Scoping, Framework and Process for the Development of a Regional Waste Management Strategy in the Inuvialuit Settlement Region

Submitted to: Beaufort Regional Environmental Assessment (BREA)

Submitted by: AMEC Environment & Infrastructure

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SCOPING, FRAMEWORK AND PROCESS FOR THE DEVELOPMENT OF A REGIONAL WASTE MANAGEMENT STRATETY IN THE INUVIALUIT SETTLEMENT REGION

Submitted to:

Beaufort Regional Environmental Assessment (BREA)
Waste Management Working Group
Calgary, Alberta

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TABLE OF CONTENTS

PAGE

TABLE OF CONTENTS (cont)

PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

1.1 Background Leading to This Study

Renewed interest in oil and gas exploration and development in the Mackenzie Delta / Beaufort Sea Region arose in 2004 with the Comprehensive Study of the Devon offshore drilling program, submission of the Mackenzie Gas Project environmental impact statement, and the subsequent beginning of the Joint Panel Review process. In June 2004, the Inuvialuit Game Council (IGC) sent a letter to the Minister of Environment requesting that a strategic regional environmental assessment be undertaken to prepare for oil and gas related activities in the Beaufort Sea offshore.

The Government of Canada responded by providing funds over two years for the development of a Beaufort Sea Strategic Regional Plan of Action (BSStRPA). BSStRPA identified issues and provided recommendations regarding various aspects of oil and gas exploration activity in the offshore and near-shore Beaufort Sea. The plan was finalized in April 2008.

Resources to implement BSStRPA recommendations and actions were generally not available to departments and agencies following the planning process. Subsequently, a series of meetings and a federal workshop were held to identify next steps, particularly requirements for, and potential means of, implementation. Ultimately, a Beaufort Basin Regional Environmental Assessment (BREA) was identified as the next step in implementing the BSStRPA recommendations. The Government of Canada announced funding to the department of Aboriginal Affairs and Northern Development Canada (AANDC) for the implementation of BREA in August 2010. Implementation is ongoing until 2015.

The BSStRPA Steering Committee and Inuvialuit Communities identified twenty-three issues, and provided thirty-two recommendations and fifty specific actions to address these issues. The issues and their associated recommendations and actions were grouped under three themes: Improving regulatory efficiency and effectiveness (Theme 1); Optimizing benefits and mitigating environmental, social/cultural impacts (Theme 2); and, Planning for uncertainty (Theme 3). A number of these recommendations and proposed actions were identified as priority issues from Inuvialuit communities and are being implemented under BREA.

In the planning document, Theme 1, Issue #1 was identified as “a need to improve environmental assessment and regulatory processes” and Recommendation # 1.4 under this heading was for the “Development of a regional waste management strategy” (BSStRPA 2008). Specifically, the recommended action originating from BSStRPA, and in the initial stages of being addressed here under BREA, was; “Federal and territorial departments with a waste management responsibility should continue to engage with the Inuvialuit and industry to develop a regional waste management strategy. The strategy, once developed, should be applied consistently by proponents and regulators. The work should be coordinated to refine existing documents such as the Environmental Studies Research Fund (ESRF) Waste Management Guidelines.”

1.2 Current Context

In the past, improper treatment and disposal of waste from oil and gas exploration and development (E&D) activities have had environmental and socio-economic consequences in the ISR and have resulted in impacts to local community waste management facilities. In addition, sumps containing exploration drilling wastes have left their mark on the natural landscape outside of communities. Existing waste management infrastructure and disposal opportunities in the region do not meet industrial needs and future onshore and offshore activities will exacerbate this problem.

During periods of operation, industrial activities (predominately oil and gas) in the Inuvialuit Settlement Region generate substantial quantities and varieties of waste, which are different from, but additional to existing community sources of waste. Reliance on community infrastructure for the disposal of materials from industrial sources is not a reasonable solution to waste management issues of the oil and gas sector, as these facilities are not designed, managed or licensed to accommodate industrial waste streams. However, it is inevitable that industry will rely to varying degrees on community infrastructure since there are currently no other waste management alternatives beyond total removal of waste from the region. As a result of these, and other issues, determining appropriate approaches to management of waste often represents one of the most challenging aspects of environmental assessment and regulatory reviews. Waste management issues may be dealt with more efficiently and effectively through the development of regional approaches, including the development of a Regional (Oil and Gas) Waste Management Strategy (RWMS). It is expected that a RWMS that is developed to help manage wastes from the growing oil and gas sector in the ISR would directly benefit the communities in the region as well. In this way, industry could be viewed as a partner in assisting the communities determine and address specific municipal needs, in addition to those required for industrial development.

1.3 This Study

Consultations and discussions undertaken first under BSStRPA and subsequently in the development of BREA consistently identified waste management as a priority issue to be addressed. A BREA Waste Management Working Group was formed early in the implementation of the initiative and a waste management work plan was subsequently developed. This report and the research and analysis leading up to its development mark the completion of Phase 1 of the work plan. More importantly, they represent the preliminary steps in the possible development of a RWMS in the ISR. With the acceptance of this report by the BREA Steering Committee, the current mandate of the Waste Management Working Group will be complete. Once the Steering Committee has reviewed and considered the report and framework, a decision may be made whether or not to proceed with further work in this area, up to and including the possible development of a Strategy.

1.4 Scope

The scope of work for this study included a range of undertakings to identify the appropriate components and key aspects of a RWMS. Specifically, the study:

- identified relevant examples of oil and gas related waste management strategies or similar regional initiatives focused on, but not necessarily limited to, Alaska, Norway, or other locations similar to the area of interest (i.e. northern and/or isolated, relatively undeveloped);
- identified and summarized reasons for the development of regional waste management strategies or initiatives in the chosen examples, highlighted benefits to clients and stakeholders, and identified positive outcomes and challenges experienced;
- identified the current context for oil and gas waste management in the ISR. This included aspects of organizational roles and responsibilities with respect to waste management planning, program development and delivery, development and application of policy and standards, and existing regulations and enforcement;
- identified potential clients and stakeholders for a RWMS in the ISR;
- identified a step by step process to gather information, identify issues, develop and reach consensus on a RWMS in the area; and
- developed a conceptual Framework for a RWMS for current and future oil and gas exploration and development activity in the ISR based on the analysis and the project related scope of work.

The study was based on an internet search of oil and gas related waste management practices in the ISR and NWT, and the review of waste management practices in reference jurisdictions.

1.5 Objectives

The objectives of this work were to: produce a conceptual framework for a RWMS for the ISR; identify a draft process to develop a functional RWMS; and provide background and contextual information from an international, national and, most importantly, a regional perspective to assist in delivering a RWMS in the event it is decided to proceed with such an initiative.

2.0 CONTEXT OF OIL AND GAS WASTE MANAGEMENT IN THE ISR

Oil and gas waste management requirements in the region are addressed in federal, territorial and Inuvialuit Final Agreement (IFA) legislation, guidelines and environmental assessment and regulatory processes. Rights to petroleum (oil or gas) resources in the Northwest Territories are governed by the *Canada Petroleum Resources Act*, R.S.C. 1985, c. 36 (2nd Supp.) (*CPRA*). The CPRA licensing regime north of 60º is administered by the Department of Aboriginal Affairs and Northern Development Canada (AANDC or Minister). Table 2-1 summarizes relevant federal, territorial and land claim (IFA) related oil and gas waste management regulations, standards and codes of practice.

Table 2-1: Summary of NWT Waste Management Best Practices

Jurisdiction	Governing Body	Applicable Regulatory and Industry Documents
Government of the Northwest Territories	Department of Environment and Natural Resources	Under authority of the NWT *Environmental Protection Act* (EPA), ENR supports its following Guidelines for use by the Oil and Gas sector: • Guideline for the General Management of Hazardous Waste in the NWT, February 1998 [1]Environmental Guideline for Contaminated Site Remediation, November 2003
IFA / ISR	Northwest Territories Water Board	Under the *Northwest Territories Waters Act* the Northwest Territories Water Board has the responsibility for licensing water use and waste disposal in the Inuvialuit Settlement Region (ISR) of the Northwest Territories. Undertakings that require large amounts of water and produce discharges of waste have the potential to impact the environmental quality, and are thus, of concern to the Board. The Board supports the use of the following guidelines: • Discharge of Treated Municipal Wastewater (1992) • Drilling-Waste Disposal Sumps (2005) • Spill Contingency Planning (2007) • Mine Site Reclamation (2007) • Waste Management (to be approved by Board)
		Oil and Gas Approvals in the Northwest Territories – Inuvialuit Settlement Region: A Guide to Regulatory Approval Processes for Oil and Natural Gas Exploration and Production in the Inuvialuit Settlement Region (2001)
		Protocol for the Monitoring of Drilling-Waste Disposal Sumps. Inuvialuit Settlement Region Northwest Territories; Northwest Territories Water Board, October 2005
		Guidelines and Strategies for Oily Waste Management in Arctic Regions, Joint Secretariat Inuvialuit Renewable Resources Committees, March 2008
		Drilling Waste Management Recommended Best Practices, Ellis & Associates Inc., March 2004 Sponsored by ESRF

[1] GNWT-ENR) *Environmental Guideline for Contaminated Site Remediation, November 2003*, is devised for use of remediation of contamination on Commissioner's Land (including private land within municipalities) in the NWT. It has historically been used outside these boundaries in select cases where applicable federal parameters are lacking or less stringent.

Jurisdiction	Governing Body	Applicable Regulatory and Industry Documents
Government of Canada	National Energy Board	Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands, National Energy Board, Canada-Newfoundland and Labrador Offshore Petroleum Board, April 2009
		Offshore Waste Treatment Guidelines (NEB et al. 2002)
		Northern Land Use Guidelines Camp and Support Facilities, Indian and Northern Affairs Canada, March 2011
	Environmental Studies Research Fund (ESRF)	Cuttings Treatment Technology Evaluation, Jacques Whitford Stantec Limited, July 2009 Environmental Studies Research Fund Report No. 166
		Drilling Waste in the Mackenzie Delta (Inuvialuit Settlement Region) Region (Edition 1); Drilling Waste Recommended Best Management Practices (March 2004)

2.1 Federal Context

The *National Energy Board Filing Requirements for Offshore Drilling in the Canadian Arctic* (Filing Requirements) specify the information to be submitted to the National Energy Board (NEB or Board) in support of an application for an authorization for offshore drilling activities. The Filing Requirements are intended to provide clarity regarding the NEB's expectations for the information to be filed with an application. The applicant must demonstrate to the Board that it has complied with applicable legislation and regulatory requirements. The Filing Requirements should be read in association with the *Canada Oil and Gas Operations Act* (COGOA) and its regulations, particularly the *Canada Oil and Gas Drilling and Production Regulations and Guidelines* issued by the NEB regarding these regulations.

The NEB regulates oil and gas exploration and production activities, including the drilling of offshore wells in the Canadian Arctic, under the COGOA and its regulations[1]. The purpose of the COGOA, among other things, is to promote safety, protection of the environment, and the conservation of oil and gas resources. Land tenure or rights issuance, benefits plans, and royalty management are administered by the Department of Aboriginal Affairs and Northern Development Canada. Relevant regulations include:

- Canada Oil and Gas Drilling and Production Regulations;
- Canada Oil and Gas Installation Regulations;
- Canada Oil and Gas Certificate of Fitness Regulations;
- Canada Oil and Gas Operations Regulations; and
- Oil and Gas Spills and Debris Liability Regulations.

Additional Well Approvals would also be required under the *Canada Oil and Gas Drilling and Production Regulations* for drilling or changing the condition of a well, formation flow test, and co-mingling of multiple reservoir zones. Finally, the applicant would need to comply with all acts and regulations applicable to the Canadian Arctic offshore. Such acts include, but are not limited to: *Arctic Waters Pollution Prevention Act*; *Canada Shipping Act*; *Fisheries Act*; *Canadian Environmental Protection Act*; and the *Oceans Act.*

2.1.1 Environmental Assessment

Under the new *Canadian Environmental Assessment Act* (CEAA 2012), the NEB is given the authority to issue offshore approvals to drill exploration or production wells. As part of its environmental protection responsibilities, the NEB must ensure that an environmental assessment (EA) is conducted for proposed activities in the Canadian Arctic offshore. The NEB coordinates EAs with Northern boards and agencies for proposed oil and gas projects. The proposed project location determines which process is used in conducting the assessment. The EA typically starts well in advance of an offshore drilling application being submitted. An EA must be completed before a COGOA authorization can be granted.

EA is required under federal legislation such as the *Canadian Environmental Assessment Act* (CEAA 2012), and the *Inuvialuit Final Agreement* (IFA) section 11, and must be completed for exploratory or development projects that require an NEB authorization under paragraph 5(1)(*b*) of the COGOA. For drilling projects that require a COGOA authorization from the NEB, the applicant must submit an Environmental Protection Plan (EPP) which includes management of waste. The applicant must also submit a Safety Plan and a Contingency Plan which includes emergency response procedures. The NEB will expect the applicant to agree to make those plans public.

2.1.2 NEB Related Guidelines

The NEB oversees the following guidelines to aid operators in the management of waste material discharged to the natural environment from offshore drilling and production installations:

- The Offshore Waste Treatment Guidelines (that supplement a required Environmental Protection Plan).
- The Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands.

Offshore operators are expected to take all reasonable measures to minimize the volumes of waste materials generated by their operations, and to minimize the quantity of substances of potential environmental concern contained within these waste materials. No substance should be discharged unless the Board has determined that the discharge is acceptable.

In addition to demonstrating compliance with the above noted guidelines a proponent wishing to undertake an offshore exploration or production drilling activity must provide an Environmental Protection Plan that includes a Waste Management Plan. These plans should provide the following information:

1. Description of the planned discharges, the limits of these discharges (i.e. discharge criteria for contaminants of concern), and, for waste discharges, the equipment and procedures for treatment, handling, and disposal of waste material. This may be described as part of the EPP or in a separate Waste Management Plan (WMP).

2. Identification of the limits (i.e. criteria) for any waste material and reference to any guidance or standards that were used to establish those limits.
3. Description of the system for monitoring compliance with the limits for discharges (i.e. criteria) to the environment of any waste materials identified in the EPP or WMP, including the sampling and analytical program to quantify that compliance. The sampling and analytical program must form part of the EPP or WMP, or alternatively the EPP or WMP may summarize and reference a separate document commonly known as an Environmental Compliance Monitoring Plan.
4. Description of the arrangement for monitoring compliance with waste management under the EPP, or as part of a WMP, and details for measuring performance in relation to its objectives.
5. Description of the procedures for the systematic observation and reporting of sheens, or presence of oil, on ice near the installation, including the estimation of the areal dimensions and temporal persistence of each, and the tentative identification of the discharge with which it is associated.
6. Details of incident reporting procedures, including reporting any exceedance of limits described in the EPP or WMP.
7. Description of any agreements or arrangements for disposal of waste material associated with drilling activities.
8. Identification of any best practices and technologies available for the wastes anticipated for the project and the rationale for selection.
9. Demonstrate that the waste management process described was developed with reference to the *Offshore Waste Treatment Guidelines*.

2.2 Inuvialuit Settlement Region

The *Canada Oil and Gas Drilling and Production Regulation* does not apply to subsurface resources owned by Inuvialuit under the IFA. The grant of interests in oil and gas on lands owned by Inuvialuit is governed by the terms of the settlement agreement. The Inuvialuit Final Agreement applies throughout the Inuvialuit Settlement Region and defines ownership by the Inuvialuit Land Corporation (ILC) of the surface and subsurface rights to 13,000 km^2 (referred to as 7(1)(a) lands) and the surface rights alone to 78,000 km^2 (referred to as 7(1)(b) lands). The Crown retains ownership over 80 percent of the land in the ISR.

Proposed development projects that occur in the Inuvialuit Settlement Region require environmental screening or review under the *Inuvialuit Final Agreement*. An environmental screening is conducted by the Environmental Impact Screening Committee (EISC). Projects may be referred to the Environmental Impact Review Board (EIRB) which carries out environmental impact assessments and public reviews. Proponents should provide the same information to the NEB and EISC or EIRB so that conclusions are based on the review of consistent information.

Typically, during the EISC or EIRB processes there is extensive consultation that ensures local perspectives and issues are identified. The IFA addresses the prevention of loss or damage to wildlife and habitat and subsequent compensation if there is loss in terms of harvesting opportunities.

The IFA requires the NEB to wait for an EISC or EIRB decision before issuing any regulatory authorization. The NEB considers the recommendations before it can decide, on the basis of environmental impact considerations, whether or not the development should proceed and, if so, on what terms and conditions, including any necessary mitigation measures.

2.3 GNWT ENR Waste Management Acts and Regulations

GNWT has authority, through the Department of Environment and Natural Resources (ENR), to manage environmental issues including disposal of wastes, contingency planning, spills, and air quality. This authority is derived from the NWT *Environmental Protection Act* (EPA). ENR applies its authority on lands where the GNWT has administrative control; these are referred to as Commissioner's Lands (essentially communities and highways). The waste related ENR regulations, guidelines, and other guidance documents summarized in Table 2-2 have been drafted to enable environmental management on these lands. In the ISR such administrative responsibility includes the Inuvik and Tuktoyaktuk community landfills. The vast majority of development activity in the NWT is large scale industrial undertakings on federal lands, which in a pre-devolution setting, constitutes 95% of the NWT land mass. It is anticipated that recent devolution agreements between the Federal authorities and GNWT may involve the modification of this current regulatory framework.

Table 2-2: Summary of GNWT Community Waste Management Best Practices

Government of the Northwest Territories	Department of Municipal and Community Affairs	Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories (2003)
	Department of Environment and Natural Resources	Guideline for the Management of Waste Antifreeze, September 1998
		Guideline for the Management of Waste Asbestos, April 2004
		Guideline for the Management of Waste Batteries, September 1998
		Guideline for Industrial Waste Discharges in the NWT, April 2004
		Guideline for the Management of Waste Paint
		Environmental Guideline for Contaminated Site Remediation, November 2003
		Guideline for the Management of Waste Solvents, September 1998
		Used Oil and Waste Fuel Management Regulations (GNWT 2003)

2.3.1 Community Solid Waste

Community solid waste is managed under the jurisdiction of the Department of Municipal and Community Affairs (MACA). MACA, in 2003 developed “Guidelines for the Planning, Design, Operations and Maintenance of Modified Solid Waste Sites in the Northwest Territories”. These guidelines outline the planning, design, operation and maintenance of community waste management facilities and landfills. The Guidelines are intended to provide protection of groundwater, surface water and to have proper management of nuisances associated with the landfill operations. These Guidelines are developed to satisfy the requirements of the Northwest Territories *Public Health Act* and are used as reference for the regulatory agencies, designers, owners and operators of solid waste facilities.

