TECHNICAL REPORT

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DECOMMISSIONING OF SHIPS
–
ENVIRONMENTAL STANDARDS

SHIP-BREAKING PRACTICIES/ ON SITE ASSESSMENT
BANGLADESH – CHITTAGONG

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DET NORSKE VERITAS

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Summary:

This report represents a subtask of a DNV study on ship decommissioning (Decommissioning of Ships – Environmental Standards). The project has published the following reports;

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The study (Decommissioning of Ships – Environmental Standards) include a phase emphasising on the potentials of introducing a "Best Practice Approach" (BAP) for ship demolition facilities. The aim of this task is to identify procedures or methods providing for improvements associated to environmental performance and occupational safety/ human health in relation to the demolition process.

In order to establish a knowledge baseline for identifying recommendations in identifying a BAP, an on-site assessment was required. Det Norske Veritas DNV initiated a dialogue with relevant Bangladesh authorities as well as Norwegian governmental representation in Bangladesh. This resulted in a formalised co-operation with the University of Chittagong (UOC). The survey undertaken in Chittagong, Bangladesh was a joint effort activity and has provided a base for further co-operation between DNV and UOC.

This report summarises the activities carried out in Chittagong. Furthermore make use of findings and conclusions made in the process of identifying a methodological approach for improving conditions associated to safety, health and the environment in the ship breaking industry.

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Preamble

This work is largely based upon the findings and results following the undertaking of an On-Site Assessment carried out at the ship-breaking facilities of Chittagong, Bangladesh. In the process of both planning and undertaking this activity, DNV was dependent on local co-operation.

DNV would like to thank the Institute of Marine Sciences, University of Chittagong (UOC) for their efforts and assistance in the planning and execution of the on-site activities. The work was undertaken in close co-operation with university staff. Dr. Yousuf Sharif Ahmad Khan, Mr. Sayedur Rahman Chowdhury, Mr. S.M.A Jabber, Mr. Pranab Das and Mr. Md. Musa Miah provided essential support to the work. Their engagement and commitment has been highly appreciated.

The established and formalised co-operation between the two institutions has proven successful and the results are an encouragement to future collaboration.

The Norwegian governmental representation at the Royal Norwegian Embassy in Dhaka has also provided excellent assistance and support to our team. We would like to use this opportunity to express our gratitude.

1 INTRODUCTION

1.1 General

The material composition of a vessels structure, components and systems will reflect the era from when it was built. Likewise, cargo-remains, system agents and onboard spares and consumables will reflect its type and pattern of trade. At the end of the operational life, the vessel still represents a resource, as a considerable proportion of its lightweight is suited for reuse or recycling. However, the extraction processes required, produce debris and wastes that in it self represent a threat to the environment and consequently to human health. Further, the methods adopted in the demolition and extraction process are suffering from serious deficiencies with regard to general safety aspects.

In order to ensure the safety of workers and the environment, the extraction and demolition processes requires managerial routines covering the aspect of Safety, Health and the Environment (SHE). Knowledge on the nature, scale and the environmental impacts of ship-scrapping as it is performed today, will be important inputs when defining such routines. One major challenge is that of identifying, quantifying and locating all onboard substances of concern. Proper documentation on on-board substances will ease and improve the planning of operations necessary for the processes associated to extraction, sorting, handling refining and reuse/ recycling.

Ship breaking on the sub-Indian continent has developed into an activity of considerable volume supplying raw material to the steel-industry for both re-rolling and re-melting. The breaking processes also supply second hand material and equipment for re-use both locally but also for export.

Steel scrap from ship breaking provide as an alternative to the consume of non-renewable ore resources allowing the manufacture of steel to be undertaken significantly more energy efficient. In this perspective, ship breaking can be claimed to be a sound sustainable industrial activity.

However, the extraction of steel-scrap and materials and components for re-use, provide challenges associated to methods adopted ensuring that these are equally sustainable. Previous work carried out by DNV has revealed an unsatisfactory level of SHE-related standards in the ship-breaking industry both regarding facilities and operations.

This report addresses the objective item 3 of the project; Decommissioning of Ships – Environmental Standards (ref .:/37/). The scope is based on recommendations made in a former study undertaken by DNV, (ref.: /1/).

1.1.1 Decommissioning of Ships – Environmental Standards, Objective item 3

A set of recommendations for the establishment of guidelines for the ship-breaking process based on a Best Practice Approach should be identified. These should be developed mirroring the realities and possibilities of ship breaking of today reflecting upon present location and existing infrastructure. Successful implementation is of utmost importance when providing recommendations. The following aspects should be included;

- General safety (work procedure and protective measures).

- General waste management.
- Hazardous waste management including in particular procedures associated to extraction, removal, treatment and disposal.
- Contingency plans and procedures.
- Monitoring of health and the environment.

The ambition of these recommendations should be to establish a base-frame representing a first step in the process of identifying acceptable standards and norms for the industry. The "continuos improvement" approach adopted by widely recognised safety and environmental management standards might provide as an appropriate mechanism or tool in order to move the procedures to higher levels and to ensure further development. The feasibility of such approach should be assessed including identifying potential implementation barriers, training requirements, investment requirements, etc.

A SHE-focused base-frame in the format of a "Best Practice Approach" (BPA) will require input on current practices and aspects related to all the processes involved. This will enable prioritising of areas for improvements associated to environmental performance and occupational safety/ human health in relation to the demolition process and to provide recommendations. Actual on-site knowledge is vital in this context.

1.2 Bangladesh - Chittagong

Bangladesh is situated at the apex of the Bay of Bengal surrounded almost completely by India except from a region in the south-east, which boarders to Myanmar (formerly Burma). The land area of Bangladesh is approximately 148,393 km^2 and its coastline stretches some 710 km. With its 124 million inhabitants (1997 estimate), this is one of the most densely populated areas of the world (with more than 800 people per km^2). Bangladesh consist nearly entirely of a delta with a considerable number of waterways making it appear as a sheet of mosaic from the air. The Bangladsh part of the Ganges-Brahmaputra-Meghna river system carries an estimated sediment load of more than 1060 million tons annually to the Bay of Bengal, which ranks first in sediment flux to the oceans on a global scale (ref.: /24/). Because of heavy rainfall during the monsoon season, which lasts from -July to October, the sediment flux is not distributed evenly through the year. It has been reported that 70-80% of the annual rainfall on the Ganga Plain occurs during July to September (ref.: /31/).

An overview of Bangladesh and the location of Chittagong is shown in Figure 1 in Appendix A.

Bangladesh is a poor country with low life duration expectancy, estimated to almost coincide for male/female at 59,5 years (1997 estimate).

Like most other developing countries, Bangladesh experiences growth in population as well as in industrial development activities, both factors representing an increase in potential environmental burden. The major pollutants are municipal and industrial waste, agro-chemical residues and discharge from ships and boats (international/ coastal). An increasing concern is the pollution originating from the growing ship breaking industry.

1.2.1 Environmental concern and ship scrapping

The inland network of waterways acts as drainage for water from upstream countries (India, Nepal, Bhutan and China), and bring pollutants in, adding to the input produced by Bangladesh itself. Because of its large population and numerous waterways, the amount of pollutants reaching the coast is considerable. This mechanism adds to the pollution sources located at the coast itself.

The scrapping of ships is taking place at several sites along the coast of Bangladesh. The area of Fauzdarhat, a 16-km beach situated approximately 20-km south-west of Chittagong, is undoubtedly the most important. Parallel ship-breaking activities taking place here, represent the second largest facility in the world with respect to the numbers of vessels being scrapped. In size (no. of vessels scrapped per annum), only Alang/Mumbai (India) represents a larger capacity. However, these facilities are recognised by attending to smaller tonnage than that of Chittagong. Chittagong is the largest facility for large vessels, scrapping some 52% of all vessels above 200.000 dwt (1997-1998). The reason being the large tidal difference providing an intertidal zone particularly suitable for beaching large vessels.

Ship-breaking was initiated in this area in 1969 and has now grown into a considerable industry occupying a large number of people, not only in the breaking process itself, but also in association to the processes of refining and material re-use. It is believed that more than 100,000 individuals earn for their livelihood from the scrapping activities of Chittagong.

The extent of the ship breaking area of Chittagong (Fauzdarhat) is shown in Appendix A (maps). In Appendix D, representative activities ongoing in the area is presented by photography.

The increasing number of large tankers reaching “phase-out” age is expected to increase ship breaking and associated activities in the Chittagong area. This adds to the challenges already facing Bangladesh with respect to the environment, to human health and to safety issues.

1.3 The Best Practice Approach (BPA)

The increasing concerns related to the process of ship demolition are focussing on:

- Environmental standards.
- Occupational safety and health.
- Contingency preparedness and disaster management.

These subjects represent the essence of the established SHE approach. The BPA must reflect upon all these three elements, as it will provide for the development of operational procedures influencing Safety, Health as well as the Environment.

The BPA can perform as an element in a comprehensive management tool package. Such a tool, an Environmental Safety Manual (ESM) may make provisions as follows.:

- Management tool for ship breaking facilities.
- Third party performance verification base.
- Tool for development and continuous improvement.
- Basis for benchmarking with other facilities.

The ESM can be developed in compliance to available standards or norms (ISO 14001).

A SHE-management system may be developed using the ESM-approach comprising of an Environmental Management Plan, an Occupational Safety and Health Plan, as well as a Contingency Preparedness and Disaster Management Plan. An overlaying inventory of best practices will be governing for all these tools.

Existing DNV tools can be adopted in order to establish the structure and content of a SHE-baseline (SHE-description) (International Safety Rating System, ISRS/ International

Environmental Rating System, IERS/ PROSPER). This will not refer to any specific level of performance but merely establish a base for the application of a system allowing the facility to monitor and control its performance.

An Inventory of Best Practices (IBP) may include guidelines, procedures, standards and requirements and can be identified independent upon any management system. However, the inventory should address items such as present materials and associated hazards, operational requirements and managerial routines, requirements associated to facilities, training and related matters.

Different related tools, for example the Environmental Guidelines for Ship-Breaking Industries (EGSI) developed by the Central Pollution Control Board, Delhi, India, identifies procedures aiming at providing for the protection of the workforce as well as the environment. Such tools are sometimes based on national legislations not only on issues directly linked to the actual ship-breaking operation, but also with reference to siting of ship-breaking facilities, to required consent from appropriate authorities and to required authorisation. An international approach should be generic and only refer to national requirements.

Based upon the BPA, an inventory complying guidelines, procedures, standards and requirements referring to actual operations (IBP) is addressed. The inventory will have a mutual sections for practices related to the identification and handling of materials, items and hazards covering all involved areas (SHE).

The inventory represents minimum requirements for a ship-breaking facility. These will involve the facilities themselves (not limited to where the vessel is beached) and also operational procedures adopted. Emphasis has been made on environmental safety and on human health. Adopted standards refer to national legislations or regulations where applicable.

2 CURRENT PRACTICES AND SHE-RELATED IMPACTS

2.1 General

An insight in actual practices adopted in the various phases of the demolition and re-use procedures can be provided by literature. However, it becomes evident that the information available, largely based upon statistics, unverifiable assumptions and 3rd. party impressions, are not adequate in this context. In order to assess potentials for improvements, it was concluded that existing references did not make the necessary provisions and further, that on-hands experience gained by on-site investigations was unavoidable.

2.2 Particulars of the vicinity of Chittagong

Mangroves

The area where the ship scrapping industry is located in Chittagong, used to be covered by a mangrove forest, which have declined since the start of the scrapping in 1969. The mangroves may be seen on Figure 11 in Appendix D. A study of the mangroves was not an item of this study and thus the mangroves will not be further discussed in this report. However it should be emphasised that the mangroves have many important qualities such as prevention of sediment transport and purifying of the water.

The ship scrapping industry is not the only one responsible for the pollution problem in the coastal waters of Bangladesh. Dr. Khan et. al. undertook an extensive study in 1993 where the different types of coastal pollution were investigated (ref.: /32/). The report concluded that "*The time may come when it (pollution) will go beyond our control. So, for the interest of the nation we should take immediate care of our marine health to prevent pollution*". The authors also suggested the following points when considering prevention of pollution of the coastal waters of Bangladesh.

1. Receiving facilities for oil and oily substances should be developed in the Chittagong and Mongala ports.
2. A coastal guard system to be introduced to detect disposal of waste products and oil spills.
3. The industrial effluents must be treated economically in such a way that it should not foul the receiving environment and does not cause inconvenience to the nearby inhabitants.
4. Sewage treatment plant should be installed in Chittagong and Khulna cities immediately.
5. Suitable monitoring systems should be established and bioassy test of fish and water sample may provide valuable information in combating future hazards and taking preventive measure.
6. If any aquatic resource faces death because of pollution, the enterpreneurs should be penalised.

Most of these relatively comprehensive recommendations, may also be considered for the ship scrapping industry in general.

2.3 On-site assessment, Chittagong

The discussions concerning the location of an on-site activity included many aspects both of technical, scientific and practical character. The final decision of Chittagong, Bangladesh was reached based upon an overall consideration. However, the spirit of co-operation and expertise sharing of UOC and local authorities, was important in the decision process.

The assumption made that conditions surrounding activities connected directly or indirectly to ship scrapping in this area are representative for the activity of the Sub-Indian continent in general might very well be questioned. However, it rests upon the fact that the challenges associated to the task of dismantling are met under similar terms;

- Vessels are beached by own power.
- Dismantling is undertaken directly on the beach.
- Automation or use of "powered" tools is minimised leading to a high level of labour intensivity.
- No regulations are implemented.

The diversity between ship scrapping represented by the major actors (India Bangladesh and Pakistan) are associated to the type of tonnage received rather than methods adopted. This difference may mirror the nature of sites available or national policies. Sites in Bangladesh are due to large tidal differences, particularly suited for larger vessels.

The preparations for the activity included many discussions with the mentioned institutions in order to establish practical and technical constraints and possibilities. Prior to initiating the actual site work, work-schedules where prepared identifying the tasks to be undertaken. The planning included equipment checkout and procedures associated to obtaining necessary import permissions for the planned sample import (for analysis) from appropriate authorities.

2.3.1 Work schedule and sampling planning

The on-site assessment in Chittagong was divided in three main tasks:

- Sampling offshore and onshore.
- Interviews with relevant personnel.
- Visits to scrap processing and refining facilities.

A separate task, that of visual inspection, was integrated in all work undertaken at all locations visited. When feasible, this was documented by filming and photography. However, the DNV team was restricted in some areas and not allowed to film freely. This applied in particular to the beach-areas.

During the execution of the assessment, a number of meetings were arranged with personnel from the UOC, from local environmental authorities and from DNV. These discussions and the close fieldwork co-operation have clearly built relations. An overview of the activities carried out in Chittagong is given in Appendix B.

The DNV team was to a large extent operating freely without restrictions during the assessment. However, some restrictions applied at the beach areas. Further, the team was not permitted on board vessels being scrapped. The restrictions where claimed by the sites themselves and grounded on reasons of safety.

2.3.2 Sampling

The sampling programme was identified based upon previous work and conclusions (ref.: /1/) and covered; Air, Onshore (land) and Offshore (intertidal zone). Figure 2.3.2 gives an overview of the ship scrapping area from the sub tidal zone to the reprocessing industry onshore. Figure 3 in Appendix C provides an overview of sample-points. All sample-points were logged by the use of GPS. Appendix E gives a listing of sample analysis undertaken and Appendix D introduces a selection of photographic documentation from the fieldwork.

