,69**	FNU	20%	0,3	

a) Eurofins Environment Testing Norway AS, NS/EN ISO/IEC 17025:2005 NA TEST 003
c) Eurofins Environment Testing Sweden AB, ISO/IEC 17025 SWEDAC 1125

Prøvenr.:	NR-2015-03276	Prøvetakningsdato:	27.05.2015
Prøvetype:	FERSKVANN	Prøve mottatt dato:	04.05.2015
Prøvemerking:	W3 27.04.15	Analyseperiode:	05.05.2015 (- 21.05.2015
Kommentar:			

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
Kond_Temp	NS ISO 7888:1993	**23,6**	°C			
Konduktivitet	NS ISO 7888:1993	**946**	mS/m	20%	10,0	
Kvikksølv	NS-EN ISO 12846	**0,002**	µg/l	40%	0,001	Eurofins a)
Bly	NS-EN ISO 17294	**0,45**	µg/l	20%	0,005	
Jern	NS-EN ISO 17294	**259**	µg/l	20%	0,30	
Kadmium	NS-EN ISO 17294	**0,080**	µg/l	20%	0,0030	
Totalt organisk karbon	NS-EN ISO 1484;1:1997	**1,0**	mg C/l	20%		
pH	NS-EN ISO 10523:2012	**7,78**	pH units	±0,2	3,5	
pH_Temp	NS-EN ISO 10523:2012	**23,2**	°C			
STS	NS-EN ISO 4733;1983 NS-EN ISO 872:2005	**6,5**	mg/l	20%		
>C10-C12	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C12-C16	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C16-C35	Intern metode (EKSTERN_EF)	**<20**	µg/l		20	Eurofins c)
>C5-C8	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C8-C10	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
Sum THC (>C5-C35)	Intern metode (EKSTERN_EF)	**nd**	µg/l			Eurofins c)
Turbiditet	NS-EN ISO 7027:2000	**1,0**	FNU	20%	0,3	

a) Eurofins Environment Testing Norway AS, NS/EN ISO/IEC 17025:2005 NA TEST 003
c) Eurofins Environment Testing Sweden AB, ISO/IEC 17025 SWEDAC 1125

Prøvenr.:	NR-2015-03277	Prøvetakningsdato:	27.05.2015
Prøvetype:	FERSKVANN	Prøve mottatt dato:	04.05.2015
Prøvemerking:	W4 27.04.15	Analyseperiode:	05.05.2015 (- 21.05.2015
Kommentar:			

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
Kond_Temp	NS ISO 7888:1993	**23,6**	°C			
Konduktivitet	NS ISO 7888:1993	**245**	mS/m	20%	10,0	
Kvikksølv	NS-EN ISO 12846	**0,004**	µg/l	40%	0,001	Eurofins a)
Bly	NS-EN ISO 17294	**0,23**	µg/l	20%	0,005	
Jern	NS-EN ISO 17294	**177**	µg/l	20%	0,30	
Kadmium	NS-EN ISO 17294	**<0,030**	µg/l		0,0030	
Totalt organisk karbon	NS-EN ISO 1484;1:1997	**1,3**	mg C/l	20%		
pH	NS-EN ISO 10523:2012	**7,86**	pH units	±0,2	3,5	
pH_Temp	NS-EN ISO 10523:2012	**23,2**	°C			

Tegnforklaring:
* : Ikke omfattet av akkrediteringen
<: Mindre enn, >: Større enn, MU: Måleusikkerhet, LOQ: Kvantifiseringsgrense
Analyserapporten må kun gjengis i sin helhet og uten noen form for endringer. Analyseresultatet gjelder kun for den prøven som er testet.

Prøvenr.:	NR-2015-03277	Prøvetakningsdato:	27.05.2015
Prøvetype:	FERSKVANN	Prøve mottatt dato:	04.05.2015
Prøvemerking:	W4 27.04.15	Analyseperiode:	05.05.2015 - 21.05.2015
Kommentar:			

Analysevariabel	Metode	Resultat	Enhet	MU	LOQ	Underlev.
STS	NS-EN ISO 4733;1983 NS-EN ISO 872:2005	**2,5**	mg/l	20%		
>C10-C12	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C12-C16	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C16-C35	Intern metode (EKSTERN_EF)	**<20**	µg/l		20	Eurofins c)
>C5-C8	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
>C8-C10	Intern metode (EKSTERN_EF)	**<5,0**	µg/l		5	Eurofins c)
Sum THC (>C5-C35)	Intern metode (EKSTERN_EF)	**nd**	µg/l			Eurofins c)
Turbiditet	NS-EN ISO 7027:2000	**0,53**	FNU	20%	0,3	

a) Eurofins Environment Testing Norway AS, NS/EN ISO/IEC 17025:2005 NA TEST 003
c) Eurofins Environment Testing Sweden AB, ISO/IEC 17025 SWEDAC 1125

NIVA
Norsk institutt for vannforskning
Line Roaas

Laboratoriesjef

Rapporten er elektronisk signert

Tegnforklaring:
* : Ikke omfattet av akkrediteringen
<: Mindre enn, >: Større enn, MU: Måleusikkerhet, LOQ: Kvantifiseringsgrense
Analyserapporten må kun gjengis i sin helhet og uten noen form for endringer. Analyseresultatet gjelder kun for den prøven som er testet.

NIVA: Norway's leading centre of competence in aquatic environments

NIVA provides government, business and the public with a basis for preferred water management through its contracted research, reports and development work. A characteristic of NIVA is its broad scope of professional disciplines and extensive contact network in Norway and abroad. Our solid professionalism, interdisciplinary working methods and holistic approach are key elements that make us an excellent advisor for government and society.

Norwegian Institute for Water Research

Gaustadalléen 21 • NO-0349 Oslo, Norway
Telephone: +47 22 18 51 00 • Fax: 22 18 52 00
www.niva.no • post@niva.no