2.4 ISR Existing Landfills

Tuktoyaktuk and Inuvik are the largest communities in the ISR and each have landfills that historically have been utilized for waste disposal by oil and gas exploration companies. An overview for each landfill as presented in CAPP (2009) is provided in the following paragraphs.

2.4.1 Inuvik Landfill

The Inuvik landfill is operated by the Town of Inuvik and is open 7 days a week. All loads must be tarped or covered when being transported to the landfill. Tipping fees vary depending on the size of the load. The landfill is located on permafrost with no liner. It is covered and compacted in the summer to protect the permafrost. Due to the absence of a liner, operators must assess their own risk tolerance when disposing of waste at this facility. The landfill accepts community waste, asbestos and small amounts of hydrocarbons. The contaminated soils are land farmed and require an analysis prior to being accepted. Batteries and steel are collected for recycling in the south. White goods are collected and the Freon is removed from the inventory every two years.

2.4.2 Tuktoyaktuk Landfill

A landfill exists in Tuktoyaktuk to serve the domestic needs of local citizens and business. This landfill is not constructed to modern specifications and is not suitable for receiving oil and gas wastes.

2.5 Northwest Territories Waters Act

The Northwest Territories Water Board (NWTWB or the Board) was established in 1972 to issue water licences as outlined in the *Northwest Territories Waters Act*. Since the creation of the Nunavut Settlement Area and the implementation of the *Mackenzie Valley Resource Management Act* (MVRMA) the Board’s geographical area of jurisdiction is limited to the Inuvialuit Settlement Region.

The *Northwest Territories Waters Act* grants the Board the responsibility for licensing water use and waste disposal in the Inuvialuit Settlement Region. Undertakings that require large amounts of water and produce discharges of waste have the potential to impact environmental quality, and are thus, of concern to the Board.

The Board recommends use of the following guidelines to assist applicants in providing all the information required in the licensing process and also assist licensees with reporting requirements. Applicants and licensees who make reasonable efforts to use these guidelines should find that the processing of applications and reports for water licences is accomplished rapidly and with few difficulties.

- Discharge of Treated Municipal Wastewater (1992);
- Drilling-Waste Disposal Sumps (2005);
- Spill Contingency Planning (2007);
- Mine Site Reclamation (2007); and
- Waste Management (to be approved by Board).

2.6 Oil and Gas Waste Management Practices

As noted in the Canadian Association of Petroleum Producers Guide for Oilfield Waste Management in the Northwest Territories, December 2009 (CAPP 2009) a number of generic factors influence oil and gas exploration and development activities in the Northwest Territories. These are summarized in Table 2-3.

Table 2-3: Factors that Can Influence Oil and Gas Exploration and Development

Factor	Influence on Oil and Gas Activities
Land Area and Limited Population	Low population size and limited industrial development limit the development of advanced waste management facilities capable of treating oilfield waste, and the size of the territory creates long shipping distances and related transportation safety issues and challenges. It is noted that there are currently no commercial oil and gas industry waste management treatment and disposal facilities or operations in the NWT, including the ISR.
Transportation Limitations	The transportation of oil and gas wastes occurs primarily by transport truck, barge or a combination of these modes. The road system in the NWT is not extensive which creates many challenges for operators, including winter only access and long travel / shipping distances.
Seasonal Influence	Oil and gas wastes generated from oil and gas operations in remote areas (e.g. Mackenzie Delta, Central Mackenzie Valley) during summer months or where logistics issues prevent shipment may need to be stored on-site, or at pre-arranged location, for the duration of the spring, summer and fall because of the reliance on winter roads. In the Northwest Territories, out of necessity, wastes may need to be stored for long periods.
Waste Treatment and Disposal	There are presently no commercial oil and gas waste treatment or disposal facilities in the Gwich'in Settlement Area (GSA), Sahtu Settlement Area (SSA) or ISR. Exploration and development companies must make arrangements to transport hazardous and other industrial waste to locations in southern Canada for final treatment and disposal.

Due to the varying regulatory bodies in the ISR that have some interest in waste management in the region (Federal, Territorial, ISR), interpretation and implementation of the regulatory requirements can be daunting and pose uncertainties to operators. Gaining alignment of the regulatory requirements into one set of standardized guidelines for the region would be beneficial to industrial companies looking to gain certainty in the requirements, and thus in their developments. However, it is recognized with the process of devolution occurring at present, and with the rights of the Inuvialuit in their settlement region, this is a task that is not likely to be complete in the near term. It should, nevertheless, be considered as a recommendation in the development of the RWMS.

3.0 REFERENCE JURISDICTIONS

A review of reference jurisdictions agreed to by the BREA Waste Management Working Group follows. The intention is to provide examples of oil and gas waste management strategies or similar regional initiatives that would help shape the development of a framework for a potential RWMS in the ISR.

The three selected reference jurisdictions were Alaska North Slope, Norway and Newfoundland.

Alaska and Norway were selected for the similarities of their northern climates and isolation of their oil and gas fields. Canada's east coast and Newfoundland were considered representative due to their relative isolation. In addition, these areas were seen as important to this study because a number of key pieces of legislation and guidelines applicable to offshore oil and gas activities were developed in these jurisdictions. The province of Alberta was added as a reference jurisdiction, due to the established oil and gas sector, and associated support areas such as waste management and regulatory direction.

3.1 Screening Parameters and Indicators

The review of other jurisdictions was an internet based search using key words such as those listed in the following:

- Regional waste studies;
- Regulatory requirements;
- Regional waste strategy;
- Regional oil and gas exploration and production waste management best practices;
- Oil and gas waste management best practices;
- Exploration and production waste management strategies;
- Exploration and production waste management plans;
- Exploration and production waste management technologies (onshore and offshore);
- Exploration and production waste treatment and disposal strategies; and
- Exploration and production waste management treatment and disposal options.

The research results show:

1. Each of the reference jurisdictions has well documented information from industry and regulators that reflects the advanced nature of their exploration and production (E&P) related waste management practices.
2. Limited if any E&P "waste only" regional management approaches; instead identified requirements for E&P waste management were commonly integrated within municipal and/or regional planning studies or waste specific actions developed by oil and gas industry associations (e.g. reserve pits in Alaska).

3. That the concept of “regional” as an aspect of oil and gas activities was most often defined by the exploration and development operating area (e.g. North Slope of Alaska, Norwegian Continental Shelf which are further broken down by distinct production operating units).
4. That waste management practices adopted by the oil and gas industry were developed in response to “key regulatory decisions” enacted by regulators in response to environmental issues occurring as a result of poor or failed waste management operating practices (e.g. restrictions of oil based drilling fluids in the North Sea and other offshore operating areas of the world, including the east coast of Canada).

Key factors identified for each of the reference jurisdictions are summarized in the following.

Alaska/North Slope

- Public concern regarding oil and gas activity in sensitive terrain is high and there are non-government-organizations (NGO’s) who actively lobby to protect and prevent oil and gas development in sensitive environments of the north slope, especially in the Arctic National Wildlife Refuge (ANWR).
- Mid 1980’s Promulgation of Alaska Department of Environmental Conservation (ADEC) solid waste regulations put drilling waste management disposal practices and reserve pit closure standards under a new regulatory program.

Norway

- Active role by the government of Norway in the E&P program (e.g. Statoil a prominent Norwegian government owned oil and gas company); and the recognition that a cooperative attitude and participation with the private sector was important to advance innovative operating practices.
- The active role of The Oil Spill Prevention Administration and Response (OSPAR) which has been a critical force in ensuring the effective and consistent application of environmental practices in the development of the North Sea E&P activities.
    - ❑ The OSPAR Convention is the current legal instrument guiding international cooperation on the protection of the marine environment of the North-East Atlantic. Work under the Convention is managed by the OSPAR Commission, made up of representatives of the Governments of 15 Contracting Parties and the European Commission, representing the European Union.
    - ❑ OSPAR Decision 2000/3 came into effect on 16 January 2001 and effectively eliminated the discharge of cuttings contaminated with oil based fluids (OBF) (includes Oil-based muds (OBM) and Synthetic-based muds (SBM) greater than 1% by weight on dry cuttings).

Canada/Newfoundland

- The timing of development on Canada's east coast was advantageous in that the E&P industry had adopted improved operating practices that could be applied in Canada. Key to success on the east coast has been an active regulatory authority and an E&P industry that has proven practices and success from other operating areas.

Canada/Alberta

- Alberta has a well-established oil and gas industry that has been developed over 100 years. Due to the significance of the sector in Alberta, a number of waste management facilities of varying technologies have been installed throughout the province near areas of high activity by the private sector and by the energy companies themselves.
- Waste management in Alberta is informed by a number of Directives issued by the regulator (Alberta Energy Regulator).

3.2 Alaska North Slope

The Alaska North Slope oil and gas development area, covering about 89,000 square miles of federal, state, and native land holdings, is the geographical region of Arctic Alaska north of the Brooks Range, extending from the Canadian border on the east to the Chukchi Sea on the west. This region includes the Arctic National Wildlife Refuge (ANWR), the Central Arctic (between the Colville and Canning rivers), the National Petroleum Reserve Alaska (NPRA), the Beaufort Sea Outer Continental Shelf (OCS), and the Chukchi Sea OCS areas. This area is also recognized as the North Slope Borough.

Currently, most oil production on the North Slope takes place on state lands in the general vicinity of Prudhoe Bay. In 1977, the Prudhoe Bay field's working interest owners organized to form the Prudhoe Bay Unit (PBU). The PBU is approximately 385 square miles in size and comprised of an Eastern Operating Area (EOA) and a Western Operating Area (WOA). The EOA is 192 square miles in size and the WOA is 193 square miles. Within the EOA is an area of approximately six square miles of land, that encompass the Deadhorse lease tracts, including the Deadhorse Airport, the North Slope Borough's Oxbow Landfill, and properties of oil industry support contractors.

The state and the federal government are jointly responsible for regulating oil production in the area, described as follows:

- **Federal:** US EPA, National Oceanic and Administration (NOAA); U.S. Dept of Interior, Bureau of Land Management; U.S. Fish and Wildlife Service;
- **State:** Alaska Department of Environmental Conservation (ADEC); Alaska Oil and Gas Conservation Commission (AOGCC); Alaska Department of Natural Resources (ADNR);
- **Local:** North Slope Borough (NSB).

For this study the PBU represents the “regional area” where the E&P waste management issues arose and in turn where the response strategies and practices adopted and summarized for the North Slope originated. Search results identified waste management regulations and practices for specific topics such as reserve pits (sumps), drill cuttings, fluids and produced water, production and chemical wastes within the “regional operating area” of the North Slope. The practices adopted by industry in response to regulatory requirements set the minimum standards for E&P operations onshore and are being further refined for planned offshore activities. In addition, the data also show that the prohibitive cost of waste transport to approved treatment and disposal locations in the south and the environmental and cultural sensitivities of the North Slope have also had significant influences on the adoption of waste reduction and the development of industry managed waste treatment and disposal facilities.

3.2.1 Regional Strategies and/or Initiatives

Regional strategies now being applied on the North Slope reflect the development and adoption by industry, state and local regulators of waste management practices developed over the forty plus years of exploration and production activities. These practices and procedures are applied from the initial licensing of the activity through to the day-to-day operations. These practices have been developed to accommodate the remoteness and environmental sensitivity of the region and the specific physical and chemical characteristics of the waste materials. State licensing approvals issued as a public document titled a “Best Interest Findings” report, summarize the full scope of planning and operational requirements with specific details of accepted practices including waste management for the pending development.

3.2.2 Best Interest Findings (BIF)

A state requirement of any decision on the sale and/or leasing or disposition of state land for an E&P development is a public review of the proposed activity and the release of a written finding from Alaska Department of Natural Resources (ADNR) that demonstrates the proposed development is in the state's best interests. The written finding, known as a "Best Interest Finding," considers and discusses certain topics required by law, such as the reasonably foreseeable effects of the disposal on the area's fish and wildlife, historic and cultural resources, and communities, responses to comments received from the public review and actions in response to applicable laws and regulations. A document produced by the Alaska Department of Natural Resources (2011) provides an example of a BIF report that identifies the full scope of industry requirements and the “minimum” waste management requirements for the proposed development. The specific requirements of industry waste management “best practices” to be utilized by the development are presented in Appendix A.

3.2.3 North Slope Borough Comprehensive Plan

The above noted Best Interest Findings report summary also included the following specific commentary regarding the authorities of the North Slope Borough (NSB) over any development activities:

"The NSB has adopted a comprehensive plan and land management regulations under Title 29 of the Alaska Statutes (AS 29.40.020-040). These regulations are Title 19 of the NSB Municipal Code and require borough approval for certain activities necessary for exploration and development of oil and gas leases. These activities include construction of facilities, placement of gravel pads, use of explosive devices and tundra travel. The NSB may assert its land management powers to the fullest extent permissible under law to address any outstanding concerns regarding impacts to the area's fish and wildlife species, habitat, and subsistence activities. The NSB also established a Traditional Land Use Inventory (TLUI). The TLUI data sets are restricted access documents and specific site location data should not appear in final reports or distributed to others (NSB 2011, Dale 2011). The NSB also advises that for any earth-moving activity, ice road, or seismic survey that a Certificate of Inupiat History, Language and Culture/Traditional Land Use Inventory (IHLC/TLUI) Clearance from the NSB Planning Department may be required."

A review of the NSB comprehensive plan identifies the expectations of the NSB of any development and the need to ensure to preserve and strengthen the opportunity of the residents to continue in subsistence living and the Inupiaq character of life in the face of petroleum development within the Borough. This plan is written for the NSB, a community in which the Inupiat people and the lnupiaq character of life predominate. Consequently this plan is absolutely unique. While attempts have been made to reflect and accommodate state and national interests, the plan has been designed for the values and circumstances of the people of the NSB.

The NSB recognizes that their "Comprehensive Plan", including text, data, and maps, represents a key governmental instrument for land use planning and regulation, and the development activities of local, state and federal agencies. The Comprehensive Plan provides for the conservation and preservation of the Inupiaq character of life and also for the systematic and orderly development of the communities and the various natural resources of the Borough. The plan also includes details of the NSB landfill and incinerator and recognizes the economic benefits of controlled usage of these facilities by the E&P industry as outlined in industry planning documents and as noted in the following section.

3.2.4 Summary

Best management practices on the Alaska North Slope have been influenced by decisions of state regulators and US federal agencies in the late 1980's to address environmental contamination issues associated with exploration and development activities. Specifically, initiatives adopted to address contamination from drilling sumps and poor drilling waste disposal practices led to improvements in drilling waste (liquids and solids), produced water, oil contaminated solids (e.g. soils, tank bottoms), other wastes (e.g. chemicals) and domestic wastes associated with camps and associated support facilities. Exploration and production best management practices include practices for onshore and offshore activities summarized as follows:

- sumps are prohibited;
- drilling fluids are recovered and reused;

- drilling solids/cuttings are disposed of to injection wells;
- produced waters are treated for reuse and/or release to surface water or used for enhanced oil recovery (Class III injection wells);
- domestic organic wastes are treated with an approved incinerator at the point of generation with non-burnable wastes and incinerator ash transported to the landfill at the Northshore Borrow municipal landfill;
- oily waste and contaminated soils are incinerated at company facilities or the Northshore Borrow incinerator;
- oily fluids are recovered and injected into the product pipeline with other fluids injected in downhole systems;
- hazardous wastes are collected and shipped south for approved disposal at lower 48 facilities; and
- recyclables are transported to depots in southern Alaska for processing.

Industry has responded to the above requirements with training for all personnel and the uniform usage of *The Alaska North Waste Reuse and Disposal Guide*. The guide outlines the accepted management practices for all liquid, solids and semi-solid wastes produced as a result of North Slope exploration and development activities (Appendix A).

3.3 Norway

Oil and gas exploration and development is the largest industry in Norway with all extraction of resources in the approximately 50 offshore fields. There are no onshore oil and gas production activities, only refining and industry support infrastructure. The majority of the oil and gas extraction activities take place in shallow waters (up to 300 meters depth) within the Norway Continental Shelf (NCS) and only few extractions are done in deep water (300 – 1,500 m depth) although there is significant effort underway to develop the more deep water resources e.g. Barents Sea.

3.3.1 Regulatory Summary

Authorities that oversee offshore oil and gas activities include: Norway Climate and Pollution Agency (KLIF); Directorate for Nature Management (DN); Directorate for Cultural Heritage (RA); Norwegian Polar Research Institute (NP); Norwegian Mapping Authority. Each of these works with a local Environment Unit office in 434 municipalities in Norway to oversee industrial environmental enforcement initiatives including onshore associated oil and gas activities.

The Pollution Control Act (1981) and Pollution Control Regulation of 2004 provides primary regulation and enforcement of industrial activities including oil and gas exploration and development. Prime responsibility for these activities lies with KLIF that oversees and approves operations through the evaluation of development applications (Environmental Impact Assessments (EIA's), screening and approval of discharge to sea, emissions to air, the use and discharge of chemicals and establishing waste management requirements.

The Pollution Control Regulation of 2004 was instrumental in:

- banning incineration at sea;
- banning and/or regulated waste discharge or dumping of materials and waste into Norwegian waters; and
- establishing permitting requirements for industry and waste treatment technologies.

All the different regulations concerning waste and waste handling are gathered in one big regulation called “Avfallsforskriften”/Waste regulation.