Figure 2.3.2 Overview of the scrapping area of Chittagong.

The sampling activities at the ship breaking area provided an opportunity to study the material distribution and subsequent refining activities from dismantling in the intertidal zone and sequential cutting onshore to carrying onto lorries for further distribution. These processes are assessed and discussed in detail in Chapter 2.6.1.

It should be noted that due to limitations regarding our ability to sequentially plan the sampling programme, the conditions under which sampling had to be undertaken, was not always ideal. Examples of this may be illustrated by air sampling undertaken during unfavourable wind conditions, by sediment sampling (intertidal zone) on incoming tide, etc. In chapter 3, the results are discussed including references to the conditions under which sampling was undertaken.

2.3.2.1 Sediment samples

A total of 11 sediment samples where taken offshore (see Figure 5 and Figure 6 in Appendix D). These where all collected in the intertidal zone, stretching some 600 meters up to the “dry” boarder. The consistency of this area is mostly mud. The samples where collected as follows;

- A number of 8 samples were taken in the area where the ship breaking activity takes place.
- 1 was taken close to a mangrove (south-east of the ship breaking area).
- 2 samples were taken nearby a fishing village about 5 km north-east of the ship breaking area.

The latter represents a source of reference. During the work, UOC presented some historic data from Cox Basar, an area situated in the south-eastern part of Bangladesh. These reports have been made available for this project in the capacity as sources of reference (see reference list).

Originally, ambitions included undertaking sampling of sediment in the sub-tidal zone (the zone where the seawater always is present). Due to problems related to equipment, this was not possible.

A total of 10 samples were collected using the core sampler which collected sediment from 0-5 cm sediment depth (see Figure 6, Appendix D) whilst the remaining (one sample) was collected by hand (close to land). The different cores from one sampling point were mixed in a bucket. The sample was then preserved in plastic bags.

Samples where analysed for;

- water content
- grain size
- heavy metals
- hydrocarbons
- PCB

During sampling, visual inspection confirmed oil-sheen on the sea surface (see Chapter 2.3.2.2 and Figure 7 in Appendix D). There where also oil-remains attached to different structures positioned in the intertidal zone (wooden structures), (see Figure 8 in Appendix D).

Visual inspection also confirmed fishing taking place in the immediate vicinity of ship breaking facilities (see Figure 9 and Figure 10 in Appendix D) and that remains of the the mangrove (previously also covering the breaking sites) could be recovered far away from the ship breaking area. In this area the mangroves had clearly signs of oil (see Figure 11 in Appendix D). The ongoing fishery was carried out by locals, concentrating mostly on shrimps.

In order to improve the understanding of the effects of the ongoing processes, visual inspection proved to be of great value (see e.g. Figure 12 in Appendix D). A general overview of the ship-breaking process is provided in Chapter 2.6.1.

2.3.2.2 Sea water sample

One sea-surface water sample was collected by use of a water can in the intertidal zone area inside the ship breaking area. The sample has been analysed for presence of hydrocarbons and PCB.

As mentioned earlier visual inspection confirmed that there at some places was oil sheen on the sea surface (see Chapter 2.3.2.2 and Figure 7 in Appendix D). At some places it seemed as if there was oily particles also floating on the sea surface.

2.3.2.3 Water sample

One water sample was collected by use of a bottle from a stream flowing through the ship breaking area (see Figure 13 in Appendix D). The water sample has been analysed focusing on hydrocarbons and PCB.

The water sample was taken from a stream passing a collection centre for waste oils (see Figure 14 in Appendix D). At this location, there were clearly signs of oil in the ground and, as mentioned above there was also an oil sheen in the stream that was passing.

2.3.2.4 Sludge samples

A number of two sludge samples collected by use of plastic bags were taken in one of the ship breaking yards. One of the samples was taken in what seemed to be the bottom of an oil tank (day-tank), (see Figure 50 in Appendix D). The other sample was taken from a sludge layer on the ground (beach), (see Figure 15 in Appendix D). The samples where preserved and marked.

Both samples where analysed for hydrocarbons, PCB and metallic compounds.

The ground of the ship breaking areas was partly covered with a nearby continuous sheet of sludge/oil residues originating from tanks, piping, separators and other oil-containing equipment.

2.3.2.5 Asbestos sampling

Fairly evenly distributed white particles (smaller and larger lumps) was observed at the yards and in its vicinity and recognised as most likely being asbestos (see Figure 16, Figure 46 and Figure 47 in Appendix D). At two different locations, samples of this material were collected. The samples have undergone laboratory asbestos analysis.

The road connecting Chittagong to Dhaka running parallel to the beach area of Fauzdarhat provides basic infrastructure for scrapping-related activities. Alongside the road, numerous shops, workshops and warehouses are situated. Several of the facilities alongside the road were advertising asbestos for sale. At one of these, the manual re-processing of asbestos lumps to powder was located (see Figure 17 in Appendix D). To establish or disprove the claim of the product sold as being asbestos, a sample was taken from the refining process. Another sample was taken along the road where sacks were advertised for sale (see Figure 18 in Appendix D). Laboratory analysis has established the nature of the substance, (see also chapter 2.3.2.9).

In the ship breaking area it seemed as if asbestos was collected from various parts of the vessels and transported to companies for re-manufacturing. The asbestos extraction process caused debris and residues. There where no actions taken to prevent this from spreading (hence the white particles/ lumps observed in the area), (see Figure 16, Figure 46 and Figure 47 in Appendix D).

2.3.2.6 Soil samples

A number of 2 soil samples were collected on a site for the re-manufacturing of steel plates. The samples were collected by the use of a plastic bag (see Figure 19 in Appendix D). Hand-operated grinders removed remaining paintwork from the plates (see Figure 49 in Appendix E). Thereafter, torch cutting and welding was carried out. The re-manufactured plates where then used as brackets, etc. for machinery for different industries.

The soil samples have been analysed for metals, PCB and TBT.

All activity on this site took place directly on the ground, thus all residues from the refining processes were deposited directly on the ground.

2.3.2.7 Paint sample

One paint sample was stripped off steel plating at the steel plate re-manufacturing plant, see item 2.2.2.6 and Figure 20 in Appendix D.

The paint sample was analysed for metals, PCB and TBT.

2.3.2.8 Electrical cable sample

One sample of insulation material surrounding electrical cabling was collected. This has been analysed for PCB.

Electrical cables were offered for sale in many of the shops along the roadside, (see Figure 21 in Appendix D). The traders informed that all damaged cabling was sorted and the insulation burned off in open fires at the breaking sites (see Figure 48 in Appendix D), whilst the remaining was sorted and sold. Burning of PVC-cables on ordinary fires may give discharge of e.g. dioxins and dust to the air. This will give both local and non-local effects.

2.3.2.9 Air samples

In the ship breaking area, three different air samples were taken:

- Asbestos.
- Heavy metals.
- Organic compounds.

Two different pumps supplied a stream of air through two different filters for asbestos and heavy metals. These where situated in the immediate vicinity of the welding and cutting stations (see Figure 22 in Appendix D). At the same location, a pump connected to a cartridge filled with a medium to capture organic compounds was also installed. The air sampling procedure was ongoing for four hours.

The first two hours the wind direction was toward the pumps and thus it is expected that the filters/cartridge would detect possible polluted air. During the two latter hours the wind declined (landbreeze) and it is expected that the filters/cartridge recived less polluted air through the inlet.

Respective filters/cartridge was analysed for asbestos, heavy metals and organic compounds.

Air samples were also collected at the steel plate re-manufacturing facility (se chapter 2.3.2.6). A welder was equipped with air sampling equipment similar to that described above and sampling for organic compounds (see Figure 23 in Appendix D) was undertaken. Another worker occupied with the operation of an automatic torch-cutting unit was equipped with the same type of sampling equipment but modified for heavy metal sampling. The sampling interval was approximately 3 hours.

The samples were analysed for heavy metals and organic compounds.

At the location described in chapter 2.3.2.5 (alongside the road to Dhaka), air samples was collected, simulating respiration and potential of asbestos uptake by the workers occupied in the asbestos re-manufacturing processes. At this site, workers where occupied in crushing the substances (traded further as asbestos), by the use of wooden clubs. The sampling procedure is illustrated in Figure 24 Appendix D. The sampling sequence lasted for some two hours.

The respective filters/cartridges have been analysed for asbestos.

The general extraction activities in the actual ship breaking area, those of welding, torch cutting, dismantling, wincing, and plate-carrying, generated smoke and dust possibly containing asbestos, heavy metals, etc., resulting in poor air quality. Similar conditions where observed at some of the refinement plants.

At the asbestos-refinement plant, material residues covered the entire area, (see Figure 25 in Appendix D). The manual crushing generated visible clouds of dust. A warehouse where both “raw” and refined asbestos was kept was identified. This facility was located close to the heavily trafficated road and close to housing facilities.

2.4 Interviews

2.4.1 General

In gathering information related to the processes of the ship scrapping and related activities, a number of individuals at different levels were interviewed. These interviews are documented in Chapter 2.5. Some of the interviews were documented by use of digital video camera whilst others by written notes.

These interviews where specific and to some degree circumstantial. However, attempts was made to followed a certain pattern. This is illustyrated by the bullets below:

- Name and age.
- Present type of work.
- Experience duration and job variation (within ship scrapping).
- Salary.
- General view on own job situation.
- Accidents; type(s), number, injuries/ casualties, compensation.
- Health problems caused by ship scrapping.
- Environmental problems caused by ship scrapping.

2.5 Summary of interviews

The table below (table 2.5) is a listing of interviews undertaken and provides a condensed summary of statements and information that was given. The essence of the information is extracted in the light of making provisions in a Best Practice Approach (BPA) context.

Table 2.5 Overview of information gathered during the interviews of the different people.

Interview with	Provided information	Comments
Mr. Shajahan Khan. Senior Chemist, Dept. of Environment (UOC), (ref.: /9/).	Mr. Khan has worked in the environmental area fore several years and has had several visits to the ship-breaking area. Thus he was familiar with the activities and had great knowledge and acted as a "door opener" to the ship breaking facilities. He provided us with the following information: • Normal age of an employee in the ship breaking yards is 15-35 years. • Average age is about 25 years. • Normally the workers are seeking other kind of jobs outside the ship breaking area, but often this area is the only place where jobs are available. • About 50-100 employees are killed each year in different kinds of accidents e.g. explosions and falling objects. • There are about 50 different ship breaking yards in the area of Chittagong. • Each yard is buying the vessels themselves and there is normally no co-operation between the different yards. • One yard may have 2-3 vessels at the same time. Normally only one is scrapped at the time. • Ships may also spend some time at anchor outside the coast before they are brought to the actual scrapping site. • The owner of the yards hire work leaders, which in turn hire a number of workers that work for and get paid directly by the leaders.	Employment in ship-breaking have a low "status". Most of the individuals occupied are illiterate and do not have other job-alternatives. A large number are from areas outside Chittagong. Work is undertaken with hand-tools without any type of protective gear.
S.M.A Jabber. Research Fellow. (UOC), (ref.: /10/)	Mr. S.M.A Jabber is student at the University of Chittagong and also a research fellow in the Environmental company Entermet. He provided us with the following information: • The ship scrapping in Chittagong started in 1965. • The vessels are run ashore on high speed at high tide with minimal ballast into the intertidal zone. The vessels flat bottom allows them to lie stable on the silt/sand/clay bottom. • The vessels are then cut by use of torch-cutter and all kinds of equipment is floated onshore by use of air filled barrels or transported by small boats e.g. lifeboats (see Figure 26 and Figure 27 in Appendix D). • Large sections are pulled ashore on high tide by the use of winches (see Figure 28 in Appendix D). • The plates are then cut to certain sizes and are then hand carried from the shore to lorries that are transporting the plates to different kind of industries (see Figure 29 in Appendix D). • About 30 workers are needed to carry the largest plates and accidents are happening (especially during the rain season, when the ground is very slippery). • All other kind of equipment is taken to different kinds of shops and re manufacturing companies (see Figure 30 in Appendix D). • Oil and other pollution from ships that is deposited in the intertidal zone is taken away by the tidal water. The tidal water difference is about 6 meters. • It takes in average 5 months to scrap a vessel. However this of course depends upon the size and type of ship in addition to the demand for scrapping products. • The fishing activity has declined in the scrapping area during the last decades.	Prior to being beached, the vessels are often quayed in the harbour of Chittagong where valuable components are dismantled (communication equipment, navigational aids, general electronics). Fishing is undertaken in the direct vicinity of the ship breaking. The fish is offered for sale in the markets of Chittagong.

Md. Shamsul Alam. M/S. Universal Trader's. Pahartali, Chittagong. All kinds of iron goods retail and whole seller, (ref.: /11/).	Md. Shamsul Alam is owner of the company M/S. Universal Trader's which is dealing with all kinds of iron goods retail and whole seller. He provided us with the following information: • His company is mostly trading with anchor chains from vessels. • Small chains are often reused and sold to ships in operation. • Large chains are cut and sold to re-rolling mills (see Figure 31 in Appendix D). • The following prices for different types of metal are typical: - Iron plates: 10.000 taka/ton - Iron Shaft: 9.000-30.000 taka/ton - Aluminium: 60.000 taka/ton - Brass: 70.000 taka/ton - Copper: 75.000-80.000 taka/ton - Cable copper: 90.000-100.000 taka/ton - Cast iron: 8.000-8.500 taka/ton - Damaged scrap 7.000 taka/ton • The owners often own more than one "shop", so that they can follow the product from the ships to the consumer. Mr. Alam had interests in shops dealing with chain and steel plates, in a re-rolling plant and a shop that sells iron bars to the consumers. • A lot of effort (manpower, time) is put into the sorting process of different metals and qualities, in order to maximise the profit when the different scrapping materials and items are resold. (This is possible, since the labour is very cheap.)	100 taka ˜ 2US$ (February 2000) Customers are bigger steel-mills and other processing industries.

Md. Yousuf. Managing Director. FUCHS-GHL Lubricants (Bangladesh) Ltd. Chittagong, (ref.: /12/).	Md. Yousuf is managing director in FUCHS-GHL Lubricants in Chittagong. He had earlier a company that regenerated waste oil from ships, cars etc. This company is now a joint venture with the company FUCHS (of Germany). He provided us with the following information: • Waste oil and lubricating oil from the vessels is normally collected in the ships and regenerated by this company (see Figure 32 in Appendix D). • The raw material and final products are checked in the company's own laboratory (see Figure 33 in Appendix D). • The rebuilding of the plant that were going on, used almost only parts from the ship scrapping industry (pipes, steel plates, valves, separators etc.). • The workers inside the plant were encouraged to use safety equipment, but because of the temperature and humidity, they were reluctant to use it.	Collected by the ship breaker who at that point is the owner of the vessel. Some safety equipment was observed while visiting the facility.
Interview with foreman for workers that were re-processing asbestos, (ref.: /13/).	The foreman is in charge of 5-6 workers occupied with re-processing asbestos (see Figure 17, Figure 24 and Figure 25 in Appendix D). He provided us with the following information: • Earlier there was no market for used asbestos and the asbestos was thrown into the sea. • Now re-processed asbestos is mainly sold to industries in Dhaka where it is used in the production of new asbestos used to coat boilers. E.g. the cotton mill industry is using this asbestos. • Before the price for asbestos was about 2 taka/kg. Today the price is 14-15 taka/kg. • His company is regenerating 2-4 tons of asbestos each year. • No one of the workers that are crushing asbestos is normally using masks and other protective equipment. • No one of the workers is feeling sick. • There are about 100.000-200.000 persons working directly or indirectly with the ship breaking industry.	100 taka ˜ 2US$ (February 2000)

2.6 Scrap Processing – Organisation and procedures

2.6.1 Background and administration

The ship breaking industry at Fauzdarhat in Chittagong was initiated in 1969. The nature of this site offered many advantages making it particularly suited for ship breaking:

- A long uniform intertidal zone.
- A tidal difference of 6 meters.
- Protection by the Bay of Bengal.
- Stable weather conditions.
- Low labour costs.
- Some existing infrastructure (connected to the capital (Dhaka) by road and railway).