Waste Regulation (Avfallsforskriften, 2004)	The Waste Regulation contains 14 chapters, and regulates explicitly different waste categories such as: • Waste electrical and electronic equipment (EE equipment). • Handling of discarded refrigeration equipment containing CFCs. • Batteries which are hazardous to the environment. • End-of-life vehicles. • Collection and recycling of discarded tires. • Take-back systems for beverage packaging. • Refund of taxes paid on trichloroethylene TRI, and hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) • Landfilling of waste. • Incineration of waste. • Hazardous waste. • Permits for trans-frontier shipment of waste. • Discarded insulating glass units containing PCBs.

3.3.2 Regulation of Offshore Discharges

The most significant offshore discharges from the petroleum industry are chemical discharges from wells and well operations, and discharges of oil and naturally occurring chemical substances from produced water. Sea discharges are regulated by discharge permits from the Norwegian Pollution Control Authority (NPCA), based on the provisions of the *Pollution Act*. Active research and development of chemicals with no negative environmental impact is being carried out to reduce chemical discharges. New cleaning technologies to reduce the content of oil and naturally occurring chemical substances in produced water that is discharged to the sea

are being developed. At several fields, produced water is re-injected into the reservoirs to avoid discharges. The authorities have established a strategy that has been defined by the so-called zero discharge targets, to achieve reduction of discharges to the sea. As of now, in principle, no environmentally hazardous substances shall be discharged, nor shall there be any discharge, or discharge shall be minimized, of environmentally harmful substances.

Norway is signatory, in accordance with its *Pollution Control Act* (March 1981, No. 6), to Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues. This directive enhances the availability and use of port reception facilities for ship-generated waste and cargo residues. The objective is to protect the external environment by ensuring the establishment and operation of adequate reception facilities for ship-generated waste and cargo residues, and by ensuring delivery of ship-generated waste and cargo residues to port reception facilities. These facilities are licensed by the local County Governor under permitting requirements of KLIF. The port operator provides annual reporting on the wastes managed at their receiving facilities with details about the port reception facilities, including their location, capacity and available equipment, as well as other relevant matters.

3.3.3 Waste Management Initiatives

All pollution is prohibited. At this stage in its exploration and production cycle of its oil and gas fields and with its close alignment with the European Union, Norway's waste management strategy is focused on waste minimization and reduction. All of its oil and gas operations are closely monitored by its Climate and Pollution Agency (KLIF) and companies must report annually on waste volumes and types generated and disposed of, chemical usage and disposal, and track energy consumption as CO_2 production (they pay $46 US/tonne tax to the government) for all activities including their waste management program. These requirements dictate all exploration and development practices and close attention to their environmental and waste management planning and undertakings. They may be allowed to discharge certain wastes and emissions with approval following application to the Norway Pollution Control Authority (SFT). Applications must be accompanied with a risk assessment and a compliance monitoring program for the waste discharges and emissions anticipated from any planned exploration or production program. Norway also follows on with a "polluter pays" principle inherent in its screening and approval of oil and gas activities. This is based upon the documentation provided by the company with its application and information gathered from a regional emissions and discharges monitoring program in place for Norway's offshore oil and gas development area.

Norway and other North Sea operators are now addressing the environmental liability issues as the industry looks to the abandonment and removal of offshore platforms and production facilities. When fields are closed down and decommissioned, the installations in principle are to be sent onshore, according to international regulations. A report of the Norwegian Oil and Gas Association (OLF), May 2002, provides a summary of these issues and outlines how the industry is approaching its responsibilities (Appendix B).

3.3.4 Summary

Norwegian based E&P companies, through the Norwegian Oil and Gas Association, have responded to the environmental sensitivities and regulatory requirements of operations in the Norway Continental Shelf. Specifically, in conjunction with KLIF they have developed standards that dictate operating practices and waste management practices and procedures.

The NORSOK standards are similar to documents prepared by the Canadian Standards Association (CSA). They consolidate industry best practices and provide guidance materials intended to achieve the implementation of procedures and the adoption of technology to minimize adverse impacts of industrial operations on the environment. They advocate cost effective technical and/or operational solutions, based on the principle of BAT and life cycle cost analyses and have materials relevant to this study as follows:

NORSOK standard S-003 Environmental Care Rev. 3, December 2005 (Appendix B in this document):

This NORSOK standard is a guideline that applies to field development, design, construction, installation, modification and decommissioning of installations for offshore drilling, production and transportation of petroleum. This standard includes criteria and methods for establishing limitations for emissions to air, discharges to sea, for selection and handling of chemicals and for waste management.

3.4 Canada East Coast

Newfoundland and Labrador exploration and development has been selected as the reference jurisdiction for Canada's east coast.

3.4.1 Overview of Oil and Gas

Newfoundland and Labrador produces about 270,000 barrels of crude oil per day representing 10 percent of Canada's total crude oil production. There is currently no natural gas production in the province. There are three producing offshore oil projects: Hibernia, Terra Nova and White Rose. Exploration for and development of petroleum resources in these frontier areas of Canada is regulated by three *Acts* of the Federal parliament:

- Canada Oil and Gas Operations Act, R.S.C. 1985, c. O-7;
- Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act, S.C. 1988, c. 28; and
- Canada-Newfoundland Atlantic Accord Implementation Act, R.S.C. 1985, c. O-7.

Each jurisdiction has its own *Drilling and Production Regulations,* as published in *Canada Gazette II,* on 9 December 2009:

- Newfoundland Offshore Petroleum Drilling and Production Regulations;
- Nova Scotia Offshore Petroleum Drilling and Production Regulations; and
- Canada Oil and Gas Drilling and Production Regulations.

The Regulations stipulate the environmental protection requirements that also address waste management practices to be included in an application for authorization to conduct work or activities related to drilling or production operations as described below.

The National Energy Board, Canada-Nova Scotia Offshore Petroleum Board and Canada-Newfoundland and Labrador Offshore Petroleum Board (the Boards) have issued guidelines to assist operators in developing Environmental Protection Plans (EPP) to meet the requirements of sections 6 and 9 of the *Drilling and Production Regulations* (Regulations). The environmental protection plan shall set out the procedures, practices, resources, and monitoring necessary to manage hazards to, and protect the environment from, the proposed work or activity and shall include:

- a summary of and references to the management system that demonstrate how it will be applied to the proposed work or activity and how the duties set out in these Regulations with regard to environmental protection will be fulfilled;
- the procedures for the selection, evaluation and use of chemical substances including process chemicals and drilling fluid ingredients;
- a description of equipment and procedures for the treatment, handling and disposal of waste material;
- a description of all discharge streams and limits for any discharge into the natural environment including any waste material;
- a description of the system for monitoring compliance with the discharge limits identified, including the sampling and analytical program to determine if those discharges are within the specified limits; and
- a description of the arrangements for monitoring compliance with the plan and for measuring performance in relation to its objectives.

3.4.2 Selection and Use of Chemical Substances

The EPP shall summarize and refer to the process for the selection, evaluation and use of chemical substances including process chemicals and drilling fluid ingredients in accordance with the *Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands* 25 (OCSG).

3.4.3 Offshore Waste Treatment Guidelines (OWTG), 2010

The Offshore Waste Treatment Guidelines (OWTG), 2010 edition, outline recommended practices for the management of waste materials by operators of petroleum drilling and production operations in Canada's offshore areas. The waste materials discussed in these guidelines include effluents, emissions, and solid wastes normally associated with the operation of installations engaged in petroleum drilling and production activities.

The OWTG version of December 2010 provides performance targets for best management practices (BMPs) for concentrations of waste materials to be discharged from offshore drilling operations (Table 3-1). Based on current knowledge and experience available to the Boards, waste material discharged at the concentrations and in the manner specified in these guidelines is not expected to cause significant adverse environmental effects in areas where offshore petroleum activities are anticipated to occur in the near future. In addition, the performance targets recommended in these guidelines for concentrations of specific waste materials in discharges are believed to be achievable using proven and practicable best practices in waste management and treatment.

Table 3-1: Performance Expectations (Best Management Practices) for Offshore Discharges

Waste Types	Performance Target (BMPs)
Produced Water	The performance target for produced water to be discharged to sea from a production installation is as follows: • a 30-day volume weighted average oil-in-water concentration in discharged produced water should not exceed 30 mg/L; and • a 24-hour average oil-in-water concentration in discharged produced water, as calculated at least twice per day, should not exceed 44 mg.
Drilling Muds	All substances that make up drilling muds are screened through the chemical management system developed by the operator in consideration of the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands 22.* These chemical selection and management systems are intended to be used as source control to manage the toxicity of chemicals used offshore. Acceptability of mud ingredients under this screening should not be construed as permissibility to discharge them, or the mud formulation of which they are constituents.
Drilling Solids	The performance target for “synthetic-on-cuttings” or “enhanced mineral oil-on-cuttings” concentration is as follows: • the 48-hour mass weighted average of retained “synthetic-on-cuttings” or “enhanced mineral oil-on-cuttings” discharged to sea should not exceed 6.9 g/100 g oil on wet solids.
Storage Displacement Water	The performance target for storage displacement water is as follows: storage displacement water that is to be discharged to sea should have a residual oil concentration that does not exceed 15 mg/L.
Bilge Water	The performance target for bilge water is as follows: bilge water that is to be discharged to sea should be treated such that the residual oil concentration does not exceed 15 mg/L.
Ballast Water	The performance target for ballast water that is to be discharged to sea, if it is known or suspected to be contaminated with oil, should be treated such that the residual oil concentration does not exceed 15 mg/L.

Waste Types	Performance Target (BMPs)
Deck Drainage	The performance target for deck drainage that is to be discharged to sea, if there is potential for it to be contaminated with oil, should be collected and treated such that the residual oil concentration does not exceed 15 mg/L.
Produced Sand	Discharge of produced sand will depend on the concentration of oil in the produced sand and its aromatic content. In all cases, the sand should be treated to reduce oil concentrations to the lowest level practicable.
Well Treatment Fluids	The performance targets for well treatment fluids are as follows: on a production installation, well treatment fluids may be recovered and directed to the produced water treatment system, if feasible, and then treated as a component of produced water; or where it is not feasible to discharge well treatment fluids through a produced water treatment system, well treatment fluids should be collected and treated such that the residual oil concentration does not exceed 30 mg/L before being discharged to sea.
Cooling Water	To prevent biofouling and corrosion of piping and mechanical systems on the installation, it is typical to add biocide to the cooling water prior to circulating it through the installation. Although chlorination is typically used, other biocides may be chosen by the operator for control of corrosion and biological activity as required. All biocides should be screened through the chemical management system developed by the operator in consideration of the *Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands.*
Desalination Brine	Desalination brine recovered from the production of potable water may be discharged without treatment.
Sewage and Food Wastes	The performance target for sewage and food wastes is as follows: sewage and food wastes should be reduced through maceration to a particle size of 6 millimeters or less prior to discharge to sea.

3.4.4 Summary

The best management practices adopted for Newfoundland and other east coast of Canada exploration and production activities are similar to those of Alaska and Norway in that they focus on best available technology and the value of “environmentally friendly” chemical ingredients in key operational fluids. Waste materials transported to onshore treatment and disposal facilities are those that cannot be treated economically on the drilling platform to allow offshore disposal. Onshore treatment includes chemical and physical separation, land treatment and land filling.

Industry practice is to utilize, as much as possible, water based muds that can be discharged offshore assuming the oil content is less than 6.9 g/100 g oil on wet solids. If oil based fluids are required they are adopting synthetic oil based muds (SBMs) with proven environmental suitability for release in accordance with the Offshore Chemical Selection Guidelines for Drilling & Production Activities on Frontier Lands, April 2009.

3.5 Alberta

The oil and gas sector has been active in Alberta for over 100 years and regulated for over 75 years. Through time, historical data exists for some waste streams whereby common acceptable treatment and disposal practices have been established, and regulatory direction/guidance has been developed.

3.5.1 Regulatory Summary

The Alberta Energy Regulator (AER) succeeds the Energy Resources Conservation Board and will take on regulatory functions from the Ministry of Environment and Sustainable Resource Development that relate to public lands, water, and the environment. In this way, the AER will provide full-lifecycle regulatory oversight of energy resource development in Alberta—from application and construction to abandonment and reclamation, and everything in between.

Oilfield waste management is overseen by the AER a single regulatory authority as a result of recent changes in Alberta's environmental approvals procedures. The management of off-site environmental effects from oil and gas activities is the responsibility of Environment and Sustainable Resources Development (ESRD) under the authority of the *Environmental Protection and Enhancement Act (Consolidated up to 62/2013)* and *Alberta Regulation 192/96 - Waste Control Regulation*.

The day to day management of waste generated from exploration and production activities is managed under by the Energy Resources Conservation Board (ERCB) the Oil and Gas Conservation Act and the regulations under that Act. Under this act "oilfield waste" means an unwanted substance or mixture of substances that results from the construction, operation, abandonment or reclamation of a facility, well site or pipeline include an unwanted substance or mixture of substances from such a source that is received for storage, treatment, disposal or recycling at a facility authorized for that activity pursuant to the Environmental Protection and Enhancement Act.

3.5.2 Alberta Waste Management Infrastructure

Wastes generated from exploration and production is managed by industry in onsite facilities including landfills (solid waste) and subsurface disposal wells (produced water and enhanced oil recovery). Onsite waste management is approved as an "oilfield waste management facility" means a facility for the purposes of processing, treating and/or disposing of oilfield waste. There is also an extensive commercial waste management industry operating under approvals from the ERCB. Waste management infrastructure in place in Alberta for the management of E&P wastes is as follows which consists of one or more of the following components:

- waste storage area/facility;
- waste transfer station;
- waste processing facility;
- surface facilities associated with waste disposal wells;
- waste disposal well (Class Ia or Ib);
- cavern;
- landfill;
- biodegradation facility;

- thermal treatment facility; and
- other oilfield waste management technology or facility.

3.5.3 Alberta Best Management Practices

Directives are documents that set out new or amended AER requirements or processes for implementation. Licensees, permittees, and other approval holders under the jurisdiction of the AER are required to obey all directives.

E&P waste management practices are dictated by AER Directives and Guidelines established under the Oil and Gas Conservation Act. Key Directives that set out best management practices include:

- Directive 50: Drilling Waste Management
  Sets out criteria for the approval of onsite (within the lease) treatment and disposal of drilling waste and the criteria for offsite commercial and/or industry operated drilling waste management facilities.
- Directive 51: Injection and Disposal Wells - Well Classifications, Completions, Logging, and Testing Requirements – sets out criteria and approvals for use of injection wells for waste disposal.
- Directive 58: Oilfield Waste Management Requirements for the Upstream Petroleum Industry.
- Sets approval requirements for the design and operations of the waste management facilities and infrastructure.
- Manual 001: Facility and Well Site Inspections
  This is a resource document for AER personnel. Its purpose is to ensure that oil and gas production and processing facilities, injection and disposal facilities, custom treating plants, waste management facilities, and well sites are inspected in a consistent manner throughout Alberta.

4.0 ANALYSIS, RELEVANCE AND LESSONS LEARNED FOR THE ISR

The data from the comparative jurisdictions provides information on industry waste management practices utilized by oil and gas exploration and development activities in remote, isolated and extreme environments. The data is based upon practices adopted by the oil and gas industry in response to regulatory requirements and applied within their operating area / production units which are considered the equivalent of the regional scope of the BREA study.

4.1 General Summary

The key learning from all jurisdictions are as follows:

- A “region” for the oil and gas industry is commonly defined by the operating areas being explored for the oil and gas resource.
- Strategies being applied associated with the reference jurisdictions are now primarily focused on waste reduction efforts and the industry has adopted practices to manage the large volume wastes (e.g. drilling fluids, cuttings, produced water, sanitary sewage and oily solids and tank bottoms) relieving the pressure on municipal facilities.
- Landfill disposal is selective and only when the industry does not have its own disposal options.
- Best available technology (BAT) and management practices are well proven for oil and gas exploration and development generated wastes.
- Detailed environmental, social and land use information for the operating areas is critical to any planning and development activities, and provides industry with “geographical and social infrastructure locators” for the planning and implementation of their operating practices.
    - ❑ BREA should make it priority as they advance their waste management planning to initiate dialogue with the North Slope Borough to gain from their experience in “living with” oil and gas exploration production and to better understand their “Comprehensive Management Plan”.
- Engagement and dialogue between industry and government at all relevant levels is critical for the advancement of appropriate regulatory, operational, health, safety and environment procedures and practices. These are represented in the NORSOK standards in place in Norway and CAPP and regulatory guidelines in place in Canada.
- Well defined and mandated EPP as outlined for Norway and Canada’s East Coast are fundamental to ensuring consistent quality environmental planning and strategies for any facets of the exploration and production activities including waste management.

The internet based search identified the evolving trend by the E&P industry to improve its operating practices with the development of “environmentally friendly drilling fluids”, greater accountability for its wastes and waste management practices and optimized operating practices. Environmentally friendly chemicals, closed loop systems and directional drilling help to reduce the overall ‘footprint” of E&P activities, and in turn reduce the wastes generated.

5.0 CONCEPTUAL FRAMEWORK FOR A RWMS IN THE ISR

5.1 Understanding, Integrating and Addressing Waste Management Issues

The data from the reference jurisdictions demonstrated how the regulators and industry responded to issues of failed waste management practices, addressed the problems of the large volumes and chemical nature of drilling fluids, cuttings and produced water and production wastes. This information will be necessary for BREA in its planning for the RWMS to assist team members in explaining to the stakeholders the need for an RWMS and the value of advanced planning. Specifically, this information is important to assist the RWMS team managing the consultation to anticipate potential negative reaction to the idea, and it should collate waste management best practices data to address specific questions and considerations including some of the following:

- itemizing the benefits of the RWMS and its associated infrastructure on the local environment as reflected from experiences in other jurisdictions; and
- information to demonstrate how the RWMS planning and organization is intended to address concerns that may be expressed by public interest groups and NGOs, opponents to O&G, practices and/or concerns for “in my back yard” from facilities that may be developed with the advancement of the planned RWMS.

A successful RWMS should consider the appropriate location(s) of waste treatment and disposal facilities that of themselves can bring their own issues. The following information may also be required as the program advances:

- details of how the RWMS would proceed taking into consideration existing environmental, traditional land use and other activities and priorities already in place in the ISR; and
- a preliminary list of mitigative measures that could be used to offset concerns raised regarding the RWMS and its associated features.

A brief description of waste management methodologies that may be considered in the development of the RWMS is included as Appendix C for reference.

5.2 Conceptual Framework Draft Table of Contents

INTRODUCTION

- Why a Regional Waste Management Strategy in the ISR
- Objectives of a RWMS in the ISR
- Key Considerations for a RWMS in the ISR
- Scope (temporal, spatial, issues) of a RWMS in the ISR
- Benefits of a RWMS
    - *Industry*
    - *Communities / Municipalities*
    - *Commercial Sector*

REGIONAL SETTING

- Environmental
- Physical Geography
- Geology
- Permafrost
- Hydrogeology
- Surface Water
- Vegetation
- Wetlands
- Wildlife
    - *Terrestrial*
    - *Marine*
- Fisheries and Aquatic Resources
    - *Freshwater*
    - *Marine*
- Air Quality
- Climate Change

- Land Use
  - *Traditional Land Use – non oil and gas*
  - *Current Land Use – non oil and gas*
- Communities
  - Community Conservation Plans
  - Sensitive Areas
    - *National and Territorial Parks*
    - *Bird Sanctuaries*
    - *Ecological and Biological Significant Areas*
- Regulatory Overview
  - *Onshore ISR*
  - *Offshore ISR*
- Industry Needs and Approach
- Regulatory, Industry and Stakeholder Participants
- Integration and Synergies with Other Initiatives

ISR OIL AND GAS INDUSTRY ACTIVITY

- Historical Activity
- Current Activity
- Future Activity (see Scenarios)
- Existing Waste Management Infrastructure
- Existing Waste / Waste Sites

CURRENT Oil & GAS WASTE MANAGEMENT PRACTICES BY WASTE TYPE AND LOCATION (ONSHORE VS OFFSHORE)

- Waste Classification / Identification
- Waste Generation
  - *Challenges*
- Waste Reduction

- *Challenges*

- Waste Storage
  - *Challenges*
- Waste Transportation
  - *Challenges*
- Waste Recycling
  - *Challenges*
- Waste Treatment
  - *Challenges*
- Waste Disposal
  - *Challenges*
- Summary

WASTE MANAGEMENT METHODOLOGIES

- Methodologies
  - Down-Hole Injection
    - *Classifications (e.g. Class 1a, 1b)*
    - *Associated waste types*
    - *Challenges*
  - Landfills
    - *Classifications (e.g. Class I, II, III)*
    - *Associated waste types*
    - *Challenges*
  - Industrial Landfills
    - *Associated waste types*
    - *Challenges*
  - Sumps

- *Associated waste types*
- *Challenges*

- Thermal Treatment
  - Incineration
    - *Associated waste types*
    - *Challenges*
  - High Temperature Thermal Desorption
    - *Associated waste types*
    - *Challenges*
  - Low Temperature Thermal Desorption
    - *Associated waste types*
    - *Challenges*
  - Others?
- Mobile Treatment Technologies
  - Incineration
    - *Associated waste types*
    - *Challenges*
  - Thermal Desorption
    - *Associated waste types*
    - *Challenges*
  - Wastewater Treatment
    - *Associated waste types*
    - *Challenges*
  - Others?
- Offshore Waste Treatment and Disposal
  - *Associated waste types*

- *Challenges*

- Disposal at Sea
  - *Associated waste types*
  - *Challenges*
- Others?
  - Treatment, Recovery, Disposal
  - Biocell
  - Waste to Energy
  - Plasma Gasification

LESSONS LEARNED FROM OTHER REGIONS

- Alaska's North Slope
- Canada's East Coast
- Norway
- Alberta
- British Columbia

LESSONS LEARNED FROM PREVIOUS ISR O&G ACTIVITY

- Offshore
- Onshore

APPLYING LESSONS LEARNED TO ISR

REGIONAL WASTE MANAGEMENT SCENARIOS

- Scenario 1: No Activity – Low Activity (Initial Exploration, Little Production)
  - *Scenario 1 – Regional Waste Management Requirements and Options*
- Scenario 2: Moderate Activity (Growing/Developing Sector – Exploration Growing, Production Facilities Under Construction and Initiating Operations)
  - *Scenario 2 – Regional Waste Management Requirements and Options*
- Scenario 3: High Activity (Fully Established E&P Industry)

- *Scenario 3 – Regional Waste Management Requirements and Options*

EVALUATION OF OPTIONS AND SELECTION

- Evaluation Criteria
  - Technical Criteria
  - Environmental Criteria
  - Socio-economic Criteria
  - Financial Criteria
  - Cultural Criteria
- Selection of Options
  - Scenario 1
  - Scenario 2
  - Scenario 3

6.0 PROPOSED PROCESS FOR DEVELOPMENT OF A RWMS IN THE ISR

Figure 6-1 presents an overview of a proposed process, from the initial scoping stage (i.e., this document) to the final implementation of an RWMS and associated components. This represents an **outline of activities or steps in the planning and development of an RWMS.**

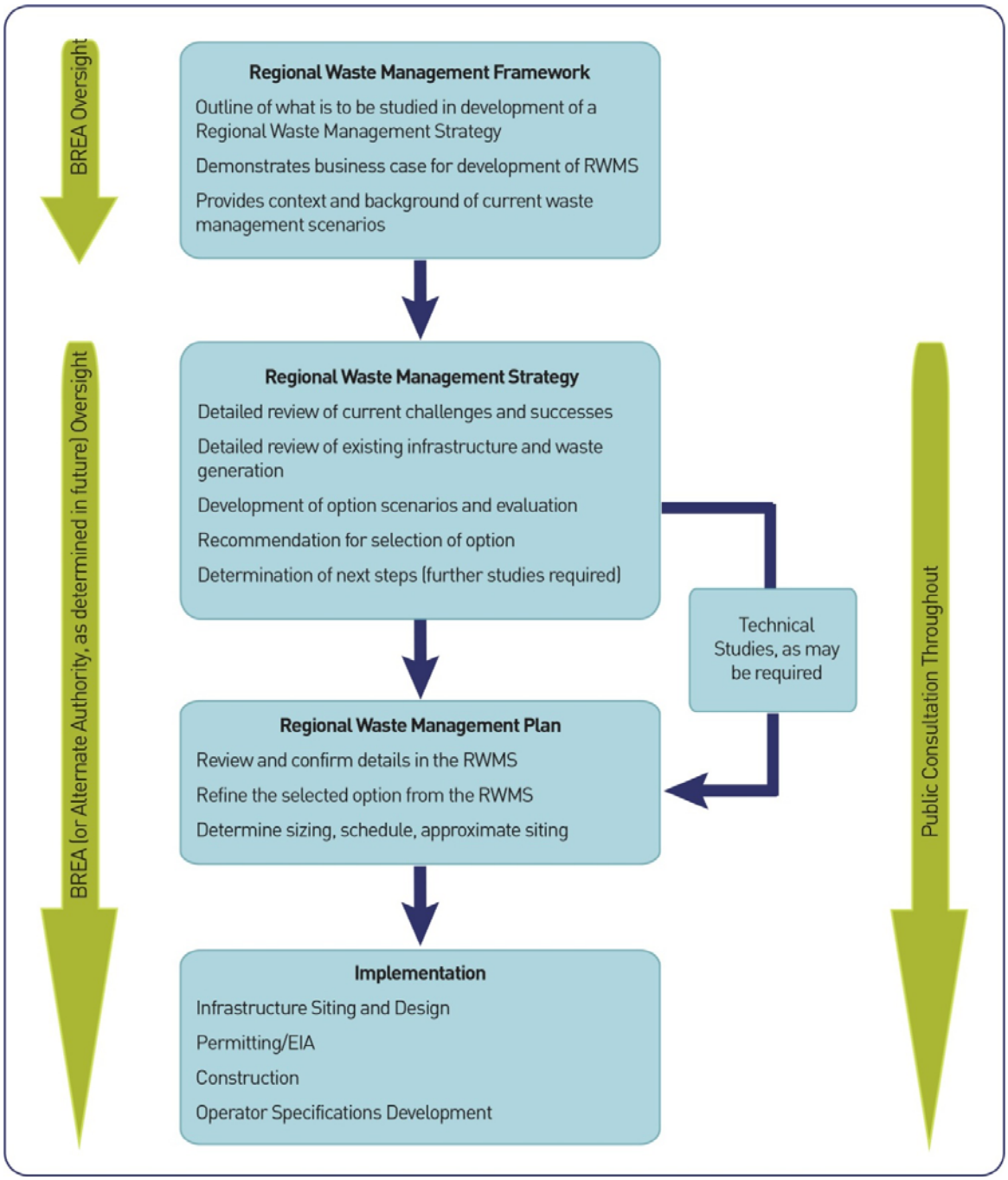

Figure 6-1: Process Overview

The advancement of the RWMS will require the engagement of multiple stakeholders and a formal organizational structure to ensure the accommodation of the environmental, social, economic, heritage and land use aspects of the ISR. This section provides some thoughts on the scope of these needs, information requirements, and suggested strategies to be applied for the advancement of the RWMS.

6.1 Oversight Body

The successes in the reference jurisdictions can be attributed to the presence of effective regulatory standards and evolving practices over several years of exploration and production by industry. The process to develop an RWMS begins with determining the governance structure and particularly the primary oversight body (e.g. Steering Committee, Advisory Committee, BREA Waste Management Working Group) for the work. At this point in time, it is too early in the process to define who would comprise the oversight body, but it should include representation from:

- Federal Government Departments;
- NWT Government Departments;
- Inuvialuit Organizations;
- The Oil & Gas Industry;
- Local environmental groups;
- Communities; and
- Engineering / planning experts in the region.

The oversight body will need to determine its rules of engagement, bylaws and procedures. It is important that this group represents key stakeholders in how oil and gas waste is to be managed in the ISR. This group will be making key decisions as the RWMS study is completed.

6.1.1 Development of Regional Waste Management Strategy

The oversight body will develop a Terms of Reference for the development of the Regional Waste Management Strategy. The study should be contracted to an engineering consulting firm, which has experience in development of a regional waste management strategy, waste management in the oil and gas sector, and waste management in Canada's North. The engineering consultant will be responsible for developing and documenting the outcome of each of the steps in the process, as outlined below. They will also be accountable to the oversight body to communicate issues as they may arise and to seek decisions at key points in the process.

The engineering consultant should propose a methodology that should contain as a minimum, the following components:

- detailed review of the background, history and drivers for oil and gas waste management in the ISR;

- review of environmental setting, including geography, geology, permafrost, land use, hydrogeology, surface water, vegetation, wetlands, wildlife (terrestrial and marine), fisheries and aquatic resources (freshwater and ocean), air quality, climate change and sensitive areas (national parks, territorial parks, bird sanctuaries, ecological and biological sensitive areas);
- review of Inuvialuit Community Conservation Plans;
- review of oil and gas activity in the ISR, including historical, existing and future activity;
- detailed description and review of current waste management in the ISR, including waste generation, waste storage, waste transportation, waste disposal, waste treatment and current challenges faced;
- detailed description of waste management technologies and options including down-hole injection, landfill, thermal treatment, sump and mobile treatment;
- development of possible waste management scenarios that combine storage, transportation, disposal and treatment technologies to handle the wastes that may be generated, as well as conceptual-level design and costs for each scenario;
- establishment of criteria for evaluation of the scenarios, including technical, environmental, socio-economic, cultural and financial criteria;
- establish the methodology for evaluating the scenarios against the criteria (Various but similar methods could be considered including a multiple accounts analysis, Kepner-Tregoe analysis, or one aligned with *CAN/CSA-ISO 31000-10 Risk Management – Principles and guidelines* and *CAN/CSA-Q850-97 Risk Management – Guideline for Decision-Makers* – generally a weighting value is given to each criterion and a rating value to each option against each criterion).
- selection of waste management scenario, using the criteria established above;
- public communication and consultation throughout the project, as deemed appropriate by the oversight body; and
- implementation of the RWMS.

6.2 Consultation and Communication Plan

Throughout the process, public consultation and communication will be needed to help ensure the recommended scenario is acceptable to stakeholders. The consultation and communications plan will provide BREA and associated parties the opportunity to acquire information to assist them in documenting and understanding the issues (social, political, cultural, environmental and economic) related to the RWMS and its associated factors. Secondly, it will also allow communities and stakeholders to gain information and a greater understanding of the timing and planning specifics associated with the proposed RWMS.

The steps of the consultation and communication plan necessary to gather information, identify issues, develop and reach consensus on a RWMS should include as a minimum the information identified in the following sections.

6.2.1 RWMS Consultation Team Operating Considerations

The scoping study demonstrated that the accommodation of the needs and interests of multiple stakeholders (industry, regulators, landowners or users of the area to be developed (e.g. Norwegian fishing industry) were critical to the successful advancement of waste management practices in the reference jurisdictions. The advancement of the BREA Regional Waste Management Strategy for the ISR will require accommodation of the multiple stakeholders found in the ISR as outlined in section 10.1, and the team must work out details and/or considerations for sharing information and roles and responsibilities (this optic could be critical in advocating an RWMS).

6.2.2 Who Should Be Consulted?

Decisions made about who should be consulted are important as they can set the basis for community agreement and or opposition. A high level list of those agencies and associations that should be considered, as a minimum, for consultation are as follows:

- Inuvialuit Regional Corporation;
- Inuvialuit Land Administration;
- Environmental Impact Review Board and the Environmental Impact Screening Committee;
- Inuvialuit Game Council & Hunters and Trappers Committees in each community;
- NWT Water Board;
- Wildlife Management Advisory Council;
- Fisheries Joint Management Committee;
- Fisheries and Oceans Canada;
- Aboriginal Affairs and Northern Development Canada;
- Department of Environment and Natural Resources (GNWT);
- Department of Municipal and Community Affairs (GNWT);
- Municipal Governments of Inuvik, Tuktoyaktuk and Paulatuk (Sachs Harbour & Ulokhaktok are optional);
- Inuvik and Area Chamber of Commerce;
- Representatives of CAPP (Canadian Association of Petroleum Producers) and/or companies holding exploration permits and/or significant discovery licenses; and
- Others to be determined.

Of the above list of organizations, BREA may wish to approach some to participate in the planning, management and implementation of the consultation efforts (e.g. IRC, IGC, ILA, EISC & EIRB) as they will not only be familiar with the region but will also understand the importance and value of communication and consultation.

There will be a need to prepare a final list of organizations, associations and special interest groups who will be consulted and identify how the communications will occur (e.g. open community meetings or one on one meeting with key representatives).

6.3 Consultation Process Design

Consideration of the following:

- establish meeting objectives in advance of any consultation to assist the team in focusing their preparation and to ensure effective meetings and/or communications;
- adapt the organization, scheduling and content of the communications to the requirements of the local community and their policies and guidelines for consultation;
- establish a timeline for the consultation efforts taking into consideration community and or other agency needs and requirements;
- design the consultation so as to take into consideration any specific requirements for review and discussion of such initiatives; and
- consider local protocols of order in establishing the consultation schedule and undertaking public meetings.

6.3.1 Additional Requests for Support

Determine if any additional support may be required to ensure effective participation of interested parties and stakeholders (this may require special budget considerations). This could include but may not be limited to:

- information-sharing and awareness;
- participation at meetings including honorarium for elders and others;
- travel costs;
- preparation of technical briefs and responses;
- analysis and reporting related to the consultation and accommodation activities;
- response to potential impacts on established traditional land use of related interests; and
- communications and printing.

6.3.2 Records Management

An efficient record keeping system should ensure that the information is accessible, searchable, retrievable and reliable. It should also enable the sharing of documents between the members of the team (various local agencies or authorities participating as the management team). Where multiple groups might be involved in supporting the consultation process, a centralized record keeping system is essential to maintain a complete record of consultations.

A consultation record typically includes:

- date and time of correspondence or meeting;
- where the meeting took place and who attended;
- information shared at the meeting regarding the RWMS and related consultation process;
- feedback received from meeting participants;
- responses to the concerns and information requests made at the meetings should also be documented; and
- rationale for key decisions and or issues raised that require follow-up action in relation to the RWMS.

All correspondence (e.g. letters, e-mail messages, notes on telephone calls, notes from each meeting) should be recorded and filed in the records management system. BREA will need to consider how to prioritize this information and retain it to demonstrate how the RWMS team has fulfilled some of its communications/consultation objectives.

It is also recommended practice for federal officials to indicate who created the record and who performed the activity recorded.

7.0 IMPLEMENTATION OF THE PROCESS

- Notify those groups and stakeholders identified for communications/consultation of the contact details for the RWMS management group and all details for communicating with the Team.
- In a timely manner, provide those identified for consultation/communication with clear and relevant information relating to the RWMS.
- To ensure that those scheduled for consultation/communication are adequately notified and able to meet scheduled meetings timelines, the RWMS communications lead should send information to them by a variety of means including registered mail, email and fax. Using registered mail ensures that recipients have an original copy on file; however, this method of correspondence can be slow. E-mails and faxes ensure timely receipt of documents. Follow-up phone calls are recommended. Timely communication facilitates an open and respectful dialogue between the RWMS and those to be consulted.
- When consulting with stakeholders and interested 3rd parties ensure the Team is aware of who is authorized to represent them and their related interests.
- Schedule the RWMS related information exchange so as to allow any of the interested parties with enough time to assess any potential issues or impacts of the RWMS on their local land use and business interests. The RWMS communications team should, prior to any meetings, follow up with the participants to ensure all information was received and to judge “first impressions” of the RWMS.
- Ensure that the RWMS communications team understands the importance of providing coordinated and timely responses to communication received from consultations/communications meetings including setting out standards or letter templates.
- Throughout the consultation process, consider ways and means to avoid or mitigate potential adverse impacts of the activity on potential or established land use and business or priority interests for potential facility or operational locations determined following the RWMS.
- Ensure that throughout the communication/consultation process, a procedure is in place to ensure all received information requests or comments on the RWMS and/or response information pertinent to the RWMS is shared with all team members.

8.0 POTENTIAL SCOPE OF A RWMS IN THE ISR

Figure 8-1 outlines which aspects of waste management in the ISR could be considered within the scope of a RWMS and which could be out of scope.