The seashore including adjacent areas are state owned. The ship breaking yards themselves are however privately owned and thus the area they occupy is leased from the government. The set-up or establishment of such a site is subjected to an application procedure. Governmental planning and administration concerning this is handled by the Mercantile Marine Department.

Details regarding permissions concerning establishments on the actual seashore are administrated by local authorities (Chittagong Port Authority) whilst those concerning the adjacent inland areas are dealt with by Bangladesh Inland Water Transport Authority (BIWTA). Environmental matters associated with the ship breaking yards are under the jurisdiction of the Department of Environmental Pollution Control (ref.: /5/).

Import of vessels to Bangladesh for breaking is subjected to a governmental authorisation procedure. In essence, an import license is required. The Department of Industries issues these.

2.6.2 Ship breaking capacity

In the year of 1983 there were 32 companies involved in the scrapping industry in Chittagong. Typically, a number of 40 vessels could be in different stages of the process at then same time. Today there are approximately 50 established ship-breaking yards on this beach-area (ref.: /5/). During DNVs assessment, a number of 26 vessels beached and under demolition were counted in the area. The “run-through” time from when a vessel arrive to when its final structure is removed vary according to size and demand. However, it was suggested that the demolition process for a VLCC can be undertaken in 5-6 months.

It is expected that ship-scrapping activities along the beaches of the Chittagong coastline will increase during the next few years. The reason being that the area is well suited for beaching large vessels (such as large crude carriers (VLCC’s) and bulk carriers) and that the demand for such facilities are increasing. The expected peak in number of scrapping candidates are increasing following the initiatives of IMO aiming at phasing out old tonnage and the building boom of the 70’s (ref.: /1/). The discussions following the “Erica-incident” on the use of ageing tonnage might even accelerate this. It should be noted however, that the market demand (i.e. oil freight) also will be among driving factors.

2.6.3 The scrapping process

The various activities involved follows a sequential pattern as illustrated in figure 2.6.3.

DNV was informed that approximately 50,000 people are engaged directly in the ship scrapping industry at the actual yards (ref.: /9/). However including the indirect employment created by refabrication, recycling and re-sales, it was claimed that the total number of jobs dependent upon the scrapping activities lies somewhere in the region between 100,000 and 200,000. Thus the majority of people working with ship scrapping are not working in the ship scrapping yards, but are engaged with activities mainly connected to the latter stages in the reprocessing of materials/ components.

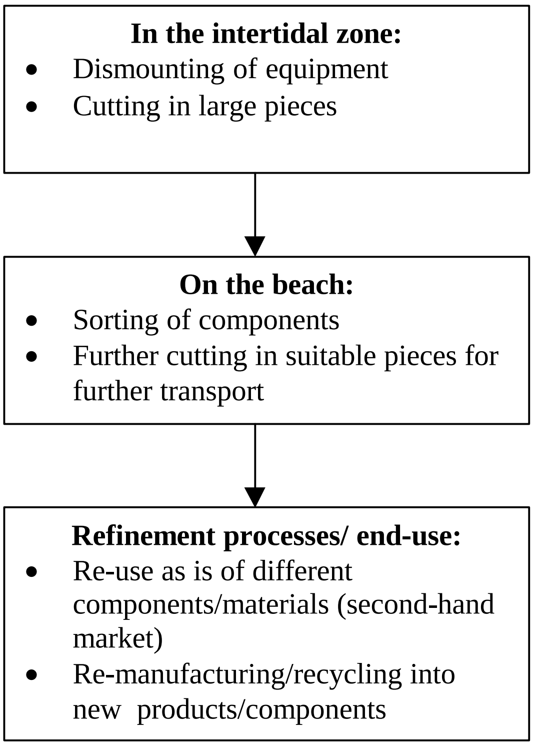

Figure 2.6.3 Overview of scrapping process.

2.6.4 General description of the scrapping process

The 26 vessels identified during the DNV on-site assessment represented different stages of the scrapping process. Exact details of these vessels has not been obtained, neither was permission to go onboard granted. However, it is established that both categories of large vessels, tankers and bulk carriers, were represented.

The scrapping process is undertaken individually and seems to follow a certain pattern. In figure 2.6.4, a listing of the various processes from arrival of the vessel in Bangladesh' water to final destination of different compounds/materials is illustrated.

Offshore – quayside (Chittagong harbour)

- Some sources claimed residues of cargo and oil were collected and tanks washed. However, the existence of any waste reception facilities could not be established or documented.
- Valuable components are dismounted and sold to second hand market (e.g. small motors and pumps, navigation equipment, life saving equipment, furniture, electrical cabling, see Figure 21and Figure 30 in Appendix D).

↓

Intertidal zone

- The vessel is beached by own propulsion power at high tide. On low tide the vessels are lying stable on their flat bottom (see Figure 34 in Appendix D).
- The stern aft of the propeller is dismounted. The stern is divided into two parts along the centreline of the vessel. The two parts are dropped down into the sea and winched to the shore at high tide. The propeller is then removed (see Figure 35 in Appendix D).
- Hull (side) plating is removed beneath normal waterline by the use of torch cutting equipment in order to gain access to engine room and adjacent areas. Equipment is then disassembled and taken ashore (e.g. pipelines, boilers, separators and pumps). Larger components, engines/generators, are broken down and sent for re-melting (see Figure 12 and Figure 36 in Appendix D).
- The items are dumped or lowered down through the hull openings. The items are then floated by use of air filled oil barrels or by boats on high tide (see Figure 27 in Appendix D) ashore.
- The straight steel plates along the centre section is then dismounted (and sold for refurnishment). Outer hull plates are removed first followed by bulkhead structure. The outside plates are retained at the bottom in order to avoid water intrusion. The plates are dumped in the mud and then winched to shore, (see Figure 12 and Figure 36 in Appendix D).
- The bow is cut free from the rest of the hull and winched to the shore.
- When the bow is removed, whole section of the ship is cut loose and winched ashore.

↓

Onshore – in the scrapping yard

- The bow, steel plates and sections are cut into smaller pieces suitable for further transportation by lorry. Torch cutting, winches, manual pulling and crowbars are in use (see Figure 26 in Appendix D).
- Different pieces/materials are carried by from 1 to up to 30 people from the beach to temporary storage sites (see Figure 29 in Appendix D).
- At these temporary sites, materials are sorted in different piles. The materials are unified into the same “standard” sizes, cut if necessary, and stored in separate piles for plates with different thickness, pipes of different diameters, etc. (see Figure 37 in Appendix D).
- In order to achieve the highest prices, all equipment components are disassembled e.g. valves, flanges and gaskets are disassembled from the pipelines.
- All materials that have been temporarily stored are then manually lifted onto lorries carrying the material to the next stage in the process.

↓

Onshore – final destination

- From the scrap yard the different materials are transported to local processing industry e.g. steel mills, steel plate re-manufacturing, asbestos re-manufacturing, lubricating oil regenerating etc. (see Figure 17, Figure 31, Figure 32 and Figure 40 in Appendix D).
- Materials/components that could be reused is sent to the second hand market.
- Many of the refinement/re-sale plants/shops are situated alongside or close to the road from Chittagong to Dhaka (see Figure 30 in Appendix D).
- Different types of materials are often reprocessed and sold in certain “recycling areas/streets”, e.g. steel plates are reprocessed in one area/street, while toilets are sold in another area/streets and so on.

Figure 2.6.4 Overview description of the organisation of the scrapping process.

2.7 Visited scrap processing and refining facilities

In order to assess material utilisation and processes involved in the material flow originating from the actual ship demolition procedures, some scrap processing and refining facilities were visited.

2.7.1 Cold rolling mill

There are several steel mills including re-rolling mills in the vicinity of the scrapping site (within 2 to 10 km). Local sources informed that approximately 400 such facilities were established in the region.

Plating from the vessel is sorted and some is re-used rather than reprocessed in the mills. Raw material to the steel mills does not only include that of plating.

The DNV team visited a cold rolling mill processing steel plating into reinforcement steel bars. Steel plating was firstly cut into manageable rectangular sheets and then cut alongside in strips of a width of approximately 10 – 15 cm by use of a hydraulic cutting scissors (see Figure 38 in Appendix D). These where then pre-heated in a gas-fired oven to 1,100 – 1,200 °C (see Figure 39 in Appendix D) prior to being fed into the rolling unit. All handling of the steel units are undertaken manually. The plates are not cleaned (paintwork/oil residues) prior to heating. The rolling unit can be fitted with different moulds allowing steelbars of different surface-patterns and diameter to be produced (see Figure 40 in Appendix D). The steel bars were then temporarily stored until the temperature dropped to that of the surrounding. The rods where bent into boundless and loaded onto lorries for transportation to markets/customers (see Figure 41 in Appendix D).

Most of the equipment that was in use at the plant was products from items arriving from the ship demolition process. The hydraulic cutting scissors were modified workshop equipment, while the moulds were made out of propeller shafts from ships.

The facility was well planned and laid out. The work procedures seemed well organised. The activities took place in a shed with roof but no walls. Precautions preventing residues from entering the ground (oil from machines, PCB, TBT and heavy metals from plates) was absent. The workers did not use any protective equipment. The potential for personal injuries seemed high.

2.7.2 Steel plate re-manufacturing

At this facility, the paint on the steel plates where removed by use of grinders (see Figure 49 in Appendix D). Torch cutting and welding was carried out in order to achieve correct plate sizes. Re-manufactured plates are used for different applications, e.g. in structure suspending applications, as brackets and similar for different types of industries.

The facility seemed well organised and efficiently managed. However all activities were carried out in the open air directly on the ground with the potential of causing pollution (to soil) of PCB, TBT and heavy metals (from plates). Due to the welding and cutting activity there is also the possibility of local pollution of the air first and most affecting the workers engaged. The workers did not carry any protective equipment of any sort. Again, the potential of injuries seemed high.

(This facility was included in the sampling schedule, see chapter 2.3.2.7/ 2.2.2.9).

2.7.3 Chain and steel processing (trading)

This facility specialised in higher quality raw steel. Steel plates and different steel equipment from the vessels were cut, prepared and sorted before being sold for production of new steel products. Chain steel is of a higher quality than steel from plating and is therefore processed separately, giving a higher return (price). Shafts are of very high quality and highly sought after. Chains up to 3 inches were resold (as chain) if in good condition. The larger dimensions and damaged chain are cut into manageable pieces and sold for re-melting/re-rolling (see Figure 31 in Appendix D).

The working procedures seemed well organised but precautions both regarding the protection of workers engaged as well as the environment was totally absent. All activities took place in the open directly on the ground.

2.7.4 Lubricating oil re-manufacturing

This facility produces lubricants from recaptured lube-oil remains arriving from the scrapping candidates. The products are sold on the open market as regenerated lubrication oil. The processing plant was at the time under upgrading being rebuilt. The existing process facility was built up by equipment arriving from the scrapping activities (see Figure 32 and Figure 33 in Appendix D).

The facility was very well managed and the renewed part seemed to confirm more or less to western standards. The older part however, lacked facilities for drainage/leakage collection. The workers engaged were not wearing any protective equipment.

It should be noted that this facility was recently partly bought up by the German oil product manufacturer Fuchs.

2.7.5 Asbestos re-processing

This facility consisted of sheds used for material storage whilst the actual re-processing went on in the open directly on the ground. Asbestos residues in the form of casted lumps provided as raw material in a process involving manually crushing to a powder-alike substance. This product was then sold as asbestos. The tools used were that of wooden hand-clubs.

The end product was bagged and sent to Dhaka for the production of new asbestos components (boiler insulation).

This site appeared disorganised with a mix-up of asbestos in clogs, flakes and sheets all around. From inspections carried out, it is evident that the site was heavily contaminated by asbestos. This includes both air and ground.

The workers where sitting in the asbestos residues breathing visually contaminated air (dust clouds) without any form of protection. The DNV-team provided protective asbestos mask for the workers (see Figure 17, Figure 24 and Figure 25 in Appendix D).

2.7.6 Trade facilities

Along the road from Chittagong to Dhaka, several shops where located offering almost anything one expect to be found onboard a vessel (see Figure 30 in Appendix D). Examples are:

- Small motors, pumps and machines (e.g. lathe).
- Navigation equipment (e.g. sextants).

- Life saving equipment (e.g. life buoys, lifeboats, life west), (see Figure 42 in Appendix D).
- Personal protective equipment (e.g. helmet, boots, gloves, overalls)
- Chemicals and paint (see Figure 43 in Appendix D).
- Different steel parts (e.g. anchor, chains, ventilation parts, pipes).
- Toilet and sanitary equipment (e.g. toilets, sink, and bathtubs), (see Figure 44 in Appendix D).
- Furniture (e.g. sofa, chairs, tables, beds).
- Electrical cabling (undamaged cables are reused while damaged cables are burned) and batteries (see Figure 21 in Appendix D).
- Insulation material (e.g. asbestos and mineral wool).

The area seemed to be organised in sections; in one area reprocessed steel components of different types were offered by different traders, whilst in the next area some other reprocessed product types could be found.

Most components were stored directly on the ground or in small shops/warehouses.

3 ANALYSIS AND RESULTS

All samples taken were transported to Norway and analysed at SINTEF Applied Chemistry, Oslo. An analysis-schedule was developed based upon previous work (ref.: /1/), observations during the on-site assessment and discussions with the laboratory.

An overview of the analysis undertaken is provided in Appendix E, while the results from the laboratory analysis are presented in Appendix F. In the following sub-chapters the different results are presented and discussed.

3.1 Sediment samples

The exact location of the sediment samples (11) collected in the intertidal zone outside the coast of Chittagong (North of the Karnafully river mouth) is provided in Figure 3.1 (station layout). The red flags indicate the northern and southern limits of the ship scrapping area (based on site observation by DNV). For an overview map for Bangladesh and Chittagong see Figure 1 and Figure 2 in Appendix D.

Due to the large tidal difference, there is a strong tidal current in addition to coastal current going along the shore. These two currents provide a “washing” action providing a “dilution” effect. The load of heavy metals, hydrocarbons and other spillage from the scrapping sites and other sources along the coast are spread (diluted) over a large area. A lesser dynamic scenario would give expectations to significant background pollutant levels. Another factor influencing the sediment characteristics in all of the Bay of Bengal is the large amount of sediment that is carried to the sea with the Ganges-Brahmaptura-Meghna (GMB) river system. Milliman et al. reported in 1995 that the GBM river system offers the passage of an estimated sediment load of more than 1,060 million tons annually to the Bay of Bengal, which ranks first in sediment flux to the oceans on a global scale. Islam et. al. (1999) reported that of the total suspended sediment load (i.e. 1,037 million tonnes) transported by these rivers, only 525 million tonnes (c. 51% of the total load) are delivered to the coastal area of Bangladesh and the remaining 512 million tonnes are deposited within the lower basin, offsetting the Subsidence /31/. This sediment load is not spread evenly over the year, because of the large amount of water that passes through the area during the Monsoon period. The enormous amount of sediment in the water and strong tidal current results in a very dynamic system of sedimentation and re-suspension in the intertidal zone. This make investigation of sediment chemistry very complicated. The international standards for sediment quality may therefore not be an optimal.