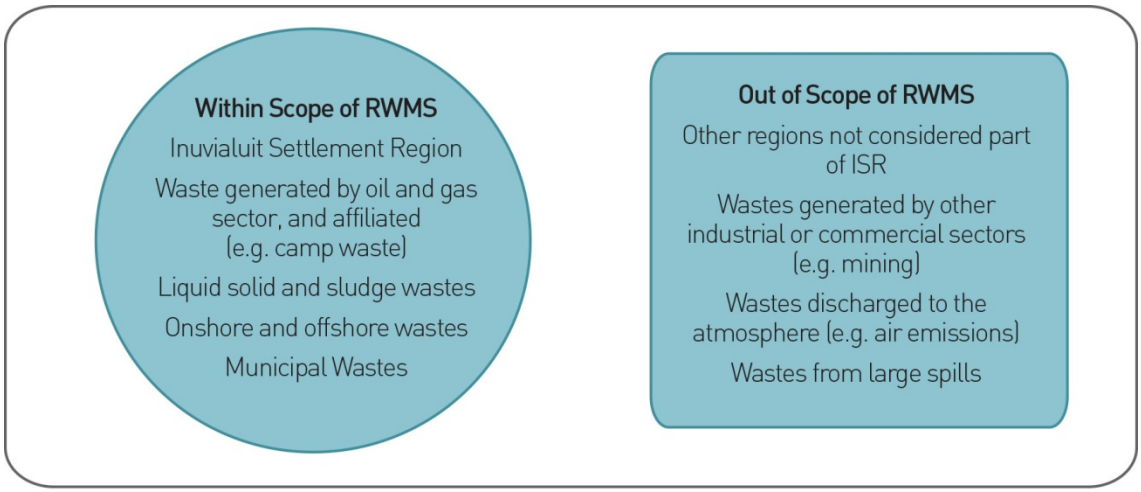

Figure 8-1: Potential Scope of RWMS

It is important to note that those aspects currently considered out of scope, could possibly be included in the future, if deemed appropriate by the oversight body.

Waste management in the far North poses significant challenges due in part to harsh climates, sparse population and limited existing infrastructure. While these challenges exist before introduction of expanded industrial development, they can be exacerbated by increasing pressures from new industrial waste streams and larger volumes of wastes from industrial development. It is expected that a RWMS that is developed to help manage wastes from the growing oil and gas sector in the ISR would directly benefit the communities in the region as well. These benefits include employment opportunities and improved environmental performance.

Also, it is possible that wastes from other industrial or commercial sectors could be incorporated into the RWMS. However, at this stage, the scope is limited to generate some momentum towards a system that benefits the significant waste generators in the region – the oil and gas sector and the communities. This scope also aligns with the initial drivers of the BREA Waste Management Working Group from the BSStRPA, Theme 1, Recommendation #1.4 in response to proposed oil and gas development.

Contaminated soils and clean-up materials resulting from spills are generally outside of the scope of the RWMS. The exception would be small volumes of waste resulting from small “operational” spills (i.e. Tier 1 spills) that would meet criteria for non-hazardous or non-dangerous wastes.

9.0 POTENTIAL CLIENTS AND STAKEHOLDERS FOR A RWMS IN THE ISR

This section provides preliminary lists of potential clients and stakeholders who would be important to the planning and advancement of an RWMS in the ISR.

9.1 Potential Clients

The following oil and gas companies have been identified as potential clients to a RWMS, as they have Exploration and/or Significant Discovery Licenses in the Beaufort Sea and Mackenzie Delta:

- AltaGas;
- BP Canada Energy;
- Chevron;
- ConocoPhillips;
- Devon NEC;
- Franklin Petroleum;
- Imperial Oil;
- MGM;
- Nytis Exploration;
- Shell Canada; and
- Suncor Energy.

9.2 Potential Stakeholders

A high level preliminary list of those agencies and associations that should be considered stakeholders of an RWMS are as follows:

- Inuvialuit Regional Corporation;
- Inuvialuit Land Administration;
- Environmental Impact Review Board and the Environmental Impact Screening Committee;
- Inuvialuit Game Council & Hunters and Trappers Committees in each community;
- NWT Water Board;
- Wildlife Management Advisory Council;
- Fisheries Joint Management Committee;
- Fisheries and Oceans Canada;
- Aboriginal Affairs and Northern Development Canada;
- Environment Canada;
- Department of Environment and Natural Resources, Government of the Northwest Territories (GNWT);
- Department of Municipal and Community Affairs, GNWT;
- Municipal Governments of Inuvik, Tuktoyaktuk and Paulatuk (Sachs Harbour & Ulokhaktok are optional);
- Inuvik and Area Chamber of Commerce;
- Canadian Association of Petroleum Producers (CAPP); and
- Companies holding exploration permits and/or significant discovery licences.

10.0 CONCLUSION

The proposed Framework for (content of), and process to develop, a regional waste management strategy in the ISR have been outlined here in some detail. However, this represents a single conceptual approach to the issue. Both the content and process outlined here will undoubtedly require, at a minimum, some further refinement in the event it is decided to proceed with an operational Regional (Oil and Gas) Waste Management Strategy in the ISR. It should be recognized also, that this is only the first step in a necessarily longer, much more inclusive and detailed process that will be required to take this from its current conceptual stage to a concrete and actionable RWMS. The development of a functional RWMS will require an organization or group of organizations to assume a strong leadership role in its development and delivery. If it is to be accomplished under BREA this will require Steering Committee acceptance and strong support.

The BREA Waste Management Working Groups intention is to provide this Framework as a basis for the development of a Strategy to address a key ISR community concern. However, we believe the Framework can serve as a model for potential use in other regions of the NWT as well.

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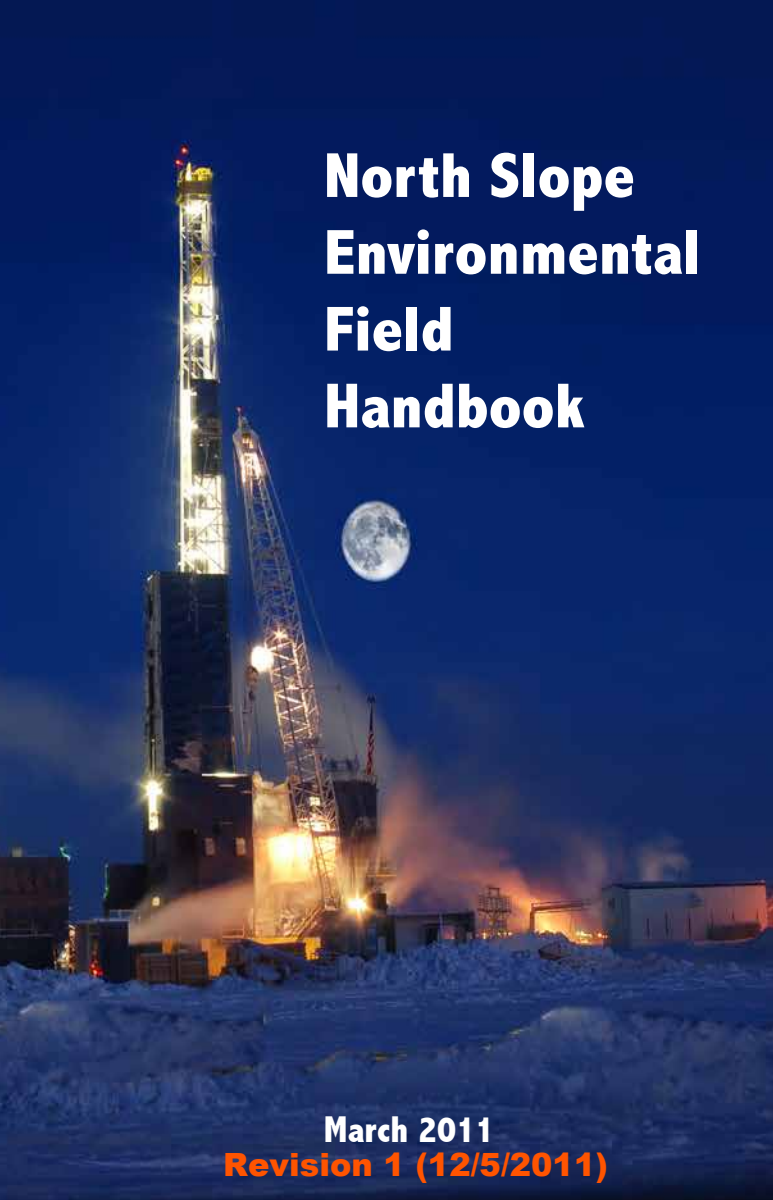
Appendix A

Examples of Alaska E & P Waste Management Requirements and Practices



North Slope Environmental Field Handbook

March 2011

Revision 1 (12/5/2011)

Environmental Staff Contacts

	SPILL	EMERGENCY
BP		
Badami	659-1200	659-1200
Endicott	659-6900	659-6900
Greater Prudhoe Bay (East)	659-5700	911 or 659-5300
Greater Prudhoe Bay (West)	659-5700	911 or 659-4222
Milne Point	670-3300	670-3399
Northstar	670-3515	911 or 670-3500
ConocoPhillips		
Alpine	670-4002	911 or 670-4900
Kuparuk	659-7997	659-7300
ENI		
OCC		670-8500
ExxonMobil		
Point Thomson	564-3668	564-3668
Pioneer Natural Resources Alaska		
Oooguruk	670-6623	670-6500

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(Section 8)

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ExxonMobil (Cover, Section 2)

Derek Helmericks (Section 5)

Pioneer Natural Resources Alaska, Inc. (Sections 4, 7)

The *North Slope Environmental Field Handbook* provides a basic overview of environmental issues in Alaska's North Slope oil and gas fields. This edition of the *Handbook* has been compiled by the following North Slope operating companies:

BP Exploration (Alaska) Inc. (BPXA)

ConocoPhillips Alaska, Inc. (CPAI)

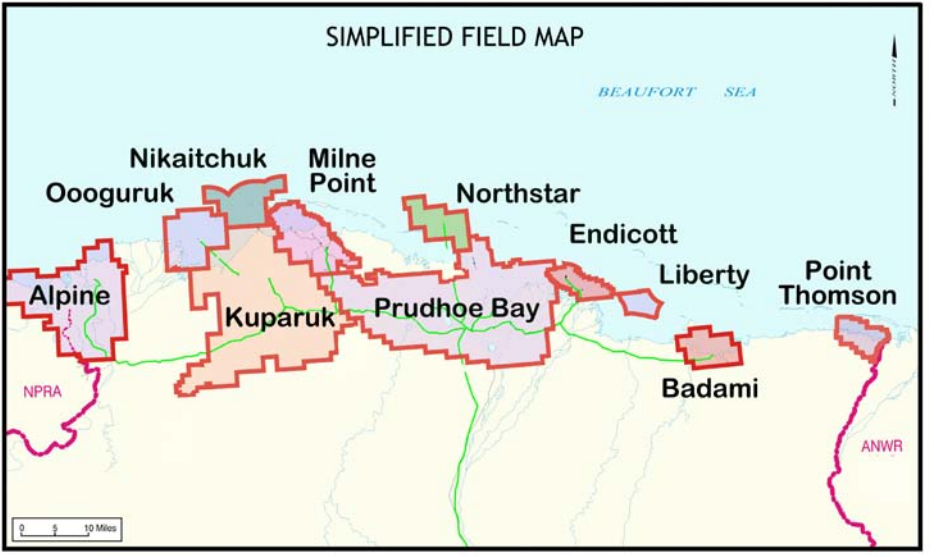
ENI Petroleum Company Inc. (ENI)

ExxonMobil

Pioneer Natural Resources Alaska, Inc. (Pioneer)

Please contact the Environmental staff in your operating area (see Contact list on page 1) for detailed information that is relevant to your location or project. The general guidance presented in this booklet is not a substitute for individual company policies, site-specific procedures, or actual regulations.

Contents


SIMPLIFIED FIELD MAP
BEAUFORT SEA
Nikaitchuk
Milne Point
Oooguruk
Northstar
Endicott
Liberty
Point Thomson
Alpine
Kuparuk
Prudhoe Bay
Badami
NPRA
ANWR
0 5 10 Miles

Section 1
INTRODUCTION

Introduction

North Slope oil producers make every effort to minimize the effect of our operations on the environment. We are unified in our commitment to environmental excellence and continuous improvement. We routinely assess our impact on the environment, and we apply what we have learned over the past decades to each new project.

Environmental management is not just the job of a few specialists — it is a critical and integral part of our day-to-day business on the North Slope. Everyone can make a difference by following a few simple practices:

- Plan ahead. Before starting a project, identify any permit requirements, spill prevention practices, or other environmental restrictions that might apply. It can take a year or more to get all the permits needed for a project.
- Order supplies and materials carefully to avoid hazardous materials and minimize waste.
- Make sure you know well in advance what to do with any waste that is generated on your project. Remember that many materials can be reused or recycled.
- Keep all vehicles and equipment in good working condition. Any defects or malfunctions should be repaired immediately.
- Use portable liners under all fluid transfer points.
- Report spills immediately, according to the procedures in your operating area.

- Keep your job site clean. Manage food and trash carefully to avoid attracting wildlife.
- Be aware of the general condition of the areas where you work. If you see something that doesn't look right, report it!

Who to Call for Help

The North Slope is divided into several operating units. The legal boundaries between fields are distinct, and procedures vary from place to place. If you need assistance, contact the Environmental staff in your operating area. If they don't have the answer right away, they will find out for you, or direct you to the people who can help you.

Contact information is provided on the first page and back cover of this handbook.

Section 2
REGULATORY FRAMEWORK

Regulated Activities

Many activities require a permit, authorization, or notification before initiating work. Some activities only require a verbal notification. Others may take weeks or even years to approve, and multiple agencies may be involved. Most permit applications are open to public review and comment.

PLAN AHEAD!
Please inform the Environmental staff about new projects as far in advance as possible.

Examples of regulated activities include, **but are not limited to,** the following examples:

Extracting Natural Resources

- Taking gravel or other raw materials from mine sites, river channels, or beaches
- Withdrawing water or ice chips from any natural source, gravel mine site, or impoundment

Off-Pad Activities

- Any work or travel on the tundra
- Any activity in rivers, streams, lakes, beaches, or coastal waters (dredging, diverting, installing bridges or culverts, etc.)
- Working in a pipeline right-of-way
- Building and maintaining ice roads and pads

Construction and Maintenance Projects

- Placing gravel for new roads and pads
- Modifying existing roads and pads (expanding, trenching, etc.)
- Adding modules or other structures (well conductors, utilities, bollards, pipeline supports, etc.) to existing pads

Air Quality

- Operating or modifying regulated air emission sources (turbines, generators, incinerators, etc.)
- Open burning
- Flaring

Water Treatment

- Installing, operating, or modifying a treatment system for drinking water or wastewater

Waste Disposal

- Drilling and operating a disposal well
- Discharging waste or wastewater to land or water surfaces
- Storing waste in surface pits or containment structures

Wildlife

- Deterring (hazing) wildlife
- Handling migratory birds (alive or dead)
- Affecting wildlife habitat

Other

- Operating oil storage containers and pipelines

Always check with your supervisor and Environmental staff before beginning your work to make sure you have all the necessary authorizations.

Regulatory Agencies

Many regulatory agencies have jurisdiction over our activities on the North Slope. They include:

Federal Agencies

BLM: U.S. Bureau of Land Management
- Tundra travel and right-of-way approvals in National Petroleum Reserve - Alaska

BOEMRE: Bureau of Ocean Energy Management, Regulation and Enforcement
- Offshore oil and gas activity

COE: U.S. Army Corps of Engineers
- Dredging and filling in wetlands and water bodies

EPA: U.S. Environmental Protection Agency
- Air and water quality
- Industrial wastewater discharges (until transition of authority to ADEC is complete)
- Hazardous waste management
- Underground injection
- Oil storage containers

NMFS: National Marine Fisheries Service
- Marine resources
- Marine mammals, endangered species and their associated habitats

USFWS: U.S. Fish and Wildlife Service
- Fisheries and habitat
- Migratory birds
- Threatened and endangered species
- National wildlife refuge management

State Agencies

ADEC: Alaska Department of Environmental Conservation
- Air quality
- Drinking water
- Spill prevention and response
- Oil storage containers
- Waste and wastewater treatment and disposal
- Stormwater management
- Soil remediation

ADFG: Alaska Department of Fish and Game
- Wildlife management
- Water withdrawal
- Activities in streams

ADNR: Alaska Department of Natural Resources
- Land use
- Tundra travel
- Water and gravel use
- Habitat protection and restoration
- Identification and preservation of historic properties

AOGCC: Alaska Oil and Gas Conservation Commission
- Reservoir management
- Flaring
- Oil and gas resource protection
- Underground injection

Local Agencies

NSB: North Slope Borough
- Land use
- Pipeline surveillance
- Subsistence resources
- Village coordination

Noncompliance

Failure to comply with applicable regulations and permit conditions can result in substantial civil or criminal penalties. A poor compliance record can delay new permits, damage future prospects for oil and gas development, and lead to additional or stricter regulations in the future. Each North Slope worker must understand the responsibilities for compliance related to his or her job.

- Follow approved job procedures. These should be consistent with environmental regulations applicable to your work.
- Be aware of the environmental concerns in your work area.
- Know the permits and the conditions that apply to your operation, and ensure that new workers or contractors are familiar with the permit stipulations. If you are unsure, contact the Environmental staff.
- If required, make sure copies of permits are on site or readily available (electronic copies may be acceptable).
- Look for ways to reduce environmental liabilities on the job, such as minimizing the generation of hazardous waste and preventing spills.
- Contact your supervisor immediately if you see or suspect something out of compliance.
- Cooperate fully with agency personnel during compliance inspections. Your supervisor and, if possible, someone from the Environmental staff should be present. Agency personnel have the right to conduct unannounced inspections at any time, unless doing so would be unsafe.

Section 3
AIR

Air Quality Goals

North Slope operating companies are committed to reducing emissions of air pollutants from our facilities. We have been monitoring air quality on the North Slope for several years and using the data to assess current and future impacts. On a global level, we are actively addressing greenhouse gas emissions and developing emission targets for our operations.