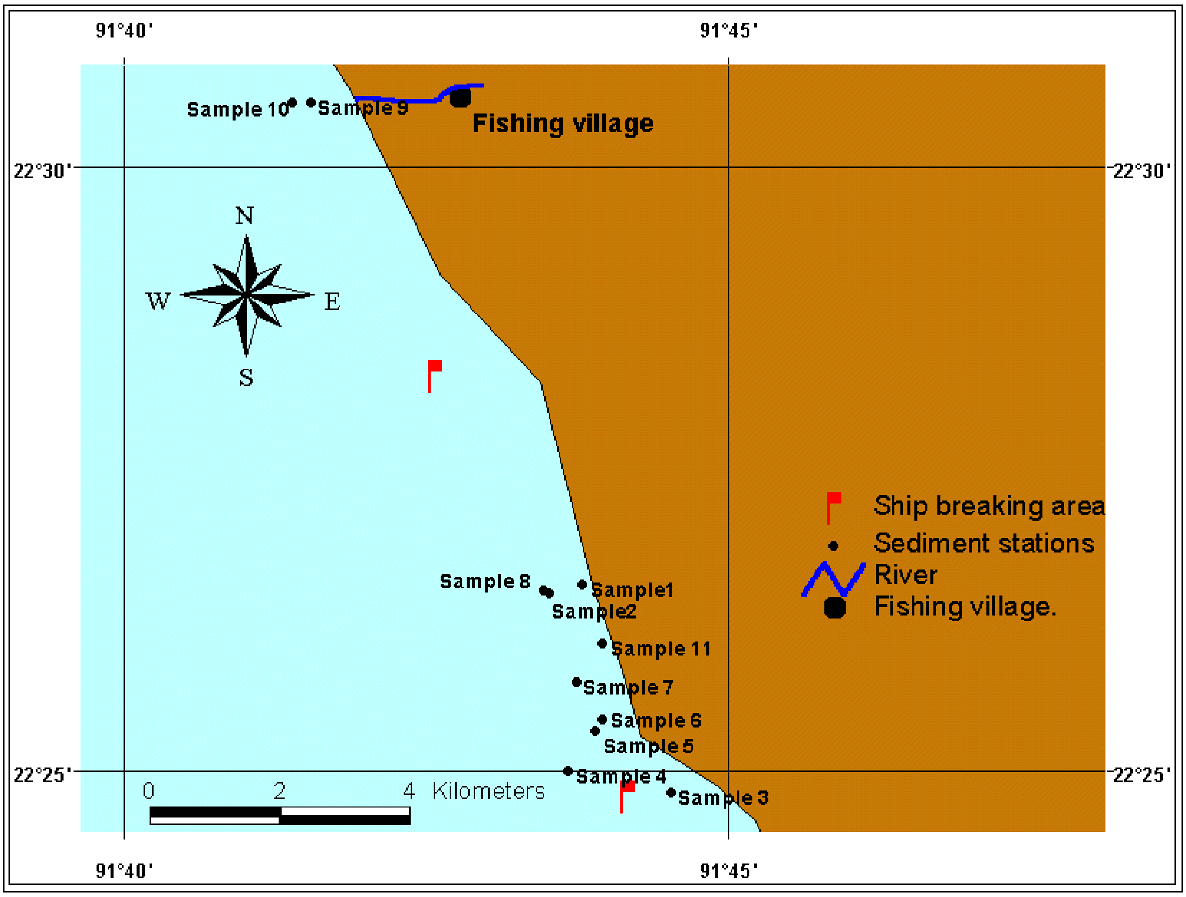

Figure 3.1 **Station layout, map showing the location of the sediment sampling. The land sea boarder is added to the map manually, and is therefore inaccurate, while the actual stations are mapped from GPS co-ordinates.**

3.1.1 Particulate size distribution & total organic carbon - analytical results

The particulate size distribution analysis conducted by SINTEF show that the silt and clay content dominated in all the sediment samples, ranging from 67.4% to 99.6% (dry weight). In station 1, 2, 3, 6 and 11, the <63µm fraction added up to more than 90%, while it in station 4, 5, 9 and 10 added up to more than 80% (same fraction). The TOM (total organic matter) content was low in all the investigated samples (3, 4, 8 and 10), ranging from 3.8% on station 8 to 5.3% on station 3. Station 4 and 10 had intermediate values of 4.2 and 4.4% respectively.

3.1.1.1 Comments to the analytical results

The results show that the sediment samples are dominated by particles smaller than <63µm and contain little TOM (total organic matter). The characteristic smaller grain size, i.e. having larger surface to mass ratios, suggests that they are susceptible to large chemical adsorptive reactions and could serve as a potential trap for contaminants. The TOM values suggest that the organic content in the samples is moderate. The level of organic content indicates that the origin of the sediment is from "weathered mineral" rocks and not biologically produced. This corresponds well with earlier investigation of the sediment in the Bay of Bengal, which have shown that the sediment is dominated by sediment carried to the sea by the Ganges-Brahmaptura-Meghna (GMB) river system, containing large amounts of sediment having its origin from the Himalayan mountains (ref.: /25/).

3.1.2 Metals - analytical results

The results from the metal analysis are given in table 3.1.2 along with some results from earlier investigations in Bangladesh.

Table 3.1.2 Metal concentrations in sediment from the coast of Chittagong. DNV results and results from earlier investigations.

Sediment	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
	mg/kg								
Sample 1 DNV 2000	<lod	66	52	29,002	0.042	738	63	23	104
Sample 2 DNV 2000	<lod	53	39	25,519	0.035	624	52	18	86
Sample 3 DNV 2000	<lod	56	42	26,610	0.031	630	54	20	90
Sample 4 DNV 2000	<lod	48	34	23,755	0.031	582	48	16	76
Sample 5 DNV 2000	<lod	47	34	23,270	0.022	549	47	15	74
Sample 6 DNV 2000	<lod	53	40	25,845	0.045	640	53	17	86
Sample 7 DNV 2000	<lod	41	27	21,803	0.028	499	41	13	67
Sample 8 DNV 2000	<lod	44	31	22,446	0.028	525	44	14	70
Sample 9 DNV 2000	<lod	50	36	24,597	0.033	606	49	17	81
Sample 10 DNV 2000	<lod	50	34	24,519	0.028	599	49	16	83
Sample 11 DNV 2000	<lod	60	93	30,516	0.052	718	58	25	172
est lod[1]	0.2	0,2	0,7	0.6	0.003	0.5	0.3	0.5	1
Limit[2]	0.11	77.20	33	41,000		770	56.10	19	95
1[3] Talukder, 1994	0.69	70	31.56	3,845.16		66.33	50.03	18.93	10.64
4[3] Talukder, 1994	0.65	56.71	30.36	4,135.16		58.93	49.24	18.9	10.16
7[3] Talukder, 1994	0.39	70.19	31.05	4,108.57		72.83	50.11	19.17	9.46
12[3] Talukder, 1994	1.16	59.58	28.93	3,499.40		60.10	44.42	17.08	9.56
Mean 20 stations	0.66	59.58	28.93	3,499.40		60.10	49.11	19.18	9.56
NE coast of the Bay of Bengal[4]	0.258	17.307	5.415	601.069		22.239	11.567	14.327	4.761

[1]: est lod : estimated level of detection for SINTEF analysis.
[2]: The limits are values taken from various sources that have been used in earlier investigations in the Bay of Bengal (ref.: /26/, /27/, /28/). These represent the level at which effects can occur.
[3]: Investigation from the Karnafully river mouth and south along the coast in 1994. Station layout are given in Figure .
[4]: Investigation from the North East Coast of the Bay of Bengal in 1996.

3.1.2.1 Comments to the analytical results

The analytical methodologies offer two approaches regarding metals in sediment;

- Total metal concentration analysis (use of very strong acids like aqua regina or hydrofluoric acid)
- The biologically available metal concentration (use of weaker acids like nitric acid)

Both methods are influenced by the metal concentration in minerals in the sediment and can produce diverse results. The analysis undertaken is that of the latter bullet above (nitric acid was used). The reference results (1994/ 1996) are from analysis following the metal concentration approach (aqua regina was used).

In comparison with international standards and norms, the results does not provide alarmingly high values. There is however an elevated concentration of metals (Cu, Fe, Ni and Zn) assumingly from ship structures of general characteristics and from paintwork. The results from these samples corresponds well with those presented in the 1994 reference (Talukder et. al., 1994). The reference area of the 1994 work is shown in Figure 3.1.2.1. The area extends from the Karnafully river-mouth and south along the coast (the present investigation were to the north of the Karnafully river-mouth). The work carried out by Dr. Khan in 1996 on the north-east coast of the Bay of Bengal found metal levels that were lower than the results presented by this work. Even though the metal levels in the sediment were lower, they found that shellfish accumulated some metals to concentrations that are higher than international standards and may be a health hazard for consumers. A study carried out in the area (Fauzdarhat-Kumira) in 1992-1993 included a quantitative investigation of trace metals in water and *Scylla serrata* (edible crab). This concluded that the concentration of some of the metals investigated (Zn and Cu) occasionally exceeded international limits for human exposure (ref.: /5/).

Even though the sediment in the ship breaking area is dominated by fine particles that metals have a high affinity for, and that there are known sources of metal contamination in the area, the concentrations found does not represent a particularly high level compared to international standards. The reason for this is probably due to;

- The strong tidal current and the current along the coast acts as an dilutor both by introducing a large number and particles and by particles being suspended in the water for a long time. (Particles are transported out of the area/ large masses of water being transported by the current will dilute the introduced metals).
- The complicated sedimentation/re-suspension system in the intertidal zone in the Bay of Bengal. The tidal currents will “wash” the sediment in the intertidal zone according to the tidal cycle resulting in the spreading of the metals over a large area.

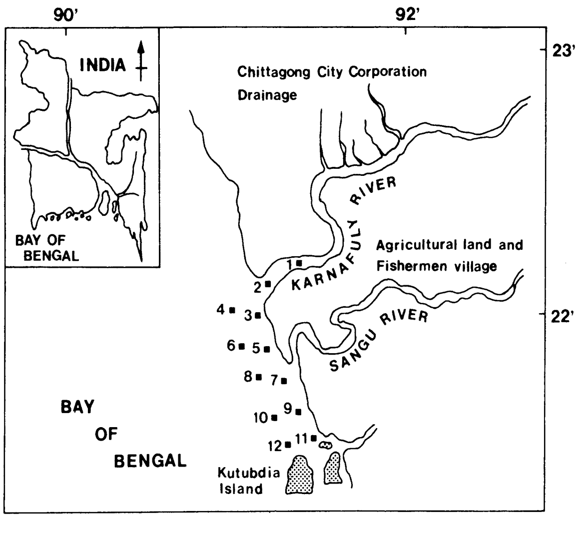

Figure 3.1.2.1 Stations investigated by Talukder in 1994. The area investigated by DNV in 2000 is just outside the northern part of the Chittagong coast on the map.

3.1.3 Polyaromatic hydrocarbons - analytical results

A number of 7 out of 11 sediment samples were analysed for polyaromatic hydrocarbons (PAH). The PAH (EPA-16) are given in table 3.1.3, while more detailed analysis and level of detection can be found in Appendix F.

Table 3.1.3 PAH presented as sum of EPA-16.

Sediment sample	1	2	5	6	7	9	11
	mg/kg dry weight						
sum PAH (EPA-16)	0.175	0.123	0.081	0.145	0.108	0.092	6.648
LOQ[1] : 0.0005-0.008 mg/kg							

[1]: Level of quantification

3.1.3.1 Comments to the results

The results suggest a low content of organic compounds with the exception of sample no. 11. In addition to the above tabulated results, a qualitative screening analysis was performed for this sample (no. 11), indicating contents of a fresh diesel/light fuel oil. The PAH content in this sample can be related to the oil content. Sample 11 were taken on the high tide mark in one of the ship scrapping areas and has therefor not been subject to the same degree of dilution (washing because of strong currents) as the rest of the intertidal sediment samples. The two lowest value were found in sample 9 (lowest) which were taken outside a fishing village north of the scrapping area (about 5 km) and in sample 5 which were the southern most station were PAH content were measured. This indicates that the ship scrapping area is the source of the PAH that is found in the sediment samples and agrees with the visual observation of hydrocarbons both on the beach and on the water surface in the ship scrapping area (see Figure 45 in Appendix D).

3.1.4 PCB, organic screening and TBT - analytical results

Sediment sample 3, 4, 8 and 10 were investigated for PCB, organic screening and organotin compounds, but non-of these parameters were detected. The organic screening used can detect benzene, toulene, ethylbenzene and xylenes, C3-C4-B (sum tri- and tetraalkylated benzenes) and aliphatic hydrocarbons. More detailed results including level of detection can be found in Appendix F.

3.2 Sea water sample

3.2.1 Analytical results

One water sample was collected by use of a bottle from surface seawater outside the ship breaking area (see Figure 7 in Appendix D). The water sample was analysed with respect to related hydrocarbons (organic screening) and other organic compounds (extended screening). The bottle was shaken prior to analysis. Based on the results, (presented in table 3.2.1) it was decided not to perform PCB analyses on the sample from the stream. Experimental methods for the analyses are given in Appendix F.

Table 3.2.1 Analytical results for sea water sample taken outside the ship scrapping area

	Oil related hydrocarbons					Compounds other than oil related hydrocarbons					
Water sample	B	T	EX	C3-C4-B	Aliphatic HC	Napthalene	C1-C3 napthalene	Phenanthrene/antracene	Pyrene	Benzo(a)-pyrene	SUM phthalat eesters
Lod[1] (g/l)	1	1	1	2	30	0.5	0.5	0.5	0.5	-	2
Results (g/l)	-	1	1	9	<30	-	-	-	-	-	-

3.2.2 Comments to the results

The results from the sea water analysis is in contrast with earlier investigations in the same area conducted by Islam and Hossain in 1984 and Dr. Khan in 1992, who detected between 10.800 and 9.280 mg/l oil in water samples from the ship scrapping area between Fauzdarhat and Kumira and 239 and 248 µg/l PHC (petroleum hydrocarbons) in sea water from the ship breaking area (Fauzdarhat) respectively. Islam and Hossain concluded, "*..it is clearly evident that the present indiscriminate ship scrapping activities in the coastal areas of Bangladesh contaminate the beach soil and sea water environment to a critical condition*". Dr. Khan also reported that surface concentration in the coastal region of the Bay of Bengal ranged from 0.8 to 5.2 µg/l, which indicates that there is an elevated level of PHC in the ship breaking area around Fauzdarhat.

The absence of hydrocarbons in the sea water sample may be an evidence of tidal currents diluting impact on the intertidal zone (the sample was collected during a rising tide) caused by the large masses of water from outside the intertidal zone flooding it. The sample was taken from the surface water at random in an area where oil shimmer on the surface was detected. A sampling bottle was used. This method will collect the surface slick (see Figure 7), witch is very thin. Prior to analysing the sample, the bottle was shaken, causing the oil to be mixed with the water. The method adopted in collecting and preserving the sample may have influenced the results.