Air Quality Control Permits

Air Quality Control permits regulate the emission of carbon, sulfur, and nitrogen compounds, as well as particulate matter and other parameters. Permits often include limits on operating hours, fuel usage, and visible emissions. They contain many requirements for maintenance, monitoring, record keeping, and reporting.

Regulated equipment at North Slope facilities may include turbines, rig engines, generators, heaters, incinerators, flares, and storage tank vapor collection systems.

Please consult with the Environmental staff before making changes to regulated equipment. Modifications can lead to permit violations.

Noncompliance could result from:

- Bringing unpermitted fuel-burning equipment to the site, such as a generator or heater
- Replacing a motor or pump in process equipment
- Changing the horsepower output of regulated equipment
- Exceeding the allowable operating hours
- Changing the fuel type or fuel specifications
- Placing a new storage tank in service
- Failing to conduct required monitoring or maintenance
- Failing to meet agency deadlines for information submittal
- Failing to keep required records

If you operate or maintain emission sources, you must be aware of all applicable restrictions and permit conditions.

Black Smoke

Incomplete combustion may produce visible smoke from flares or other emission sources. Black smoke events lasting more than a few moments may indicate a process upset or equipment malfunction.

If you observe black smoke from a flare or other emission source, please report it according to the procedures in your operating area.

Gas and Vapor Leaks

Gas leaks from wells, pipelines, valves, or other sources are potentially serious safety hazards. Any evidence of leaking gas should be reported as soon as possible. Stay out of the area until re-entry has been approved.

Substantial releases of natural gas are considered a loss of state resources, and must be reported to the AOGCC. In the long term, sustained leaks may contribute to local air pollution.

Ultra Low Sulfur Diesel

Ultra-low sulfur diesel (ULSD) has a maximum of 15 parts per million sulfur. To comply with federal and state rules, ULSD must be used in Alaska in the following equipment:

- All diesel-powered motor vehicles (such as automobiles and trucks)
- Diesel powered non-road engines (such as earth-moving equipment, drill rig engines, and portable generators/pumps)
- Marine engines

If you operate vehicles or equipment that are subject to the ULSD rule, be sure to fill up only from clearly marked ULSD bulk tanks and dispensers.

The ULSD rule applies to most stationary equipment and may apply to all in the future.

Idling Vehicles

Prolonged idling wastes fuel, fouls engines, and releases air pollutants. In general, the practice of leaving vehicles running is discouraged, even during cold weather. Policies and enforcement may vary from one location to another.

Plug-ins for engine block heaters are available at most facilities. Use them to avoid cold starts and reduce warm-up time. If a vehicle must be left idling, avoid parking it near air intake vents. Be alert for gas-venting or other conditions that may produce combustible atmospheres.

See Section 7 for guidelines on drip pan use under parked or idling vehicles.

Open Burning

Wood or other materials may not be burned in open fires without a permit. Contact the Environmental staff to find out if, where, and when open burning is allowed in your area.

Section 4
LAND

Land Ownership

The oil and gas industry owns very little land on the North Slope. Most of our operations are located on state, federal, and Native corporation lands. As mentioned in Section 1, we must comply with many regulations and permits as well as any lease terms when operating in these areas. We must also obtain approvals to work on private lands, easements, and rights-of-way. Many additional restrictions apply to wetlands and other water bodies.

Tundra Travel

Most of the tundra that surrounds our oil fields is classified as "wetland" (see Section 5), and it is protected by state and federal regulations. Even though annual precipitation is relatively low, the ground surface typically remains saturated because of poor drainage. During the brief summer, a thin "active layer" at the surface thaws to a depth of about two feet. This layer is extremely sensitive to disturbance. Below the active layer, permanently frozen ground ("permafrost") extends as deep as 1,500 feet.

For all tundra travel and off-pad work, we must obtain permission from the land-management agencies. For state lands, the ADNR publishes tundra travel opening and closure dates that apply to broad geographic areas. When an area is "open", we must still ask for case-by-case approval, and we may be limited to specific vehicles and routes. Other agencies may have additional stipulations. For example, river and stream crossings require special approval from ADFG in order to protect fish habitat.

There are three basic seasons for tundra travel:

- **Summer tundra travel** opens annually around July 15. Travel is limited to a few approved vehicles with smooth tracks, like Rolligons, Argos, Hagglunds, and Tucker Snowcats.
- **Winter tundra travel** opens when the regulating agency determines that there is adequate snow cover and frost depth to protect the tundra. Historically, the winter tundra travel season has opened as early as November and as late as January. The closing has occurred as early as April and as late as June. In a few years, no winter tundra travel was allowed at all, due to lack of snow cover.
- **No tundra travel** of any kind is allowed during spring breakup, when the tundra is particularly vulnerable. The closed period runs from the end of the winter tundra travel season until the opening of the summer travel season.

Damage to the tundra is never authorized. Report any tundra disturbance to the Environmental staff as soon as possible.

If you are planning a project or activity that requires tundra travel, please contact the Environmental staff as far in advance as possible. Provide the following information:

- A map showing your proposed route of travel and/or project location

- A description of the activity, including all equipment and vehicles that will be used off-pad
- The timing of your project, including proposed start date, duration, and end date.

Please notify the Environmental staff when your tundra travel has been completed.

Ice Roads and Ice Pads

Seasonal ice roads provide critical links to sites that do not have gravel road access. Ice roads extend from a few feet to more than 40 miles across tundra, rivers, lakes, and the frozen sea surface. Ice is also used to build seasonal pads for exploratory drilling and other projects.

It can take months of advance planning and permitting to establish an ice road route. In addition to the terrain, we must consider land ownership, cultural and archeological sites, wildlife habitat, and available water sources. Ice road construction and maintenance require tons of ice chips and millions of gallons of fresh water.

When traveling on ice roads:

- Stay on the road, and stay in your vehicle.
- Stop at all security checkpoints.
- Comply with speed limits and communication protocols.
- Report all spills, accidents, and wildlife sightings as instructed.

- If you see a polar bear anywhere in the vicinity of an ice road, STOP and contact Security immediately. Do not proceed until you are instructed to do so.

During ice road construction or maintenance:

- Do not deviate from the approved route without explicit approval from Security and Environmental.
- Use only approved sources for water and ice chips.
- Track and report water use as instructed, and be aware of how much water you are allowed to take from each source.

Snow Removal

To minimize the risk of environmental impact and property damage, snow removal crews must follow certain basic guidelines.

It is a violation of regulations and permit conditions to push excess gravel or pollutants off the pad.

- Do not push dirty, gravelly, or contaminated snow off roads or pads. Be aware of areas where contamination is most likely to be present, like parking areas, fuel pumps, and known spill sites.
- Place dirty or contaminated snow in designated stockpile or storage areas.
- Maintain a minimum distance from flowlines, valves, and well houses to avoid contact. Never blow snow onto

or into well houses, flow lines, high voltage equipment, or manifold buildings.

- Stained snow or concealed objects might not be visible to the equipment operator, so use a spotter, if possible.

Good housekeeping at the site is also important.

- Inspect sites frequently for spills, loose debris, and materials that could get mixed with snow.
- Report and clean up all spills promptly.
- Do not store materials near the edge of the pad.
- Use poles or delineators to mark the location of equipment or materials that might become buried by snow.

Use of Treated Wood

In most North Slope operating areas, the use of treated wood is discouraged and may be prohibited at some locations. "Green" wood may contain chemical compounds such as arsenic, chromium, and copper.

Please consult with the Health, Safety, and Environmental staff before purchasing, using, or disposing of treated wood.

Section 5
WATER

Water Use

Fresh water and ice chips may not be withdrawn from rivers, streams, lakes, or ponds without a permit. Your Environmental staff can tell you which sources are already approved. If your project needs additional water sources, be aware that the permitting process can take several months.

You must comply with all stipulations of the water use permit, including:

- Limits on the total volume of water that can be withdrawn
- Seasonal restrictions
- Specifications for screens and intake structures
- Reporting requirements

Project supervisors must ensure that water withdrawals are logged and reported on a regular basis, and that total allowable volumes are not exceeded.

Drinking Water

On the North Slope, drinking water is obtained from lakes, impoundments, and desalinated seawater. All drinking water systems that serve North Slope workers are approved by ADEC and operated in accordance with state drinking water regulations. Information about the quality of your drinking water is available upon request.

Any changes to drinking water systems must be reviewed in advance by the Environmental staff. In some cases, ADEC approval will be required.

Never consume untreated lake water. Naturally-occurring microorganisms can cause serious illness.

Protected Waters and Wetlands

Most surface waters on the North Slope, including tundra wetlands, are protected by federal and state laws. Activities affecting protected waters and wetlands are strictly regulated (see Section 2), and should be discussed well in advance with the Environmental staff. Tundra travel requirements are outlined in Section 4.

Several artificial water bodies, such as old gravel pits and reservoirs, also have protected status. Unauthorized activities around these sites may disrupt rehabilitation processes and violate permit stipulations.

Wastewater Discharges

Wastewater may not be discharged to tundra or other surface waters without a permit issued by state and/or federal agencies. Discharge permits often include numerical pollutant limits, as well as requirements for monitoring, sampling, reporting, and best management practices such as erosion control at the discharge point.

Examples of regulated wastewater discharges include:

- Treated graywater and sewage from camps
- Fluid used to pressure-test (hydrotest) pipelines or vessels
- Gravel pit dewatering
- Pad and containment dewatering
- Discharge of any chemicals or process wastes
- Discharges that change the temperature or turbidity of the receiving waters

Stormwater

Discharge of contaminated runoff or snowmelt ("stormwater") is prohibited by state and federal regulations.

Stormwater may not cause a sheen, excess turbidity, or erosion when it reaches the tundra or receiving waters.

Many facilities have Storm Water Pollution Prevention Plans (SWPPPs). SWPPPs describe site-specific procedures and best management practices that prevent contaminated runoff, such as:

- Keeping work sites and equipment clean (good housekeeping)
- Inspecting sites often to detect potential pollutant sources
- Promptly reporting and cleaning up spills
- Storing chemicals and other potential pollutants carefully to minimize contact with snow and rain
- Properly managing and disposing of contaminated snow (see Section 4)
- Monitoring runoff and dewatering locations for evidence of contamination, sedimentation, or erosion

Dewatering Pads and Containments

Accumulated water in impoundments and secondary containments may not be discharged without approval. If dewatering is necessary, consult the Environmental staff.

Section 6
WILDLIFE

Non-Interference Policy

On the North Slope, we are privileged to work in the midst of a healthy and unique wildlife community. All North Slope operating companies maintain a strict non-interference policy. Disciplinary action, including loss of job, may be imposed on any employee or contractor who violates this policy.

Never feed, approach or harass any wildlife.

Although the operating companies make every effort to protect both people and wildlife, individuals must also take personal responsibility.

- Follow rules and procedures, and encourage your co-workers to do the same.
- Report wildlife sightings as directed.
- Know your site's alarm and response procedures for bears and other potentially dangerous wildlife.
- Do not attempt to handle dead, injured, or trapped wildlife (including birds).
- Drive carefully and give wildlife the right-of-way.
- Never feed or allow food to be available to any wildlife.
- Remove food and food waste from vehicles (including pickup truck beds), watercraft, and aircraft.
- Never litter or pour beverages (such as sodas or coffee) on the ground.

Birds

In May, vast numbers of birds begin to return to the North Slope for the summer. Many birds are protected under the Migratory Bird Act, and some species, such as spectacled and Steller's eiders, are protected under the Endangered Species Act.

June and July are particularly critical months for nesting birds. Every effort should be made to check worksites for nests that could be disturbed, especially in heavy equipment and mobile structures. If disturbance cannot be avoided, contact the Environmental staff for instructions.

Do not touch injured, trapped, oiled, or dead birds. Contact the Environmental staff or Security for assistance.

Foxes

Both arctic and red foxes inhabit the North Slope. Arctic foxes are common on the Arctic Coastal Plain. Red foxes are most often found in the foothills and mountains of the Brooks Range but are becoming more common in coastal areas. They normally prey on small mammals and birds, but may investigate almost any type of food waste or trash at our facilities.

Many foxes carry rabies and are capable of transmitting it at any time, although they may not show symptoms until close to death. We do not want to attract foxes to our work sites.

- Assume that every fox is a rabies carrier. Be especially cautious around foxes that are aggressive, unusually curious, or overly friendly.
- Never feed foxes or leave food where it is accessible to them.
- During pad inspections, check for areas that could be used as den sites. (Foxes start to build dens in March and April.)
- If you come into contact with a fox, go to the medical clinic as soon as possible for evaluation.

Report fox sightings according to the procedures in your operating area.

Caribou

Caribou are an important subsistence resource for local residents on the North Slope. Four main caribou herds — the Porcupine, Central Arctic, Teshekpuk, and Western Arctic — migrate onto the North Slope coastal plain in summer. They calve in May and June. After calving, caribou movements are influenced primarily by insects. In June and July, caribou seek relief from mosquitoes by traveling to the coast. Harassment by oestrid flies typically lasts from mid-July into August, when caribou will seek relief in elevated areas such as drillsites or beneath facility modules or pipelines.

As caribou move through the field, they must be given right-of-way and should not be approached or harassed. Be extremely careful on the roads when caribou are present. Their movements are unpredictable, and sometimes sudden. Drive slowly. Be prepared to stop, and do not use your vehicle

to interfere or influence caribou movements. Special road restrictions may be in effect during calving season, since maternal caribou with calves are especially sensitive to disturbance from vehicles and pedestrian traffic.

Grizzly Bears

The grizzly bear (also called brown bear) ranges throughout northern Alaska from the Brooks Range to the Arctic Ocean. Grizzly bears typically occupy dens between late September/early October to mid-May. Females enter dens earlier and emerge later with their cubs, compared to single females and males.

Bears can be curious but should always be considered dangerous. They have a keen sense of smell and are always on the lookout for food. Once they find a food source, they will keep coming back for more. If bears learn to associate humans with food, they will seek out places where humans live and work, increasing the chances of an encounter. Allowing this to happen because of sloppy food-handling practices puts yourself, your colleagues, and the bears at risk.

All grizzly bear sightings must be reported immediately to Security.

If a bear is sighted, keep your distance and alert other workers. Look around for other bears (for example, cubs accompanying their mothers) and move to a secure location. Do not try to scare the bear away. Do not approach a grizzly bear for any reason.

Polar Bears

Polar bears are listed as a threatened species under the Endangered Species Act, and they are protected from hunting or harassment under the Marine Mammal Protection Act.

Polar bears can be encountered any time of the year in our coastal and offshore operating areas. During the summer, polar bears normally stay far out on the pack ice, hunting seals. As ice bridges form in the fall, they may walk or swim ashore. They travel many miles along the coast during the subsistence whaling season (fall), attracted by the scent of whale carcasses. During the winter months, females occupy dens along river banks, coastal bluffs, and on the sea ice. They typically emerge with cubs in March or April, and move back offshore with the pack ice in the spring.

Any encounter with these large carnivores is potentially dangerous for people as well as the bears, so we must make every effort to avoid interactions. Polar bears can weigh over 1,500 pounds and measure five feet tall at the shoulder (12 feet when standing on their hind legs). They can run 25 miles per hour, and they are excellent swimmers. They have a curious nature, and a remarkably acute sense of smell.

If you see a polar bear, get to a safe location immediately and notify Security.

In order to operate safely and successfully on the North Slope we must follow some basic guidelines.

- **Have a plan.** Be familiar with your site's bear alarm system, and know where to go for safety.
- **Keep your eyes open.** Even if your site has a full-time security staff or "bear monitor", scan the area before stepping outside. Be vigilant when walking between buildings, equipment, and stacked materials. Use a buddy system when working outdoors. At least one of your crew should be monitoring your surroundings at all times.
- **Design your work site**. The chance of a surprise encounter can be reduced if your work site is well lit, organized to minimize hiding places, and equipped with safety features such as protective cages at doorways and strategically staged refuge areas (vehicles, connexes, etc.).
- **Control food and wastes**. Bears can smell food many miles away. They may also be attracted to the scent of toxic materials, like antifreeze. Food and food waste must be secured indoors, whenever possible, and other potential attractants must be minimized. Bears may visit work sites out of curiosity, but their visits will be transitory if they are not rewarded with food. **Never feed bears or any other wildlife**!
- **Avoid den sites**. We must identify and avoid den sites when planning ice road routes or conducting other winter activities. Den site awareness training may be required for ice road construction and travel. There is always the possibility that a bear might emerge unexpectedly from a den. If you see a polar bear anywhere in the vicinity of an ice road, STOP and contact Security immediately. Traffic might be halted for hours or even days. Do not proceed until you are instructed to do so.

DO NOT APPROACH A POLAR BEAR FOR ANY REASON.

Any action – including photography – that affects a bear's behavior may be considered a violation of regulations and company policies.

Only trained and certified personnel are authorized to interact deliberately with polar bears or other wildlife.

Section 7
SPILLS

Introduction

Any incident that releases a contaminant into the environment can be considered a spill and will be taken very seriously. The regulations that apply to spill prevention, reporting, and response are complex, and the penalties for noncompliance are severe. Under federal and state law, we must be able to respond quickly and effectively to any type of spill or emergency.

Most of our spills on the North Slope are small drips and leaks onto gravel pads from vehicles and equipment, but we are also prepared to respond to the most catastrophic event. Comprehensive spill prevention and contingency plans have been developed for the North Slope, and our highly trained response teams are on call 24 hours a day. If necessary, we can draw on resources throughout the world.

Spill Terminology

Each company has its own corporate terminology and definitions, which are not necessarily the same as the regulatory definitions. In general:

- **Oil** includes crude and refined hydrocarbons such as diesel, hydraulic fluid, and lube oil. It can also include oily sludge, oil refuse, or other petroleum-related products or by-products.
- **Hazardous substances** include glycols, methanol, drilling muds, seawater, corrosion inhibitors, produced water — essentially anything other than oil or potable water.

- **Spills to land** include releases to gravel pads and roads, well houses, and unlined well cellars. Depending on the type of construction, some cellars are considered secondary containment.
- **Spills to water** include releases to streams, rivers, lakes, seawater, and wetlands. Almost all tundra in our operating areas is classified as wetland.
- **Spills to secondary containment** includes releases to built-in pits, dikes, berms, portable drip pans, liners, metal skids, impervious module floors, or other impermeable devices.

Spill Prevention

Every worker on the North Slope should know how to prevent spills and what to do if a spill occurs. Contact your Supervisor if you need more information about your specific duties. Prevention — our first and most effective line of defense against spills — is everyone's responsibility.

Fluid Transfer Guidelines

Many spills occur during routine fueling, pumping, and other fluid transfer operations. Most of these spills can be avoided by paying attention and taking simple precautions.

- Review fluid transfer procedures as part of the pre-job safety meeting.
- Use a checklist.

- Verify that adequate surface liners and sorbents are on hand. Surface liners are required under all connections and potential spill points.
- Be aware of special restrictions. Fueling and other fluid transfers may be prohibited on tundra, frozen water bodies, or ice roads.
- Inspect hoses, connections, valves, etc. before starting any fluid transfers. Be sure that valves are in the proper on/off position and each connection is tightened properly.
- Before starting, check all tank and container levels, valves, and vents to prevent overfilling or accidental releases. Check overfill protection devices.
- Maintain a constant line-of-sight with critical components throughout the transfer procedure. Be prepared to stop the transfer immediately if you notice any leak. Do not attempt to fix a leak while fluid is being transferred.
- Use two people if necessary, and never leave fluid transfer operations unattended.
- After the transfer is complete, continue to take these precautions while breaking connections.
- When finished, check the area for spills. Report all spills immediately to the appropriate company representative in your operating area (see back cover).

Secondary Containment

Portable Liners and Drip Pans

Surface liners and drip pans ("duck ponds") provide protection under vehicles and equipment. This is especially important when working off the pad, on tundra, ice roads, or frozen water bodies. Policies and enforcement may vary from place to place, but, in general:

- Whenever a vehicle or piece of equipment (loader, crane, etc.) is parked for more than a few minutes, a liner must be placed under the radiator/engine and any other area subject to leaks.
- Portable liners ("duck ponds") should be inspected frequently to make sure they are intact. They should be tied off or otherwise secured to keep them from blowing out of position.
- Light plants, portable generators, and other fuel-burning support equipment should be placed in containment – especially if parked off the pad.
- Liners are not a substitute for maintenance. Any vehicle or piece of equipment that is known to leak must be taken out of service until it is repaired.
- Contact the Environmental staff for proper handling of fluid or snow that collects in liners.

Secondary containment cannot do its job if it is damaged, collapsed, or full of water/ snow/ice.

Containment for Oil Storage Containers

Secondary containment is required by law for most above-ground oil storage containers. In general, oil storage tanks require secondary containment that can hold at least 110% of the largest tank (or 110% of the combined volume of manifolded tanks).

- ADEC regulates portable and stationary oil storage containers with capacities greater than 10,000 gallons.
- EPA regulates oil storage containers with capacities of 55 gallons and greater.
- Containment must be sized and maintained to preserve the design volume and adequate freeboard in the event of precipitation.
- Other materials or objects should not be stored in containment areas, and debris or excessive water should be removed promptly.
- Fire protection codes and Fire Marshal permits add another layer of regulation for flammable and combustible liquid storage.

Make sure you understand and follow the containment requirements that apply to your location. Any damage to containers or secondary containment should be reported to your supervisor immediately, and repaired as soon as possible.

Before new oil storage containers are put into service, contact the Environmental staff to make sure the tank and secondary containment are in compliance with applicable regulations.

Well Cellars and Well Houses

Most new wells are equipped with steel-or concrete-lined cellars that effectively contain fluid. However, many older wells have unlined cellars that are not considered secondary containment by ADEC, because releases into unlined cellars may eventually migrate through the pad and ultimately to the surrounding environment. Note that well houses are not considered secondary containment.

Spill Reporting

ALL spills regardless of size or location must be reported immediately to the appropriate company representative (see back cover of handbook).

This ensures proper response, cleanup, disposal, and timely agency reporting. Failure to report spills is a violation of regulations and company policies, and may result in more severe penalties than the release itself.

Not all spills are agency reportable. Some may not be considered recordable incidents within the company. Trained and authorized Environmental staff will ensure that agency and corporate notifications are made as required.

To report a spill, call the appropriate number for your operating area (see back cover). Each operating area has slightly different procedures, but you will be guided through the process when you make the call.

When reporting a spill, be prepared to provide the following information:

- Person and/or department responsible
- Contact phone number
- Substance spilled
- Location of spill
- Approximate amount spilled
- Possible cause of the spill
- Cleanup activities underway

Spill Response and Cleanup

All spills must be cleaned up to the satisfaction of the operating company and the appropriate regulatory agencies. In some cases, the person reporting the spill may be able to take care of the cleanup. However, the Environmental staff or designated spill technician should always be consulted. Cleanup workers must have the appropriate level of training and personal protective equipment for the circumstances. Applicable safety protocols must be followed.

Contaminated snow, gravel, and other materials from spill cleanups must be stored in approved locations pending proper disposal. Storage containers may require ADEC approval and secondary containment. Options may include lined outdoor pits, lined containers, hoppers, and temporary stockpiles.

Section 8
WASTE MANAGEMENT

Introduction

Handling the by-products of our operations, from drilling muds and chemical wastes to food and other camp wastes, is one of our greatest challenges. We operate in a very sensitive and highly regulated environment. Our access to "public" facilities is limited. The costs and liability of shipping wastes off the North Slope are extremely high.

North Slope operating companies are constantly working to reduce waste generation and improve waste management practices. Our goal is to minimize our impact on the environment, improve efficiency, and control costs.

Waste Minimization

We can minimize waste in several ways.

- **Source reduction.** Order only what is needed for the job, and avoid having to discard unwanted or outdated products.
- **Product substitution**. Replace products with alternatives that are less hazardous. However, some products are not as environmentally friendly as their manufacturers claim. Be sure to review the Material Safety Data Sheet (MSDS) and other available information.
- **Source control**. Good housekeeping, proper waste segregation, and spill prevention help minimize waste generation.
- **Reuse and recycling.** Material that can be legitimately reused or recycled is not classified as a waste.

Be sure to segregate materials, use the right containers, and follow instructions.

Contact the Environmental staff for information about recycling programs in your area.

Many North Slope operating companies and service companies have joined Green Star® chapters to demonstrate their commitment to waste reduction, recycling, and energy conservation. The benefits include substantial cost savings, efficiency, and community approval.

Waste Management Resources

Waste management regulations are very complex, and the consequences of mismanagement are serious; but tools are available to help workers make the right decisions.

- **Alaska Waste Disposal & Reuse Guide – the "Red Book".** The "Red Book" provides practical guidance on wastes generated in the North Slope oil fields. The document is updated on a regular basis, and it is widely used as a reference by several operating companies and service companies. In order to get the most out of the Red Book, users should attend a special training program (see below).
- **Waste Management Certification Training ("Red Book" Training).** This training program focuses on waste classification, disposal, and reuse options

on the North Slope, and use of the North Slope Manifest (see below). Upon successful completion of the training, attendees are eligible for "certification", which means that they are authorized to utilize certain in-field disposal and recycling facilities on the North Slope. For more information about Red Book training, please contact your Environmental staff.

- **North Slope Manifest.** The North Slope Manifest is a tracking form for wastes and some recyclables that are managed exclusively on the North Slope. It is mandatory for disposal wells and is gradually being adopted by other facilities. The manifest must be completed and signed by a generator, transporter, and receiver, all of whom have completed the Waste Management Certification Training.
- **Other resources.** Your Environmental staff will gladly help you with any waste management questions and can direct you to other resources and training opportunities.

Waste Classification

Disposal and reuse options depend on the way wastes are legally classified. In this section, we will discuss the major waste categories, and provide a brief overview of the disposal and reuse facilities on the North Slope.

Do not attempt to classify wastes without proper training. Direct any waste management questions to the Environmental staff.

Hazardous Waste

The EPA regulates hazardous waste under authority of the Resource Conservation and Recovery Act (RCRA). RCRA's "cradle-to-grave" rules apply to the generation, transportation, treatment, storage, and disposal of hazardous waste.

A waste may be considered hazardous if it exhibits certain physical properties ("characteristics") or it is included on specific list of wastes ("listed") that pose substantial hazards to human health or the environment. The Environmental staff uses laboratory testing, MSDSs, and prior experience to determine if a waste meets the legal definition of hazardous.

- **Characteristic hazardous waste** has one or more of the following properties:

  Ignitability: Liquids with a flash point less than 140°F. Examples: methanol, waste gasoline, thinner.

  Corrosivity: Liquids with a pH less than or equal to 2.0, or greater than or equal to 12.5. Examples: strong acids or bases.

  Toxicity: Material that exceeds regulatory limits for specific metals and compounds. Examples: benzene, lead, cadmium.

  Reactivity: Material that is unstable, reacts violently with water, explodes, or produces toxic vapors under certain conditions. Examples: pressurized aerosol cans,

- **Listed hazardous waste** includes certain chemical products, and by-products of specific manufacturing processes. Examples: methanol, spent chlorinated solvents, some refinery wastes.

There are no hazardous waste disposal facilities in Alaska. All hazardous waste generated on the North Slope must be shipped by licensed transporters to authorized facilities outside of Alaska. Between shipments, hazardous waste can be collected on site in Satellite Accumulation Areas (SAAs, described below) and controlled areas under the supervision of the Environmental staff.

No hazardous waste may be transported from one North Slope operating area to another!

Universal Waste

Universal waste is a subcategory of hazardous waste with less stringent management requirements that encourage recycling. The most common universal wastes on the North Slope are light bulbs ("lamps") and batteries (NiCad, mercury, and lithium), which contain recyclable components. Note that alkaline batteries are not considered universal wastes — they may be discarded with ordinary trash in waste baskets and landfill dumpsters.

Universal wastes are collected on site in Universal Waste Accumulation Areas (UAAs, described below), which are often near SAAs. Universal wastes are usually shipped outside of Alaska along with our hazardous wastes.

Exempt Waste

Certain types of wastes are exempt from regulation as hazardous waste under RCRA. These wastes must still be managed carefully, but they are not subject to the full spectrum of storage, transportation, and disposal rules. Exemptions are very important, but they must be interpreted carefully.

- **Exploration and production (E&P) exemption.** Wastes that are uniquely associated with oil and gas exploration and production are not regulated as hazardous waste. The exemption applies to crude oil, produced water, formation cuttings, and fluids that have been used downhole, such as returned muds, workover and stimulation fluids, and freeze-protection fluids. The exemption does NOT apply to new or unused products, or the non-exempt wastes described below.

The E&P exemption is based on the way the waste was generated, not on its composition.

- **Empty container exemption.** Wastes remaining in empty containers are not subject to hazardous waste regulations. A container is considered "RCRA empty" if there is no more than one inch of residue inside; or, if the container holds more than 110 gallons, less than 0.3% by weight. If the residue is removed from the container, however, it is no longer exempt and must be managed as hazardous waste if it is characteristic or listed.

- **Household exemption.** Hazardous waste generated in private households and camp bunkhouses is RCRA-exempt. Many communities have set up collection programs to keep this waste out of landfills and sewage treatment systems.

Non-Exempt Waste

Many North Slope waste streams are not RCRA-exempt. Non-exempt wastes include:

- Snowmelt and ponded water from pad surfaces and secondary containments
- Unused seawater
- Unused chemical products
- Vehicle fluids (diesel, gasoline), lubricants, and antifreeze
- Gravel or absorbents contaminated with glycol, hydraulic fluid, or motor oil
- Most maintenance and construction wastes

Non-exempt wastes must be classified as hazardous or non-hazardous by trained and qualified personnel.

Waste Mixtures

Waste management becomes very complicated if different "classes" of waste are mixed together. A small amount of hazardous waste, mixed with a non-hazardous waste or recyclable material, can make the whole mixture a hazardous waste. Disposal costs and liabilities for hazardous waste are very high, so it is extremely important to identify your wastes and keep them segregated.

Labeling

All containers, whether they contain wastes or new products, must be labeled properly and clearly. This is important to workers and to emergency response teams, who need to know what they are dealing with. In some cases, improper labeling is a violation of the law. If drums or containers are found without labels, the contents must be handled as hazardous until otherwise identified. The expense of identifying unknown substances can raise the handling cost significantly.

The site supervisor is responsible for ensuring that labels are readable and intact. Missing or unreadable labels must be replaced.

Dumpsters

Several types of dumpsters are available for solid waste and recyclable materials on the North Slope. Dumpsters should only be used for their designated purpose. Be sure to read the placards, and check with the Environmental staff if your material is not listed below, or if you are not sure which dumpster to use.

Think about recycling first!
Before discarding something in a dumpster, find out if recycling options are available in your area.

Landfill Dumpsters – also known as C&D (Construction & Debris) or MSW (Municipal Solid Waste) Dumpsters – are for non-oily solid waste that cannot be recycled or burned on-site. Loose trash should be bagged before it is thrown into a dumpster so that it is not blown away by the wind or easily picked up by birds and other wildlife.

Landfill dumpsters can generally be used for:

- Alkaline batteries
- Concrete (solid, small amounts)
- Electrical cable, wire
- Empty containers (bottles, buckets) — free of oil or liquid; no aerosol cans
- Glass
- Hoses (no oil, chemicals, or free liquids) – in some areas, must be cut into segments
- Insulation (no asbestos)
- Metal scraps (if not recycled; non-oily)
- Paper products (if not recycled)
- Plastic
- Rubber
- Styrofoam
- Tires (must be cut up if larger than 20" in diameter)
- Wood scraps (if not recycled)
- Visqueen, pit liner (non oily)

For very large, bulky items, special open-top dumpsters may be available.

Do not dispose of chemicals, hazardous wastes, liquids, pressurized aerosol cans, snow, or gravel in dumpsters.

Food Waste Dumpsters have animal-proof lids or cages. Never discard food waste in an open-top dumpster. Food waste should be discarded in indoor receptacles whenever possible to avoid attracting birds, foxes, and bears.

Never store food or food waste where it is accessible to wildlife.

"Burnable" or Incinerator Dumpsters are provided in some locations for trash that is burned on site. Always verify site-specific procedures.

Oily Waste Dumpsters are lined to prevent leakage. They are for non-hazardous oily wastes with no free liquids. In many operating areas, oily waste must be packed in clear oily waste bags with yellow stripes before it is placed into the dumpster. Several locations require double-bagging, and there may be weight limits on each bag. Identification tags may be required. Be sure to comply with the procedures at your location.

Oily waste dumpsters may generally be used for:

- Grease or pipe dope cans, empty and wiped clean (no liquids)
- Oil filters (must be punctured and hot-drained)

- Oily pit liner material (no free liquids, snow, dirt or gravel) cut, rolled, and tied
- Sorbents, rags, wipes, floor sweepings, or other oily debris (no hazardous wastes or free liquids)

Secondary containment requirements (see Section 7) may apply to oily waste storage containers.

Scrap Metal (Recyclable) Dumpsters are usually marked with the words "Recyclable Metal."

Acceptable materials include:

- Banding (cut up and boxed or drummed)
- Cable (spooled or rolled)
- Conduit and fittings
- Pipe (oil-free; can have small amounts of insulation)
- Plate steel
- Stainless steel, copper, aluminum
- Valves
- Wire

Do not place asbestos, batteries, light bulbs, hazardous or oily wastes, liquids, pressurized aerosol cans, gravel, or food waste in scrap metal dumpsters.

Recyclable Wood Containers. As part of a growing effort to keep usable wood out of the NSB landfill, many areas collect pallets, plywood, wood scraps, and wood packaging in designated locations.

Accumulation Areas

Satellite Accumulation Areas (SAAs) are temporary collection sites for small quantities of hazardous waste, such as spent aerosol cans, contaminated rags, paints, thinners, and solvents. Wastes are periodically collected by the Environmental staff, and moved to centralized locations in each operating area where they are prepared for shipment to disposal facilities outside of Alaska. SAAs are often established at drill rigs, paint shops, laboratories, and production facilities. Contact your Environmental staff if you would like to set up an SAA in your area.

Although procedures may vary slightly from place to place, the following guidelines apply to all SAAs on the North Slope.

- The SAA must be located at or near the point of waste generation, and under the control of a designated person or operator-in-charge.
- Each container must be labeled with the words "HAZARDOUS WASTE" or with other words that identify the contents of the container. Containers must be compatible with the contents and in good condition. Do not mix different types of waste in the same container.
- Except when filling, containers must be closed at all times. Lids and bungs must be secure; funnels should be removed (unless they have their own secure valves or lids).

- A SAA may have several containers for different types of waste, but each SAA is limited to a total of 55 gallons. Smaller containers can be used to help stay below the limits. The limit for acutely hazardous waste (found mainly in medical clinics) is one quart.
- Once an SAA has reached its capacity, the contents must be moved to a designated collection point within three days.

Universal Waste Accumulation Areas (UAAs) are used primarily to collect used batteries and light bulbs (lamps). They are often located near SAAs.

Recyclable Accumulation Areas (RAAs) are used to collect used oil and other recyclable materials. Please contact your Environmental staff to verify site-specific procedures at your location.

- Used oil from vehicles and equipment can be blended into the crude oil stream at several production facilities and sent to refineries downstream. There may be sampling and screening requirements; check with the Environmental staff.
- Do not add solvents or any other hazardous waste to used oil or other recyclable fluids.

Used oil containers must be clearly labeled with the words "Used Oil" and must have appropriate secondary containment (See Section 7).

- Be careful not to mix different types of fluid until you are sure that the mixture is acceptable.

Underground Injection Wells

On the North Slope, stable geological conditions make it possible to safely and permanently inject fluids thousands of feet below the surface. This has tremendous environmental benefits, because it eliminates the need for large surface disposal facilities on or off the North Slope.

Permits are required to drill and operate Underground Injection Control (UIC) wells, and there are restrictions on the type of material that can be injected. Each of the North Slope injection facilities has its own operating restrictions, training requirements, and manifesting procedures.