It may be that the sample is more representative of water not exposed to the activities of the ship breaking area directly and that a sample of the water taken prior to the tide going out would have been more representative.

3.3 Water sample from stream

3.3.1 Analytical results

One water sample was collected by use of a bottle from a stream flowing through the ship breaking area (see Figure 13 in Appendix D). The water sample was analysed with respect to related hydrocarbons (organic screening) and other organic compounds (extended screening). Based on the results from these analyses, it was decided not to perform PCB analysis. The water sample from the stream contained a large fraction of particulate matter and the particulate matter was included in the sample preparation. Results are presented in table 3.3.1. Further experimental methods for the analysis are given in Appendix F.

Table 3.3.1 Analytical results for water sample from stream

	Oil related hydrocarbons					**Compounds other than oil related hydrocarbons**					
Water sample	B	T	EX	C3-C4-B	**Aliphatic HC (Soil)**	Napthalene	C1-C3 napthalene	Phenanthrene/antracene	Pyrene	Benzo(a)-pyrene	SUM phthalat eesters
Lod[1] (µg/l)	1	1	1	2	**30**	0.5	0.5	0.5	0.5	-	2
Results (µg/l)	-	2	2	-	**32,000**	0.7	33	2	6	5	300
Maximum admissible concentration[2] (µg/l), /22/					**10**						

[1]: lod = level of detection

[2]: Maximum admissible concentration of dissolved or emulsified hydrocarbons (after extraction by petroleum ether), Mineral oils

3.3.2 Comments to the analytical results

An oil distillate having carbon number distribution from C_{14} to C_{32}, with a peak around n-C_{18} was observed in this sample. The oil distillate was somewhat heavier than the diesel/light fuel oil the laboratory use as a reference and further, the distillate was fresh (not degraded). The total oil concentration was high for a water sample, reflecting that most of the oil is sorbed to the particulate matter.

The water quality is compared to the maximum permissible concentration of dissolved or emulsified hydrocarbons (Mineral oils) in drinking water used in the European Community (EU). This may be a basis for comparison since this defines “clean” water. As can be seen from table 3.3.1 the results from the analyses are far above the requirement to drinking water in EU.

3.4 Residue samples

3.4.1 Analytical results

Two residue samples were analysed. One sample was taken from an oil tank being dismantled on the beach and one from a pile of sludge that was lying directly on the beach.

The actual oil content in the residue samples have not been determined as the oil content exceeded 20 % of total weight in both samples. However an organic screening was carried out in order to decide upon type of oil in the samples. The result of this screening is presented in table 3.4.1.

Table 3.4.1 Results of organic screening of residue samples.

Sample id.	Results
Oil sludge sample	The sample consisted of aliphatic hydrocarbons up to C_{32}. Suggested source fresh (not degraded) diesel/light fuel oil. The analytical results indicate low levels of other non-oil related organic compounds.
Sample from bottom of oil tank (on yard)	The sample consisted of aliphatic hydrocarbons up to $>C_{32}$, with a peak at C_{24}. Suggested source heavy oil type (lubricating oil?). The analytical results indicate low levels of other non-oil related organic compounds.

The samples were also analysed for heavy metals and the results of these analyses are given in table 3.4.1.1

Table 3.4.1.1 Heavy metals in residue samples

Sample id.	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
	mg/kg								
Oil sludge sample	0.2	99	136	14,842	0.080	964	69	198	212
Sample from bottom of oil tank (on yard)	<lod	72	67	28,971	0.072	789	64	30	154
est lod[1]	0.2	0.2	0.7	0.6	0.003	0.5	0.3	0.5	1
World wide crude oil	<0.001	<0.001	0.2-12	0.04-120[2]	0.03-0.1	<0.001	1-120	0.001-0.2	0.5-1

[1]: est lod = estimated level of detection

[2]: The highest value may be the result from contamination from pipelines.

3.4.2 Comments to the analytical results

As can be seen from table 3.4.1 the organic screening of the samples showed that the samples contained different fractions of hydrocarbons, whilst the results indicate low levels of other, non-oil related organic compounds. Based on this it was decided not to carry out any PCB-analyses of the samples.

As can be seen from table 3.4.1, it is confirmed that the heavy metals contents in the residue samples are higher than what is normally present in any crude oil. The exceptions are mercury and nickel which both are in the “normal” range compared to global crude oil qualities.

A number of hydrocarbon sources were observed in the ship breaking area during the assessment. These will “leak” to the intertidal zone during the rainy periods. The effect will be that of a “cleansing” in the dry area of the site whilst the intertidal zone will receive the “waste-water”. The large tidal difference will dilute the contaminants of the intertidal zone. However, the background contamination levels will steadily increase. From the results presented here, it follows that the contamination also will include that of heavy metals.

3.5 Possible asbestos samples

3.5.1 Analytical results

Four different samples of what was suspected to be asbestos were collected during the assessment. The results of the analyses are presented in 3.5.1.

Table 3.5.1 Results of asbestos analyses.

	Asbestos positive (Yes/No)	Asbestos type	Comments
Asbestos sample 1 on yard	Yes	Amositt	Ash-coloured
Asbestos sample 2 on yard	Yes	Amositt	Ash-coloured
Asbestos sample 1 from shop	Yes	Amositt	Ash-coloured
Asbestos sample 2 from shop	Yes	Amositt	Ash-coloured

3.5.2 Comments to the results

Asbestos may be divided into two groups i.e. serpentine and amphibole. Amositt asbestos is an ash-coloured or brown type of asbestos that belongs to the amphibole group and is extracted in South Africa. As can be seen from table 3.5.1, all four samples were confirmed asbestos of the amositt type.

Asbestos sample 1 and 2 on yard were taken from small and larger lumps found randomly on the ground (see Figure 16, Figure 46 and Figure 47 and in Appendix D). There where no procedures nor actions implemented regarding asbestos storage and handling. The spreading of asbestos induced by wind was observed by the eye.

Sample 1 was taken from a sack stored along the roadside. This was re-processed asbestos (grainy/powder alike consistence).

Sample 2 was collected from a heap at a location where asbestos was re-processed. At this site asbestos was found randomly in different shapes stored prior to re-processing.

3.6 Soil samples

Both soil samples were collected at a location undertaking steel plates re-manufacturing. Paint was removed (by grinding) and cutting/welding was performed.

3.6.1 Analytical results

Table 3.6 summarises the heavy metal analyses, Table 3.6.1 summarises the PCB-analyses and Table 3.6.1.1 summarises the organotin analyses of soil from a steel plate re-processing site.

Table 3.6 Heavy metals analyses of soil from a steel plate re-processing site.

Sample	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn	Figure in Appendix D
Sample 1 on steel plate re-processing site, (mg/kg, dry weight)[2]	3.0	568	1,211	37,831	0.266	1,792	88	5,733	5,888	Figure 19
Sample 2 on steel plate re-processing site, (mg/kg, dry weight)[2]	0.8	507	573	28,082	0.076	2,321	114	4,232	2,929	
Estimated level of detection, (mg/kg, dry weight)	0.2	0.2	0.7	0.6	0.003	0.5	0.3	0.5	1	
Local natural background values from Kanpur-Unnao area of India[3]	0.1	114	51	52,000	0.05-0.2[1]	1363	63	144	114	

[1]: No number available for the region. Number represents background values from Norway.

[2]: Analysed with nitric acid (HNO_3). The reported numbers therefore represents "biological available" metal concentrations.

[3]: Analysed with hydrofluoric acid (HF). The reported numbers therefore represents total metal concentrations.

Table 3.6.1 PCB analyses of soil from a steel plate re-processing site.

Sample	PCB-28	PCB-52	PCB-101	PCB-118	PCB-153	PCB-138	PCB-180	Sum 7-dutch (mg/kg)
Sample 1 on steel plate re-processing site, (µg/kg, dry weight)	12	194	310	199	268	353	108	1.444
Sample 2 on steel plate re-processing site, (µg/kg, dry weight)	3.4	12	19	22	45	57	42	0.2
Level of quantification, (µg/kg, dry weight)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-
Background values from Norway[1], **/20/**	-	-	-	-	-	-	-	0.003-0.03

[1]: No background value is available for the region. However PCB is not a natural existing substance and therefore background values from Norway is referred to **/20/**.

Table 3.6.1.1 Organotin analyses of soil from a steel plate re-processing site.

Sample	Monobutyltin (MBT)	Dibutyltin (DBT)	Tributyltin (TBT)	Dryweight
Sample 1 on steel plate re-processing site, (mg/kg, dry weight)	1.9	2.4	25	99
Sample 2 on steel plate re-processing site, (mg/kg, dry weight)	0.72	1.38	17	99
Level of quantification, (mg/kg, dry weight)	0.005	0.005	0.005	
Maximum levels in marine sediments reported by WHO in 1990.	-	-	26.3	

3.6.2 Comments to the results

3.6.2.1 Heavy metals

The results have been compared to the natural background values from the Kanpur-Unnao area, south of Himalaya and the Ganges River in India (ref.: /19/). It should be noted that the analytical method used implies the use of hydrofluoric acid (HF). This means that the reported numbers represents total metal concentrations in the soil. The analyses reported on here, refer to the use of nitric acid (HNO_3) and hence it is the biological available metal concentrations that is reported. Comparable levels will therefor have somewhat lower numbers than those reported for the background reference.

As can be seen from table 3.6, the heavy metal concentrations in the earth samples taken by DNV are, except for iron (Fe), all far above the background levels. Especially for copper (Cu), lead (Pb) and sink (Zn), the values are high. The high concentrations are as expected, reflecting heavy metals typically found in paint products. Investigations carried out on offshore installations in Norway has reported sink-, copper- and lead- content of 98%, 35% and 0.4 % respectively in different paint types (ref.: /29/, /30/). Steel alloys typically used in shipbuilding will also include compounds of these metals.

For mercury (Hg), there was no “local” background figures available and the sample values are compared to background values from Norway. As can be seen from the table, the sample values for Hg are within the Norwegian background values or slightly above.

3.6.2.2 PCB

Since no background levels of PCB in the soil of Bangladesh were available, the PCB concentrations in the soil have been compared to background levels of PCB in soil in Norway. Since PCB is no natural occurring substance, this comparison should be reasonable. As illustrated in table 3.6.1, the PCB concentration in the analysed soil is 7-48 times above the maximum background levels in Norway. The high concentrations are as expected since the steel plates from vessels earlier were painted with PCB containing paint. In Norway the PCB content in certain types of paint (wet) was reported to be about 5 % in the years from about 1950-1975 (ref.: /23/).

3.6.2.3 Organotin

Since no background levels of organotin in the soil of Bangladesh were available, the tributyltin (TBT) concentrations in the soil have been compared to maximum levels in marine sediments reported by the Worlds Health Organisation (WHO) in 1990 (ref.: /21/). As seen from table 3.6.1.1, the reported value for TBT in sample 1 is almost as high as maximum values reported by WHO. It is concluded that the level of organotin in the samples are high.

3.7 Paint sample

The paint sample was collected from steel-plates for re-manufacturing. The paint sample was scraped off the plate.

3.7.1 Analytical results

The tables 3.7, 3.7.1 and 3.7.1.1, summarises the analytical results of heavy metal, PCB and organotin respectively.

Table 3.7 Heavy metals analyses of paint sample from a steel plate re-processing site.

Sample	Cd	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn	Figure in Appendix D
Paint sample on steel plate re-processing site, (mg/kg, dry weight)	2.0	4,538	50	13,167	0.126	134	32	18,312	6,350	Figure 19
Estimated level of detection, (mg/kg, dry weight)	0.2	0.2	0.7	0.6	0.003	0.5	0.3	0.5	1	

Table 3.7.1 PCB analyses of paint sample from a steel plate re-processing site.

Sample	PCB-28	PCB-52	PCB-101	PCB-118	PCB-153	PCB-138	PCB-180	Sum 7-dutch (mg/kg)
Paint sample on steel plate re-processing site, (µg/kg, dry weight)	2.7	0.8	0.9	-	0.8	1.2	-	6.4
Level of quantification, (µg/kg, dry weight)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-
Reported levels in paint in Norway from 1950-1975 (ref.:/23/).								5%[1]

1: The reported value is the total PCB content (ΣPCB) which is higher than the sum 7-dutch content (ref.: /23/).

Table 3.7.1.1 Organotin analyses of paint sample from a steel plate re-processing site.

Sample	Monobutyltin	Dibutyltin	Tributyltin
Paint sample on steel plate re-processing site, (mg/kg, dry weight)	0.37	0.14	0.64
Level of quantification, (mg/kg, dry weight)	0.005	0.005	0.005
Reported values of TBTO[2] in paint used in Norway (ref.:/21/).			1-5%[1]

[1]: This is a general reported value in reference (ref.: /21/). In other sources values of 15 % TBTO is reported (ref.: /29/).

[2]: TBTO is tributyltin oxide.

3.7.2 Comments to the results

3.7.2.1 Heavy metals

As can be seen from table 3.7, there are relatively large levels of zinc, lead and chrome in the analysed paint, which is as expected. As mentioned in chapter 3.6.2.1 the content of heavy metals vary in paint, (ref.: /29/, /30/).

3.7.2.2 PCB

As can be seen from table 3.7.1, a sum 7-dutch concentration in the analysed paint of 6.4 μg/kg is reported. This number is low compared to the reported values of PCB in certain paint types in Norway from 1950-1975 where a value of 5% PCB in wet paint was representative. The relatively low concentration may indicate that vessels originally were coated with paint containing PCB, but during its lifetime, sandblasting and re-painting (using PCB-free products) has reduced the net amount present. Thus only small amounts of the original paint may have cross-contaminated the newer paint. The reports from the laboratory cannot conclude if the PCB originates from the paint itself or if it originates from an external source causing cross-contamination (e.g. PCB-containing oil).

3.7.2.3 Organotin

Table 3.7.1.1 illustrate a tributyltin concentration of 0.64 mg/kg dry weight. This is much lower than reported values of original content of TBT in paint (antifouling paints). This may imply that the paint is old and that the TBT therefore has been released to the sea. Another explanation may be that the actual sample is not representative. The sample may have been collected from a plate not exposed to fouling and therefor not treated by anti-fouling paint products. The detected TBT may origin from contamination from other plates (through stockpiling).

3.8 Electrical cable sample

3.8.1 Analytical results

The PCB analyses from the insulation of an electric cable are provided in table 3.8.1, presented as individual congeners (according to 7- dutch). The piece was randomly collected from a site where cable insulation was burnt (see Figure 48 in Appendix D).

Table 3.8.1 Results of analyses of PCB in a cable.

Sample	PCB-28	PCB-52	PCB-101	PCB-118	PCB-153	PCB-138	PCB-180	Sum 7-dutch
Cable (µg/kg, dry weight)	<0.2	0.5	9	9.2	50	52	9	130
Level of quantification (µg/kg, dry weight)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	

3.8.2 Comments to the results

Following the laboratory analysis, it is found that the PCB congener pattern resembled that of an Aroclor 1260 commercial PCB mixture. The sum of the 7-duch found in the cable, 0.13 mg/kg, is relatively low compared to findings in e.g. mastic used between concrete elements. The normal range in such mastic is 15-64,000 mg/kg (ref.: /14/, /15/). This project has not been able to identify any references establishing the presence of PCB in cable insulation.

The sample extract was analysed with the MS (Mass Spectrometry) detector run in two different modes, partly in a specific mode (SIM) to detect PCB congeners only, partly in a full scan (screening) mode to detect the possible presence of other organic compounds in the sample.

The laboratory screening analysis suggests that the cable may be contaminated by an oil product with boiling point range in the region of 300 – 450 ^{o}C. A possible source may be that of lubricating oil. It is not however established from where the PCB-concentration origin. The PCB content makes up approximately 1% of the oil content. The findings are difficult to interpret, as there was no visual surface content of oil on the cable. The laboratory therefore states that they cannot conclude whether the oil has been part of the cable composition or is a result of an external source, having contaminated the cable. If the source is external, the oil may have dissolved into the cable matrix, explaining why no surface oil was observed.

If it is assumed that the PCB originates from the cable itself, the concentration of PCB is as mentioned earlier, low. However it is a finding that should be investigated further both because of the large volume of insulation on cables and because of the possible contamination as a result of the burning of the insulation. The PCB together with the PVC in the cables may result in dioxin pollution. If the insulation on the cables is not combusted sufficiently in a controlled and monitored manner, the PCB may also still be present in the residues from the burning, which again may be spread into the ground.

3.9 Air samples

3.9.1 Analytical results

As described in chapter 2.3.2.9, air samples were taken with regard to analyses on asbestos, heavy metals and organic compounds. The corresponding results of the analyses are given in the tables 3.9, 3.9.1 and 3.9.1.1.

Table 3.9 Asbestos analyses (air samples).

Sample	**Results (asbestos fibres/ml air)**	**Figure in Appendix D**
Sample 1 on yard	<0.01	Figure 22
Sample 2 on asbestos re-processing place	<0.01	Figure 17, Figure 24
Administrative norm (ref.: /17/).	0.1	

Table 3.9.1 Heavy metal analyses (air samples).

Sample	Cd	Cr	Cu	Fe	Hg[2]	Mn	Ni	Pb	Zn	Figure in Appendix D
Sample 1 on yard, ($\mu g/m^3$)	<lod	<lod	8.5	163	0.040	11.5	1,860	9.0	180	Figure 22
Sample 2 on steel plate re-processing company, ($\mu g/m^3$)	<lod	<lod	4.1	440	0.006	<lod	2.6	28.7	120	
Estimated lod, ($\mu g/m^3$)	0.4	0.4	1.4	1.2	0.006	1.0	0.6	1.0	2	
Administrative norm, ($\mu g/m^3$) (ref.: /17/).	50	500	100[1]	3,000	50	1,000	100	50	5,000	
Combination influence, Sample 1	-	-	0.09	0.05	0.0008	0.01	19	0.2	0.04	SUM combination influence: **19**
Combination influence, Sample 2	-	-	0.04	0.15	0.0001	0.001	0.03	0.57	0.02	SUM combination influence: **0.8**

1: In smoke.
2: Hg in gas is not measured and gives normally a greater contribution than Hg in dust.

Table 3.9.1.1 Organic screening (air samples).

Sample	B	T	EX	C3-C4-B	Aliphatic HC (Soil)	Others	Figure in Appendix D
Sample 1 on yard, (mg/m^3)	0.019	0.004	0.008	0.03	0.43	*	Figure 22
Sample 2 on steel plate re-processing company, (mg/m^3)	0.018	0.015	0.07	0.24	0.66	*	Figure 23
lod (mg/m^3)	0.004	0.001	0.001	0.002	0.1	0.001-0.01	
Administrative norm, (mg/m^3) (ref.: /17/).	3	94	220 and 108	-	275	-	
Combination influence, Sample 1	0.006	0.00004	0.00002	-	0.002	-	SUM combination influence: **0.008**
Combination influence, Sample 2	0.006	0.0002	0.0002	-	0.002	-	SUM combination influence: **0.009**

3.9.2 Comments to the results

For all air samples, the analytical results are compared with Norwegian norms for working environment atmosphere (ref.: /17/). This norm is made for the evaluation of working environment standard on Norwegian work sites where the air is polluted with chemical substances and is based on technical, economical and medical assessments. The values in this norm are on the same level as for many of the member countries within the European Union (e.g. Denmark, Sweden and the Netherlands), (ref.: /18/).

3.9.2.1 Asbestos

As can be seen from table 3.9, there is less than 0.01 asbestos fibres/ml air in both samples. This is more than 10 times less than the administrative norm for working environment in Norway.

Air sample 1

Air sample 1 (asbestos) was taken on a ship-breaking yard at the beach. The result implies that there is not asbestos in the air at the place where the sample was taken. However the asbestos sample number 2 on yard (see chapter 3.5), which was asbestos positive, was taken about 10 meters away from the air sampling point. The wind direction from the solid sample on ground was not towards the air sampling point during the air-sampling period and this may explain that the air sampler did not detect any asbestos.

As earlier mentioned (see chapter 2.3.2.9) it should also be noted that the first two hours the wind direction was toward the pumps and thus it is expected that the filters/cartridge would detect possible polluted air during this period. However during the two latest hours it was landbreeze and it is expected that the filters/cartridge reviewed less polluted air through the inlet.

Air sample 2

Air sample 2 (asbestos) was taken by installing the sampling equipment on a worker that was crushing what was further traded as asbestos. The analytical results show that the sample was asbestos negative. This implies that the substance the worker was crushing during the period of air sampling was not asbestos, but a substance of similarity. However it should be noted that asbestos sample 2 from shop was taken from the heap between the workers that were undertaking the crushing process and that this sample proved asbestos positive (see chapter 3.5). This may imply that what had been crushed prior (e.g. the day before) to the air sampling was asbestos (now lying in the heap) and that the workers was exposed to asbestos.

There was no wind during the sampling period.

3.9.2.2 Heavy metals

Air sample 1

From table 3.9.1, it can be seen that only the level of nickel (Ni) is above the administrative norm levels (sample 1). The table also provides an accumulated sum of the effect that the different heavy metals are having. This sum shall not exceed the figure 1 in order to meet the norms (ref.: /17/). The value exceeds this limit with a factor of 19 (sample 1). The air quality is not in compliance with these norms.

For wind influence see description under air sample 1 in chapter 3.9.2.1.

Air sample 2

For sample 2, non-of the heavy metal components exceeds the norm values. As can be seen from the table, none of the sums of effects are above norm values. It is concluded that the working conditions in relation to air quality were within the reference norms at the point (location) where the sample was taken at the time it was taken.

As discussed previously (chapter 2.3.2.9), very little wind movement at the time of sampling may avoid the filters to “inhale” the pollutants.

3.9.2.3 Organic compounds

Air sample 1

Laboratory analysis concludes that the sample contain aliphatic hydrocarbons up to C20 at low levels. A suggested source is diesel/light fuel oil. Napthalene was found at a level of approximately 0.005 mg/m^3. No organic compounds other than oil related hydrocarbons were found in the sample.

For sample 1, non-of the organic compounds are exceeding the norm values. As can be seen from table 3.9.1.1, the sum of the effects is neither exceeding the norm values. It is therefor concluded that working conditions with regard to organic compounds was satisfactory during the sampling period for the sampling location.

For wind influence see description under air sample 1 in chapter 3.9.2.1.

Air sample 2

From laboratory results it is evident that the sample contain aliphatic and aromatic hydrocarbons at low levels. Suggested source is white spirit. Napthalene was found at a level of approximately 0.005 mg/m^3. No organic compounds other than oil related hydrocarbons were found in the sample.

Neither sample 2 contains organic compound components exceeding norm values. Again, this is also true for the sum value and it is concluded that at the working conditions with regard to organic compounds was satisfactory during the sampling period at the relevant location.

As for heavy metal sample 2 it should be noted that there was a little wind with no special direction during the sampling period and it was therefore expected that the filters got little polluted air through the inlet.

3.10 Direct environmental impacts of ship scrapping

In the following (table 3.10) a listing of results from the sampling analysis is provided. An attempt in cou impressions from the site assessment in order to arrive at recommendations that can provide as input in a I (BPA) has been made.

Table 3.10 Sample analysis summary.

Sample analysis	**Conclusions**	**Recommendations and input to the Best Practice**
Sediments	Analysed samples does not have concentrations that are alarming. However, this is probably caused by tidal water characteristics. A monitoring programme of sediment sampling should have been made. Reference studies from the same area show significant levels of various pollutants (ref.: /33/).	The nature of the activities undertaken in the beach methods adopted, provide a continuous supply of po understand the consequences of this, systematic mo monitoring programme should be established (chem both the intertidal- and subtidal zone (including also programme should be repeated in intervals with freq general activity level in the area as well as to any ac Metal concentrations in commercial products from t etc.) should be monitored continuously. The effect of the tidal water and the monsoon on the ship scrapping and other industry along the coast of
Sea water	Analysed samples have not revealed alarmingly high concentrations in the seawater. However, this is most likely due to the sampling sequence and its unfortunate synchronisation versus the tidal frequency (sample on incoming tide), se comment, item 2.3.2. Previous work (ref.: /2/, /3/, /4/, /5/, /6/, /7/, /8/) do provide documentation revealing high levels of toxic compounds in the area.	Monitoring programme of the sea-water should be in reference area also the intertidal- and subtidal zones designed and implemented in that suggested for sed A monitoring program of the mangrove forest and th on the mangrove could also be carried out in this con

Water samples	The DNV analysed samples do show high concentrations of oil water samples from the breaking area.	Insufficient facilities for disposal/storage lead to pil to the general activity of the beach resulting in dama Further, insufficient emptying or cleaning of system contamination on the ground. Waste oils require waste oil facilities. This may inc from ship structures (pumping ability) and to store (barrels require a storage space secured from the gen barrels will remain intact. However, in order to secu ground and to water, such a storage area requires to l storage area can consist of a concrete surface built o fencing. A collection system for spillage should be A multiple number of such simple storage areas sho scrapping area. For removing oil remains from structures, mobile pu tanks (or barrels) may be provided. A proper collection system should also be made for treated as hazardous waste, e.g. asbestos, PCB-conta Note that in Chittagong, the vessels quay prior to be electronic equipment (including navigational aids a opportunity to remove waste substances also. A qua required services including waste handling and rece Some of these waste products will provide as raw m
Residue sample	Sludge samples analysed contained significant levels of hydrocarbons and heavy metals.	Oily sludge from the vessels should be collected onl sludge should thereafter be sent to recycling industr factories) that may use the sludge in their productio (See comment above for water samples).

Asbestos	The analyses undertaken have verified that the samples collected in actual fact are that of asbestos. According to western regulations, asbestos was not handled satisfactory. Asbestos was detected and present mostly everywhere in the ship breaking yards and on the places where asbestos is re-processed. There were no precautions or action at any level enforced in order to control this substance. In fact it was manually crushed and recycled.	Even though the use of asbestos is not prohibited in continent, asbestos is nevertheless extremely hazard health implications (ref.: /1/) and should therefor be Asbestos should be disassembled from the vessels i asbestos dust production is achieved. The asbestos s way that it can not enter into air. All workers engage special protective equipment (asbestos masks, glove regard to the health effects of asbestos should be pro It should be proposed to implement a ban on the use countries that still allow for such. (Asbestos waste reception can be integrated in a ger system as discussed above, see water sample).
Soil	Soil analyses have established significant levels of contaminants such as heavy metals, PCB and TBT.	Sites undertaking steel component work (ship break areas) require upgrading in order to avoid soil conta be carried out in dedicated areas on appropriate surf waste oil storage. Residues from the cutting, paint re and disposed. Even though no soil samples were collected in the s contaminated with heavy metals, PCB, oil and asbes the scrapping area. A soil survey programme should be carried out in or contaminants (ship breaking area as well as re-manu
Paint	Paint analysis show a small content of PCB and TBT.	Action as above (soil) is recommended. Note that th plate and therefore not representative for all paint pr particular the level of TBT seems low. It is reasonab breaking site is high.

Electrical cable	A random piece of cabling was collected and analysis revealed the content of PCB. It is difficult to decide if the PCB originates from the cable itself or from other sources that may have cross-contaminated the cable.	A more general investigation on cables and the poss carried out. Contacts with producers and analyses of should be done. Note that cabling unfit for the second-hand market is metal. The combustion process of PCB and PVC em process should be carefully undertaken in a controll
Air	The analysed air-samples do show a content of heavy metals and organic compounds, while for asbestos there is not detected any in the air sample. The relative small content of heavy metals and organic compounds may be explained with the wind conditions during the sampling. For asbestos the negative result may be explained by the fact that the crushed substance the day of air sampling was not asbestos.	See bullet points mentioned under chapter regarding

4 DEVELOPMENT OF SHIP BREAKING PRACTICES

4.1 The Best Practice Approach

Assuming the scrapping activities of Chittagong, Bangladesh are representative of that undertaken elsewhere on the Sub-Indian continent, it can be claimed that current scrapping practices of large tonnage is undertaken with a high level of utilisation. In addition to material extraction for re-manufacturing (mainly metals), re-use of components accounts for a considerable share of the total outcome. This level would most likely not be achievable in other alternative locations (markets) mainly due to legislations. These may be illustrated by:

- Requirements related to certification for products sold to a market (CE-requirements).
- Requirements associated to materials/ systems/components and their content (including requirements to verification/ statements, etc.).
- Limitations on the usage of some substances (i.e. asbestos is banned in a number of countries).
- Reluctance to accept 2nd. hand equipment.

The extensive re-use and re-processing of equipment and materials represent an environmental gain in the context of sustainability and should be encouraged. However, the lack of organisational procedure and processing tools generate a number of unwanted occurrences. Some are listed below.

- High number of casualties.
- Acute and long term contamination of water, sediment, soil and air.
- Health implications.

Improvements in the ship breaking industries should not be initiated blindly without reflecting the ability to actually implement and take efficiently use of proposed actions. Most ship breaking nations are developing countries with limited resources in many areas; infrastructure, regulations, education etc. Some initiatives (ref.:/33/) have been proposed but sadly failed in the implementation phase.

The requirements of upgrading in the ship breaking industry is being realised not only by Governments and NGO's but also by the international community (ref.:/34/) (IMO/ UNEP) as well as the industry itself (ICS, ref.:/35/) representing two important initiatives. The issue of recycling of ships is now an item on IMO's agenda and work is initiated through the establishment of a Correspondence Group to be lead by Bangladesh. The essence of Terms of Reference for the group is listed in table 4.1. The group will provide a report to be presented for the MEPC 46 (scheduled for July year 2001). The reluctance of IMO to speed up the activities in this area has already been questioned by other organisations and institutions.

The loss of the tanker M/V Erica outside the coast of France on December 12. 1999 has initiated a discussion on operational life limitations for tankers. The phase out mechanisms in international regulations is about to come into full force as the building boom of the mid 1970's are reaching maximum operational age (discussed in detail in ref.:/1/). These are arguments used when focusing on the need for more urgent measures in the recycling industry.

Table 4.1 Extraction of Terms of Reference, IMO Correspondence group on Recycling of Ships

Gather information on current practices concerning the recycling of ships.	Identify relevant information from documents already submitted to MEPC and discussions taken place (in the committee).
Identify safety and environmental risks associated with current practices.	Collect information on procedures introduced by governments and industry to reduce risks (environmental/ safety) associated to the recycling process.
Collate information to be received from the secretariats of ILO, the Basel Convention, the London Convention and industry on their activities and preceived responsibilities associated with the recycling of ships.	Gather views on areas where IMO may usefully contribute to the reduction of safety and environmental risks associated with the recycling of ships, and in doing so, identify the originators of these views.

The Basel Convention as well as the EU are initiating activities that may accelerate the more formal frames related to ship breaking.

The industry itself seems to move from indifference to acceptance on questions related to actions required. Organisations such as the ICS, BIMCO, INTERTANKO, INTERCARGO, OCIMF and ICFTU are all expressing support to the international initiatives. Furthermore, these organisations have also highlighted the alternative of self-regulations. Hence, despite the lacking likeliness of IMO being able to provide recommendations or legislations on ship recycling within the next few years, a demand for guidelines and recommendations for both shipowners and ship breakers will arise nevertheless.

Following past work and conclusions from the assessment discussed in chapter 3, it is concluded the subjects of safety, health and the environment have at present no presence in the context of ship breaking. Any attempt in implementing initiatives to improve this situation must mirror this. The BPA can offer co-ordinated initiatives to be introduced step-by step.

4.2 The ship breaking process

The figures 2.5.3 and 2.5.4 represent the ship breaking process as it was witnessed at the site of Chittagong. Even though elements like the nature of the location, infrastructure, national requirements and local particulars may influence the process, the stepwise procedures of demolition and extraction, cutting, remanufacturing and resale are common regardless. Hence, the process as illustrated in these figures may be considered generic.

4.2.1 Decommissioning and demolition

In figure 4.2.1, the process from site area arrival through to material extraction and sorting-preparations for re-sale to the re-manufacturing markets is illustrated based upon figures 2.5.3/ 2.5.4.

The process and the actions involved are systemised in three main categories; arrival at site, intertidal zone and the breaking area. The actual re-manufacturing and resale to end-user applications are not included here.

The role of the concept outlined in the DNV Report 2000-3160 requiring onboard precautionary actions to be undertaken (GUIDEC, DNV Report 2000- 3156) and onboard material/substance verification (ENVER, DNV Report 2000-3157) resulting in a ship Inventory Dossier – Environment (SIDE) is indicated with references to the three categories (DNV). The nature of the procedures involved (PRO) make provisions for identifying consequences in relation to undesired impacts associated to safety, health and the environment (SHE).

DNV*	Preparative actions (GUIDEC documentation). Vessel may have undergone precautionary actions; cleaned, removed, secured, shut down.	ENVER/ Ship Inventory Dossier Environment (SIDE) Hazardous substances located, Identified and quantified.	*Ship-Breaking norm or standard (MARVEL).*
PRO	Preparations undertaken incl. removing of valuables carried out alongside quay.	Vessel beached, dismantling initiated by removing large structures/systems/components and transporting these to the breaking area (dry area).	Larger components and structure cut into manageable units. Systems are dismantled. Sorting and temporary storage require internal transport carried out by "lifting-teams".
X	***ARRIVAL AT SITE***	***INTERTIDAL ZONE***	***BREAKING AREA***
SHE	Opportunity to remove environmental hazardous waste and to secure systems (gasfree tanks, etc.).	Torch cutting, lifting, wincing manual extraction imposes potentials for personal injuries. Debris/chemical wastes/ emissions from the process escape to air/ sea. Causes human exposure and affect the local communities (fisheries).	Torch cutting, lifting, use of manual tools ongoing in several places within a small area carry the potential of personal injuries. Human exposure to chemicals and emissions endanger health. Pollutive remains travel freely and is a threat to the environment in general.
BPA	Require reception facilities/ pumps/storage capability/ training and general safety and precaution equipment.	Require dismantling planning including waste handling and safety protection initiatives (input from ENVER/SIDE).	Require procedure planning including waste handling and safety protection initiatives. Waste management must include the subject of disposal.

DNV*	GUIDEC/ ENVER and SIDE are proposed verifying mechanisms aimed at the ship owner in order to undertake precautionary actions and to document onboard substances (DNV report no.: 2000-3160).
MARVEL	Proposed rating concept of ship recycling facilities based upon the compliance of recommendations of Best Practice Guidelines (to be developed).
PRO	Summary of actions undertaken in the process.
X	The ship through the steps of decommissioning, demolition and re-use
BPA	Input to a Best Practice Approach.

Figure 4.2.1 Decommissioning, and material preparations for reprocessing.

The identified challenges to safety, health and the environment (SHE) can be detailed with references to sub-activities and make provisions for requirements to a best practice approach. The table attempt to illustrate this process though not at a detailed level. In order to enable implementation of improvements, a coarse approach may be appropriate. When such best practice improvements are implemented (at a coarse level), individual operations can be isolated, assessed and insufficiencies detected. This methodology can adapt to the experience return and continuous improvement processes widely used in industries in general.

The BPA approach outlined above provides a generic route that can be adopted for any particular ship breaking process. The approach can be expanded to include the next step in the process, namely the actual recycling phase.

4.2.2 Material extracted for re-use

Following the material preparation and sorting process at the ship breaking facility, distribution is required. The material stream from the breaker can be categorised:

1. Sale to end-user (shops for further sale) with no or minor re-manufacturing requirements (components, sanitary equipment, etc.).
2. Sale of steel and metal for reprocessing (steel plate cleaning and re-manufacturing/ steel mills).
3. Sale of non-ferrous materials for reprocessing.
4. Debris and waste for treatment or disposal (item 4.2.2.1).

In a similar manner as the breaking process, a flowchart can be provided for each of the groups above identifying control requirements (verification), details of actual processes involved and the impacts these may have on safety, health and the environment in order to establish precautionary actions to be taken.

4.2.2.1 Waste and extraction debris

Item 4 assume that the BPA-procedure at the breaking facility has identified and established a waste management system. Debris and wastes will have been sorted so that further treatment or disposal can be undertaken safely. An incentment to achieve this may be the introduction of payment to the breaker for volume of waste delivered (to waste reception facilities).

A definition of waste may also be introduced (adopting existing international norms or standards) for removing undesired materials or substances from the market. Such approach would enable asbestos to be removed from the recycling process.

Based on the broadly accepted “the polluter pays” principle, it may be suggested that the financing of the “waste return concept” as briefly presented here, is a contribution arriving from the sale of the particular vessel. This “fee” could be based on the material inventory dossier (as suggested above and as outlined in DNV report 2000-3160).

4.3 Safety, Health and the Environment (SHE)

Based upon the BPA, an inventory complying guidelines, procedures, standards and requirements referring to actual operations covering both the ship breaking process as well as the following phase of re-use or recycling can be identified. The inventory will include a mutual section for practices related to the identification and handling of materials, items and hazards covering all involved areas (SHE) representing minimum requirements for the ship breaking facility and the associated recycling processes. It should also address incidents and requirements associated to such (contingency preparedness). At a developed stage this inventory will in effect provide as an Environmental and Safety Manual for Ship breaking facilities (ESMaS).

Such requirements may cover the facilities themselves as well as operational procedures. Listed below are some examples:

1.	Facility Layout	Work task separation (requirements to work surfaces and drainage); Material separation (waste separation facilities).
2.	Operational procedures	Use of machinery and tools (procedures when using winches/ cranes, touch cutters, etc. (clearance zone, protective gear); Handling of hazardous substances (procedures for personal protection, storage and transport)

Adopted standards must reflect and comply to national legislations or regulations where applicable.

The ESMaS is a managerial tool for the operation containing references to all relevant norms, standards, regulations etc. and provide for implementation, maintenance and continuos improvements. Based on an identified environmental performance policy to be adopted (by the breaking facility), the manual will rest on identified environmental performance criteria. Through defined procedures, conformity (or non-conformity) with the identified policy can be monitored and verified.

4.3.1 Environmental and Safety Manual for Ship breaking facilities (ESMaS).

Introducing a managerial SHE-tool in order to systemise the decommissioning, demolition and recycling processes should focus on;

- Implementation ((initial) ambitions to change must reflect realities).
- Stepwise improvement ability (experience feedback and continuous improvement).
- Should be developed reflecting recommendations of relevant international certification regimes (ISO 14001 - compliance, etc.).

The manual must address all aspects of the SHE-concept in all activity categories (at arrival, intertidal zone, breaking area + re-use/ recycling facilities).

The content and structure of ESMaS is illustrated in figure 4.3.1.

ESMaS		
Safety/ Health	**Environment**	**SHE-Contingency and preparedness**
Occupational Safety and Health Plan	Environmental Management Plan	Contingency Preparedness and Disaster Management Plan
Inventory of best practices		

Figure 4.3.1 Content and structure of ESMaS.

4.3.1.1 Company policy

The objective of the ESMaS is based upon individual identified ambitions reflecting any relevant national/local regulations, recommendations or guidelines. These ambitions represent the company policy. ESMaS is simply a tool allowing company policies to be met.

The company policy should account for the nature of its activity including the scale and potential SHE-related impacts of the processes involved in the different activity categories of ship breaking. The company policy must be regarded as a commitment including continual improvement and compliance with any relevant legislations and regulations. The overall policy should have references to SHE.

Essential in this context is the requirement of training. The company policy should identify specific targets in relation to training both at a general level in order to provide awareness but also specifically addressing SHE.

4.3.1.2 Occupational Safety and Health

The Occupational safety and Health Plan is developed based on the company safety and health policy and may consist of sections as indicated below:

1. Accommodation and facilities; including general requirements covering sanitary as well as living conditions.
2. Working conditions; covering inperations associated to demolition and extraction allowing safety requirements to be identified.
3. Health; including the provision of general healthcare as well as monitoring of workers health.

The plan will provide objectives and targets to be met.

Examples may be:

- Unified breaks implemented in a scheduled working day.
- All vessels arriving for demolition are cleaned and secured, i.e. all tanks are cleaned and cleared (gas-free) for hot work.
- All vessels arriving required to carry an inventory dossier (SIDE).
- All workers are required to use basic protection equipment inside the breaking facility (helmet, boiler-suit, protective boots, and gloves).
- All hot work is undertaken by trained personnel equipped with additional protection equipment (welding goggles, masks, etc.).
- De-mounting of structures identified containing hazardous substances (i.e. SIDE) are handled by dedicated individuals appropriately trained and equipped (i.e. asbestos to be handled using approved masks, suits, gloves, boots, goggles, etc).
- Health programme including periodical checks (i.e. annual check) and monitoring programmes of exposed workers, etc.

The Occupational Safety and Health Management Plan will make provisions ensuring that such objectives and targets are met.

4.3.1.3 Environmental Management

An Environmental Management Plan is developed with basis in the company environmental policy. This provides a framework identifying environmental objectives and targets.

Examples may be:

- All vessels arriving the facility for breaking has undergone cleaning (including tanks, cargo areas, etc).
- All auxiliary systems (those not needed for actual beaching) have been closed down and cleaned (oil, etc. removed).
- All materials categorised as hazardous (ref.:/36/) are treated and disposed off separately.
- No combustion to take place unless by the use of (approved) incinerator.

The Environmental Management Plan will make provisions ensuring that such objectives and targets are achieved.

4.3.1.4 Contingency Preparedness and Disaster Management

The Contingency Preparedness and Disaster management Plan should identify objectives and targets with the aim of minimising consequences of any incidents. Based on an evaluation of the operations and procedures involved, emergency scenarios should be developed. These will provide input to the plan and allow specific requirements in addition to procedures and guidelines to be identified (facilities, equipment and training). The development of a Contingency Preparedness and Disaster Management Plan may identify general requirements to the operation and may thereby provide inputs to both 4.3.1.2 and 4.3.1.3.

4.3.1.5 Inventory of Best Practices

An Inventory of Best Practices including guidelines, procedures, standards and requirements complying to the respective plans listed previously should be available independent upon the plans. This will provide as a quick reference and ease implementation and training. Following findings revealed in chapter 3 and conclusions drawn in previous work (ref.:/1/), it is believed that even though a generic set of such best practices can be established, these would not be particularly helpful. This firstly because this may act as an obstacle in the continuous improvement process and secondly, the particulars from one facility to another may not be compatible.

A tailored Inventory of Best Practices based on present capabilities but including a “continually improvement structure” allowing the adoption of improved practices may also include an inventory of materials that is handled, how it is extracted, how hazards are approached, etc.

4.3.2 Using the BPA to develop the ESMaS

This chapter (chapter 4) has identified a stepwise process taking simple precautionary actions and applying these systematically to isolated activities. The methodology is partly co-ordinated with other works undertaken parallel to this.

The initial requirement when adopting the BPA is to limit the activities that should be involved and to categorise these systematically. Current procedures and practices can then be identified and reviewed and improvements proposed. At this stage, the initiative may be said to represent an “initial ESMaS.” However, this initial step is thought vital in order to enable the implementation of the improvement process. Implementing Best Practices at this stage represent the base for the ESMaS process.

The methodology outlined may require some detailing and adjustments. However, its main features are believed to be sufficient in order to undertake pilot-cases.

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APPENDIX
A
MAPS

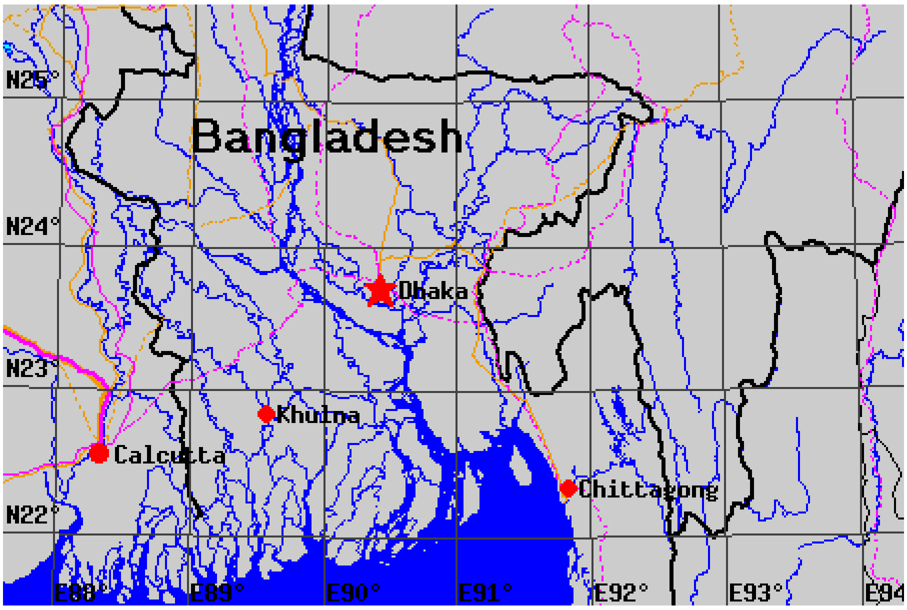

Figure 1 Bangladesh and the location of Chittagong.

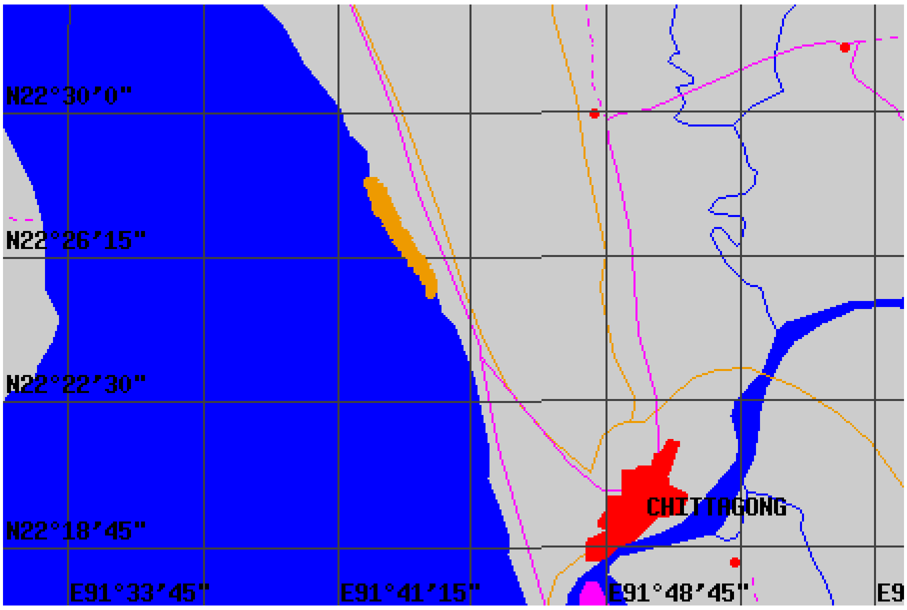

Figure 2 Location of the shipbreaking area Fauzdarhat noth west of Chittagong.

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APPENDIX

B

SCHEDULE FOR TRIP TO BANGLADESH

Date	Schedule
12.02.00	• Departure from Norway
13.02.00	• Arrival in Dhaka • Meeting with Norwegian Embassy in Dhaka • Arrival in Chittagong
14.02.00	• Planning meeting with Dr. Khan • Short boat-trip outside the ship-breaking area
15.02.00	• Strike, discussions with Dr. Khan and his team
16.02.00	• Strike, discussions with Dr. Khan and his team
17.02.00	• Strike, discussions with Dr. Khan and his team
18.02.00	• Boat-trip to get an overview of the ship breaking area • Sampling of sediment samples • Seawater sampling
19.02.00	• Site assessment (on-shore) in two ship-breaking yards • Air sampling (asbestos, heavy metals and organic compounds) • Sediment samples on yard • Sludge sampling • Asbestos sampling • Water sampling • Meeting with Mr. Shajahan Khan. Senior Chemist, Department of Environment, Chittagong
20.02	• Assessments of different small scale processing industries • Visit to cold-mill where reinforcement steel was produced from steel plates from the vessels
21.02	• Air samples (asbestos, heavy metals and organic compounds) from workers at scrap processing industries and possible asbestos re-processing unit • Visit to Grease-house Ltd (lubricating oil producing industry)
22.02	• Departure from Chittagong • Debriefing at Norwegian Embassy in Dhaka • Departure form Dhaka
23.02	• Arrival in Norway

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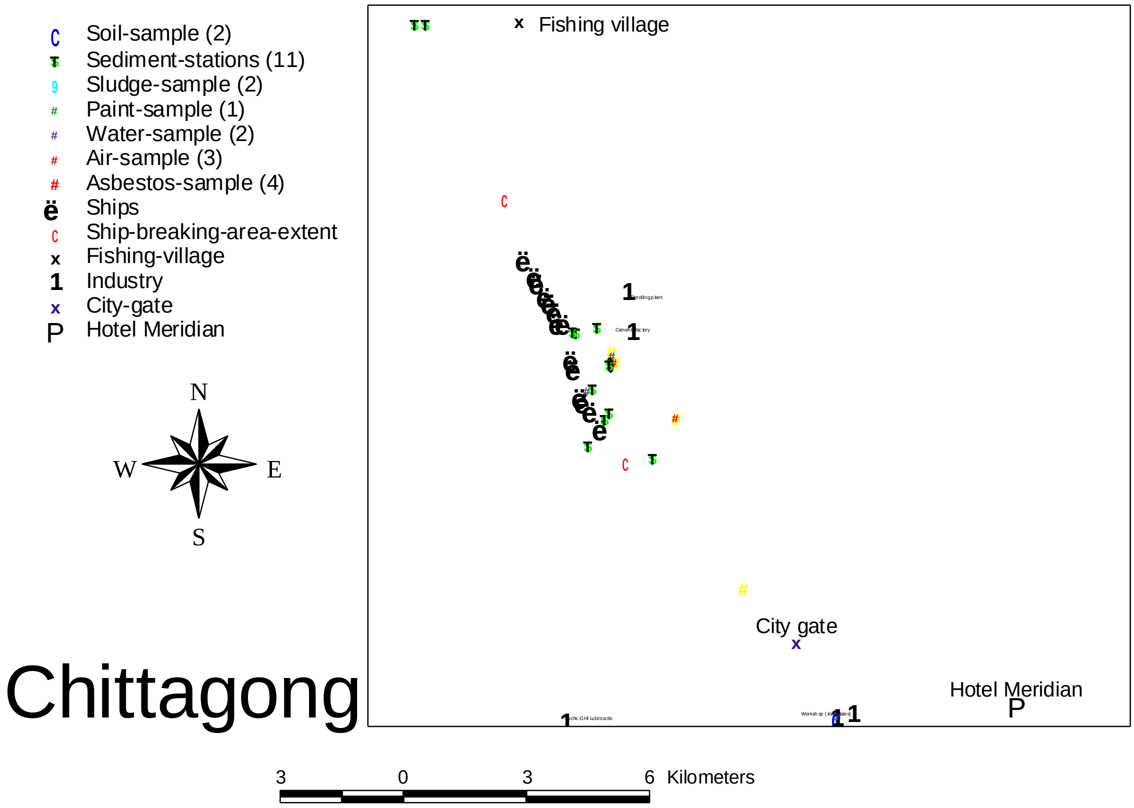
APPENDIX C
OVERVIEW OF SAMPLING POINTS


Soil-sample (2)
Sediment-stations (11)
Sludge-sample (2)
Paint-sample (1)
Water-sample (2)
Air-sample (3)
Asbestos-sample (4)
Ships
Ship-breaking-area-extent
Fishing-village
Industry
City-gate
Hotel Meridian
N
W
E
S
Chittagong
Fishing village
City gate
Hotel Meridian
3
0
3
6
Kilometers

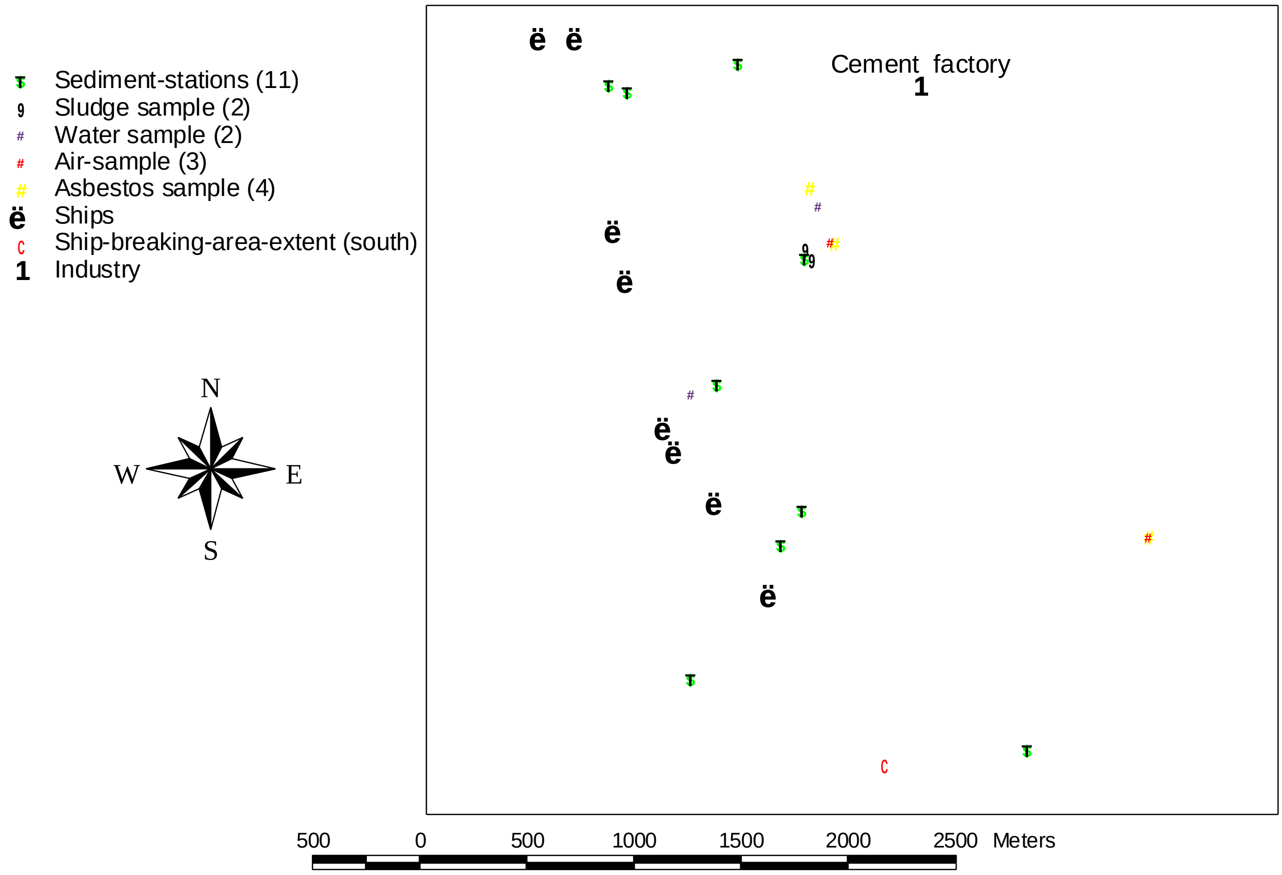


Figure 3 Sketch of DNVs sampling points, Chittagong, Bangladesh.

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APPENDIX
D
PHOTOGRAPHIC DOCUMENTATION

Figure 4 Overview of ship breaking area (aerial photo).

Figure 5 Sediment sampling offshore.

Figure 6 Core sampler used when sampling.

Figure 7 Oil sheen on the sea surface in the intertidal zone where sediment samples were taken.

Figure 8 Wooden fixtures covered with oil in the intertidal zone.

Figure 9 Fishing is taking place close to the shipbreaking area.

Figure 10 Fishing in the ship breaking area.

Figure 11 Mangroves some kilometres away from the ship breaking area. Oil can bee seen on the branches.

Figure 12 Vessel where steel plates have been removed.

Figure 13 Water sample taken in a little stream passing an oil storage site.

Figure 14 Oil storage site in a ship repair yard.

Figure 15 Sludge sample taken on a ship repair yard.

Figure 16 Asbestos recovered on the ground in large and smaller lumps.

Figure 17 Probably asbestos re-processing. A sample was taken from the heap in the middle. The workers are equipped with DNV asbestos masks.

Figure 18 Re-processed asbestos for sale along the road from Chittagong to Dhaka. A sample was taken from the sack.

Figure 19 Soil samples taken at a steel plate re-manufacturing company.

Figure 20 Paint sample taken for analyses.

Figure 21 Electrical cables. Sample was taken for analyses.

Figure 22 Air sampling equipment placed for sampling with regard to asbestos, organic compounds and heavy metals.

Figure 23 Air sampling (organic compounds) on worker that is welding.

Figure 24 Air sampling on worker that is crushing possible asbestos.

Figure 25 Possible asbestos could be found all over the ground.

Figure 26 Torch cutting of steel plates.

Figure 27 Floating of different components in the intertidal zone.

Figure 28 Winch for winching of compartments from the intertidal zone to the shore side.

Figure 29 Hand carrying of steel plates.

Figure 30 Different equipment from vessels that could be bought in the street from Chittagong to Dhaka.

Figure 31 Large chains are cut and sold to re-rolling mills.

Figure 32 FUCHS-GHL Lubricants (Bangladesh) Ltd where used lubrication oil is regenerated.

Figure 33 Raw material (black) and re-manufactured lubrication oil.

Figure 34 Ship that is lying in the intertidal zone on low tide.

Figure 35 The stern is cut off at a ship that is lying in the intertidal zone.

Figure 36 Steel plates and bulkheads have been removed from the vessel.

Figure 37 Temporarily storage of steel plates in the scrap yard.

Figure 38 Hydraulically cutting of steel plates from vessels.

Figure 39 Feeding of cut steel plates into the melting oven.

Figure 40 Production of reinforcement steel from steel plates from the vessels.

Figure 41 Loading of the reinforced steel onto lorries.

Figure 42 Different life saving equipment that could be bought on the second hand market.

Figure 43 Paint and chemicals that could be bought on the second-hand market.

Figure 44 Toilets, baths and other equipment for baths on the second hand market.

Figure 45 Oil could be seen on water and grass.

Figure 46 Asbestos found on the ground in the ship breaking area.

Figure 47 Close up photo to where asbestos sample number one was taken on the ground in the ship breaking area.

Figure 48 Burning of cables.

Figure 49 Removal of paint from steel plates.

Figure 50 Oil tank where sample was taken from.

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APPENDIX
E
OVERVIEW OF SAMPLES ANALYSED

DATE	DESCRIPTION	Possible analyses
2/19/00	Air sample 1 (STV 09): metals (8)	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
2/19/00	Air sample 1 (STV 07): Organic compounds	Organic compounds
2/19/00	Air sample 1 (STV 13): asbestos	Asbestos
2/21/00	Air sample 2 (STV 09): metals (8)	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
2/21/00	Air sample 2 (STV 07): Organic compounds	Organic compounds
2/21/00	Air sample 3 (STV 13): asbestos	Asbestos
2/19/00	Asbestos sample 1 on yard (solid)	Asbestos
2/19/00	Asbestos sample 2 on yard (solid)	Asbestos
2/21/00	Asbestos sample 1 from shop (solid)	Asbestos
2/21/00	Asbestos sample 2 from shop (solid)	Asbestos
2/18/00	Sedimentsample 1	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/18/00	Sedimentsample 2	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/18/00	Sedimentsample 3:	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		Hydrocarbons (incl. extended screening)
		PCB
		Organotin compounds
		Separate Hg
		Total organic matter (TOM)
2/18/00	Sedimentsample 4:	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		Hydrocarbons (incl. extended screening)
		PCB
		Organotin compounds
		Separate Hg
		Total organic matter (TOM)
2/18/00	Sedimentsample 5	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/18/00	Sedimentsample 6	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/18/00	Sedimentsample 7:	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH

		Separate Hg
2/18/00	Sedimentsample 8:	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		Hydrocarbons (incl. extended screening)
		PCB
		Organotin compounds
		Separate Hg
		Total organic matter (TOM)
2/18/00	Sedimentsample 9	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/18/00	Sedimentsample 10:	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		Hydrocarbons (incl. extended screening)
		PCB
		Organotin compounds
		Separate Hg
		Total organic matter (TOM)
2/19/00	Sedimentsample 11	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Fine fraction < 63 micro meter
		PAH
		Separate Hg
2/22/00	Paint sample	Organotin compounds
		PCB
		Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Separate Hg
2/21/00	Oil sludge sample	Hydrocarbons (incl. extended screening)
		Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Separate Hg
2/21/00	Sample from bottom of oil tank (on yard)	Hydrocarbons (incl. extended screening)
		Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		Separate Hg
2/22/00	Soil sample 1	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		PCB
		Organotin compounds
		Separate Hg
2/22/00	Soil sample 2	Metals (Ni, Pb, Cr, Cu, Mn, Cd, Zn, Fe)
		PCB
		Organotin compounds
		Separate Hg
2/19/00	Water sample on yard (water sample 1 from stream)	Hydrocarbons (incl. extended screening)
2/21/00	Sea-surface water sample	Hydrocarbons (incl. extended screening)
2/22/00	Electrical cable	PCB

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APPENDIX

F

REPORT FROM LABORATORY

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