- **Class I disposal wells** may inject non-hazardous and exempt wastes. Some facilities can process solids for injection as a slurry; others are limited to fluids.
- **Class II disposal wells** are restricted to waste that has physically come out of an oil and gas well. This includes all produced fluids; muds and additives that have circulated in the well; and solids that originate downhole, such as formation cuttings.
- **Class II enhanced oil recovery (EOR) wells** are used to inject produced water and other approved fluids directly into the oil-producing formation, to increase oil production. EOR, also known as "waterflood," is considered a beneficial use of fluid rather than disposal.

Drum / Barrel Management

All North Slope companies have made progress in reducing the use of 55-gallon drums. By switching to bulk storage, there is much less product wasted, and fewer empty drums require handling and disposal.

BPXA operates the North Slope Barrel Crushing Facility at the A3W2 Warehouse on Santa Fe Pad, in the Greater Prudhoe Bay operating area. Empty steel and plastic drums are cleaned at a high-pressure washing station and then crushed. Residual liquids rinsed from the drums are collected and evaluated for proper disposal. Crushed drums are recovered as scrap metal if possible; otherwise they are landfilled.

Each operating area on the North Slope has its own procedures for collecting and transferring drums to the barrel crushing facility. Please check with your Environmental staff or, in some areas, the Materials department for instructions.

In general:

- Drums may not contain more than one inch of product.
- All drums must be accompanied by proper paperwork, including billing information and a description of the last known material in the drum.
- No empty drums may be left at the barrel crushing facility without prior approval.

CONTACTS

	SPILL	EMERGENCY
BP		
Badami	659-1200	659-1200
Endicott	659-6900	659-6900
Greater Prudhoe Bay (East)	659-5700	911 or 659-5300
Greater Prudhoe Bay (West)	659-5700	911 or 659-4222
Milne Point	670-3300	670-3399
Northstar	670-3515	911 or 670-3500
ConocoPhillips		
Alpine	670-4002	911 or 670-4900
Kuparuk	659-7997	659-7300
ENI		
OCC		670-8500
ExxonMobil		
Point Thomson	564-3668	564-3668
Pioneer Natural Resources Alaska		
Oooguruk	670-6623	670-6500

Solid Waste Disposal Permit

The Alaska Department of Environmental Conservation regulates solid waste storage, treatment, transportation, and disposal under 18 Alaska Administrative Code (AAC) 60. The EPA administers the Resource Conservation and Recovery Act (RCRA) relating to hazardous wastes and Underground Injection Control Program (UIC) Class I injection wells. A different state agency, the Alaska Oil and Gas Conservation Commission (AOGCC), regulates UIC Class II oil and gas waste management wells. For all solid waste disposal facilities regulated by ADEC, a comprehensive disposal plan is required, which must include engineering design criteria and drawings, specifications, calculations, and a discussion demonstrating how the various design features (liners, berms, dikes) will ensure compliance with regulations. Before approval, solid waste disposal permit applications are reviewed for compliance with air and water quality standards, wastewater disposal, and drinking water standards, as well as for their consistency with the Alaska Historic Preservation Act. The application for a waste disposal permit must include a map or aerial photograph (indicating relevant topographical, geological, hydrological, biological, and archaeological features) with a cover letter describing type, estimated quantity, and source of the waste, as well as the type of facility proposed. Roads, drinking water systems, and airports within a two-mile radius of the site must be identified, along with all residential drinking water wells within one-half mile. There must also be a site plan with cross-sectional drawings that indicate the location of existing and proposed containment structures, material storage areas, monitoring devices, area improvements, and on-site equipment. An evaluation of the potential for generating leachate must be presented as well. For above-grade disposal options, baseline water quality data may be needed to establish the physical and chemical characteristics of the site before installing a containment cell.

Non-drilling related solid waste must be disposed of in an approved municipal solid waste landfill (MSWLF). MSWLFs are regulated under 18 AAC 60.300-.398. All other solid waste (except for hazardous materials) must be disposed of in an approved monofill (18 AAC 60.400-.495). A monofill is a landfill or drilling waste disposal facility that receives primarily one type of solid waste and that is not an inactive reserve pit (18 AAC 60.990(80)). An inactive reserve pit is a drilling waste disposal area, containment structure, or group of containment structures where drilling waste has not been disposed of after January 26, 1996, and at which the owner or operator does not plan to continue disposing of drilling waste (18 AAC 60.990(62)). Closure of inactive reserve pits is regulated under 18 AAC 60.440.

Drilling waste disposal is specifically regulated under 18 AAC 60.430. Design and monitoring requirements for drilling waste disposal facilities are identified in 18 AAC 60.430(c) and (d), respectively. Under 18 AAC 60.430(c)(1), the design must take into account the location of the seasonal high groundwater table, surface water, and continuous permafrost, as well as proximity to human population and to public water systems, with the goal of avoiding any adverse effect on these resources. The facility must be designed to prevent the escape of drilling waste and leachate; be of the minimum volume necessary for drilling waste disposal and emergency relief volume; prevent overflow from, or damage to, containment structures or other waste management areas, from operations, annual average precipitation, wind or wave action; and, ensure that drilling waste, leachate, or eroded soil from the facility does not cause a

violation of applicable water quality standards at the surface water point of compliance or at the uppermost aquifer at the groundwater point of compliance.

The plans for the proposed design and construction of the drilling waste disposal facility and the fluid management plan must be approved, signed, and sealed by a registered engineer per 18 AAC 60.430(c)(5). Presently, the preferred practice is to dispose of drilling fluids by reinjection deep into the ground; however, EPA and ADEC may authorize limited discharge of waste streams under the National Pollutant Discharge Elimination System (NPDES) permit system. All produced waters must be re-injected or treated to meet Alaska Water Quality Standards before discharge. Before a well may be permitted under 20 AAC 25.005, a proper and appropriate reserve pit, also known as a solid waste disposal cell, must be constructed or appropriate tanks installed for the reception and confinement of drilling fluids and cuttings, to facilitate the safety of the drilling operation, and to prevent contamination of freshwater and damage to the surface environment (20 AAC 25.047). Typically, a reserve pit is a containment cell lined with an impermeable barrier compatible with both hydrocarbons and drilling mud. Average dimensions are approximately 130 feet wide by 150 feet long by 12 feet deep, although specific configurations vary by site. The cell may receive only drilling and production wastes associated with the exploration, development, or production of crude oil, natural gas or hydrocarbon contaminated solids. The disposal of hazardous or other waste in a containment cell is prohibited. After the well is deepened, the residue in the reserve pit is often dewatered and the fluids are injected into the well annulus. An inventory of injection operations including volume, date, type, and source of material injected is maintained by requirement. Following completion of well activities, the material remaining in the pit is permanently encapsulated in the impermeable liner. Fill and organic soil is placed over it and proper drainage is re-established. Surface impoundments within 1,500 feet are sampled on a periodic basis and analyzed. In addition, groundwater monitoring wells are drilled and sampled on a regular basis. If there are uncontained releases during operations, or if water samples indicate an increase in the compounds being monitored, additional observation may be required. Closure of reserve pits is administered under 18 AAC 60.200. Substances proposed for disposal that are classified as “hazardous” undergo a more rigorous and thorough permitting and review process by both ADEC, per 18 AAC 62 and 63, and the EPA.

Wastewater Disposal Permit

Domestic graywater must be disposed of properly at the surface and requires a Wastewater Disposal Permit per 18 AAC 72. Typically, waste is processed through an on-site plant and disinfected before discharge. ADEC sets fluid volume limitations and threshold concentrations for biochemical oxygen demand (BOD), suspended solids, pH, oil and grease, fecal coliform, and chlorine residual. Monitoring records must be available for inspection, and a written report may be required upon completion of operations.

Appendix B

Examples of Norway E&P NORSOK Standards & Disposal of Oil Contaminated Drill Cutting

NORSOK STANDARD S-003

Rev. 3, December 2005

Environmental care

Standards Norway
Strandveien 18, P.O. Box 242
N-1326 Lysaker
NORWAY

Telephone: + 47 67 83 86 00
Fax: + 47 67 83 86 01
Email: petroleum@standard.no
Website: www.standard.no/petroleum

Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF) and Federation of Norwegian Industry.

NORSOK standards are administered and published by Standards Norway.

Introduction

The third edition of this NORSOK standard is a complete revision of the previous edition, focusing on the following elements:

- to describe the decision process at the various stages of design development and the environmental issues related to these;
- to identify the main criteria for the decisions to be made;
- to identify analytical tools and methods that can be used to arrive at specific requirements for the individual contracts;
- to provide a format for documenting the output of these decision processes which can be used in different contract forms for the execution phase of a project.

The rationale for this structure, which differs considerably from other NORSOK standards, is that there are few pre-accepted solutions that are applicable to all projects with respect to environmental issues. Previous editions of this NORSOK standard have also included many options to explore and solutions to consider. Many of these considerations have to be done in an early stage of the project development, and are usually performed by the operating company internally and/or by a FEED contractor prior to project execution. Many of the statements in this NORSOK standard are difficult to handle contractually, and it is therefore necessary to supplement this NORSOK standard with specific requirements in the execution contracts.

The intention with the third edition is that this NORSOK standard is considered to be a guideline for use internally in the operating companies and possibly in FEED contracts. It will have to be supplemented by other contract documents, such as the design basis and/or other specifications during execution. The functional requirements in this NORSOK standard are listed in tabular form in 5.2 to 9.3, and the blank column to the right may be used to fill in brief statements regarding the conclusions of studies, analyses and decisions with references to other contract documents when relevant. Thus this NORSOK standard constitutes a template for creating an operator's document for documenting and tracing the environmental decisions that are made during the project cycle.

The objective of this NORSOK standard is to achieve implementation of technology that minimizes adverse impacts on the environment. The most cost effective technical and/or operational solutions should be sought, based on the principle of BAT and life cycle cost analyses.

This NORSOK standard includes criteria and methods for establishing limitations for emissions to air, discharges to sea, for selection and handling of chemicals and for waste management. Furthermore, some options regarding technologies that may be applied to achieve the environmental objectives are listed. Project specific requirements will be the result of analyses and evaluations for the actual project, and these results can be entered into an open column adjacent to the functional requirement/objective in this NORSOK standard with a reference to more detailed contract documents, when relevant.

Guidelines for drilling rigs are presented, which may be used in drilling contracts, are presented in Annex C. This is also in the form of optional requirements, where the operating company has to select the relevant level of protection according to the sensitivity of the drilling site and other criteria.`

This NORSOK standard is published without marking of changes, compared to Rev 2, as the modifications are comprehensive.

1 Scope

This NORSOK standard is a guideline that applies to field development, design, construction, installation, modification and decommissioning of installations for offshore drilling, production and transportation of petroleum.

The principles of this NORSOK standard are applicable to new developments as well as modifications and tie-in projects. However, the relevance and applicability of the different requirements will have to be reviewed in context with the scope of the project.

This NORSOK standard covers offshore activities in areas of “normal” environmental sensitivity. More stringent requirements apply to certain licence areas, and the conditions of the exploitation licence shall be observed.

2 Normative and informative references

The following standards include provisions and guidelines which, through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements and guidelines of the standards referenced below.

2.1 Normative references

Council Directive 96/61/EC,	Integrated Pollution Prevention and Control
IMO International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), Annex 1	
IMO MEPC.107(49),	Revised guidelines and specifications for pollution prevention equipment for machinery space bilges of ships
IMO Regulations	
IMO Requirements,	International Oil Pollution Prevention (IOPP)
ISO 14001:2004,	Environmental management systems
The Framework Regulations,	Regulations relating to health, environment and safety in the petroleum activities
The Activity Regulations	

2.2 Informative references

IMO Guidelines and Standards for The Removal of Offshore Installations and Structures on The Continental Shelf, Assembly Resolution A672, 1989
OLF Handbook in Environmental Impact Assessment for Offshore Decommissioning and Disposal (2001)
OLF Guideline on waste management

OSPAR Decision 98/3,	Disposal of Disused Offshore Installations.

UKOOA Drill Cuttings Inititive, Final Report, Feb. 2002

White Paper No 21 (2004 – 2005),	St.meld. nr. 21 (2004-2005) Regjeringens miljøvernpolitikk og rikets miljøtilstand (The governments environmental policy and the state of environment in Norway)

NOTE Many useful environmental reports are to found on web-sites of

OLF: http://www.olf.no/miljo/miljorapporter/ ,
NPD: http://www.npd.no/Norsk/Emner/Ytre+miljo/Miljo/coverpage.htm
SFT: http://www.sft.no/publikasjoner/ .

Since these pages are continuously being updated, no specific reports are listed.

3 Terms, definitions and abbreviations

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1 Terms and definitions

3.1.1
shall
verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.2
should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.3
may
verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.4
can
verbal form used for statements of possibility and capability, whether material, physical or casual

3.2 Abbreviations

BAT	best available techniques
BOP	blow out preventer
BTEX	benzene, toluene, ethylbenzene and xylene (light aromatic oil components)
DREAM	dose related risk effect assessment model
EIA	environmental impact assessment
EIF	environmental impact factor
FEED	front end engineering and design
FPSO	floating, production, storage and off-loading
HSE	health, safety and environment
IMO	International Maritime Organization
NMVOC	non methane volatile organic compound
NORM	naturally occuring radioactive material
NPD	Norwegian Petroleum Directorate (Oljedirektoratet)
NPV	net present value
OLF	Oljeindustriens landsforening (Norwegian Oil Industry Association)
OSPAR	Oslo and Paris Convention
PDO	plan for field development and operation
SFT	Statens forurensningstilsyn (The Norwegian Pollution Control Authority)
VOC	volatile organic compound

4 Guiding principles

4.1 General

This NORSOK standard assumes that an environmental management system satisfying the principles in ISO 14001 or equal has been established and is maintained.

Governing documents, in the form of acts, regulations, standards, recognized practices and company requirements shall be identified, listed, and applied in the design process.

It should be noted that some of the technologies mentioned in this NORSOK standard as possibilities to be explored, may not be commercial or proven at the time of issue of this NORSOK standard. The responsible for design has to evaluate the maturity of these technologies for application when relevant.

Operational and/or accidental discharges to sea and emissions to air shall be eliminated or minimized through design, choice of chemicals and materials as well as operation and maintenance philosophies.

4.2 Framework conditions

The application of BAT is a bearing principle of the environmental regulations. BAT is further defined in the Council Directive 96/61/EC, Article 2 and Annex IV. The criteria that are part of determination of BAT according to the directive are summarized in the figure in Annex A of this NORSOK standard. However, the functional requirements stated in these regulations and the directive has to be adopted by the operating company into explicit requirements at concept and system level.

The use of this NORSOK standard may help operators and contractors in systematically addressing and documenting the environmental issues and hence obtaining the approvals and permits.

4.3 Decision process

4.3.1 Setting of objectives and goals

The operating companies will usually have environmental policies, strategies and objectives on different levels of the organisation. The company should define project specific objectives and goals based on these general statements in an early project phase.

4.3.2 Option identification and analyses

At the different stages of the design development, from concept evaluation through detailed design, option analyses should be performed where the expected environmental performance is compared between the various alternatives and against regulatory requirements, criteria defined in this NORSOK standard and the specific objectives and goals defined by company.

An example of such a decision process at the concept level follows as shown in Figure 1.

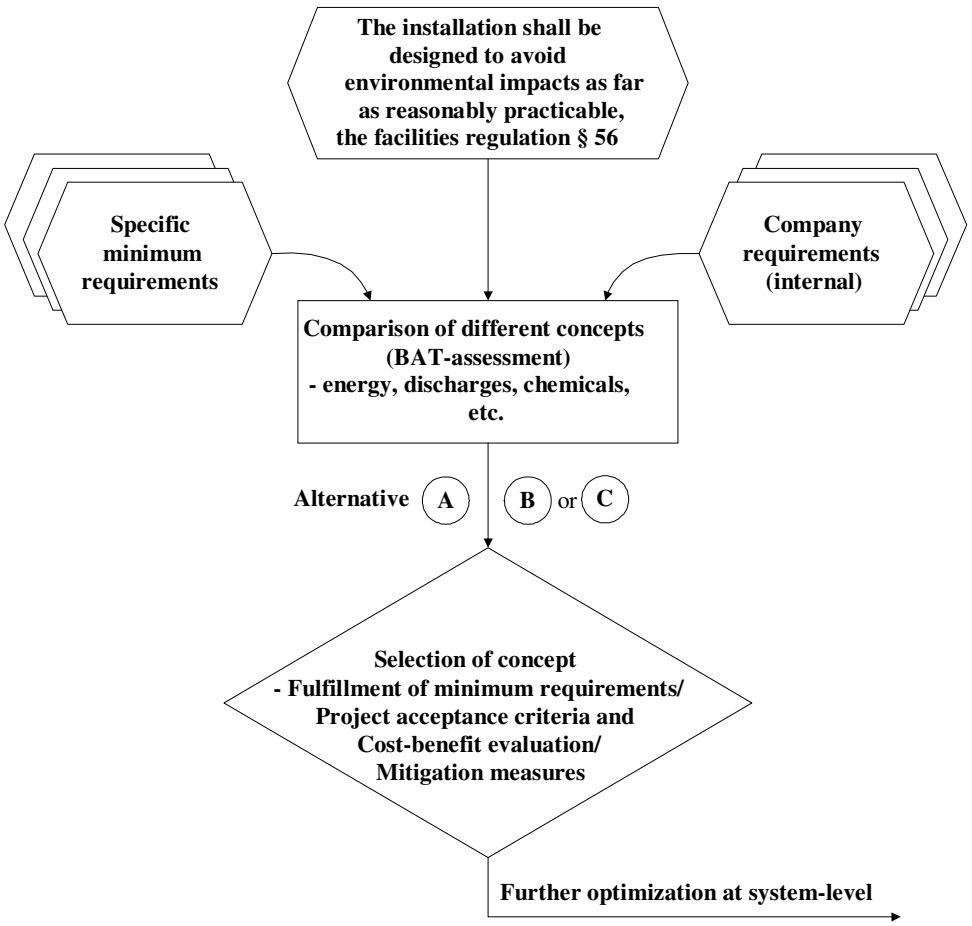


Figure 1 – Example: Integration of environmental aspects in concept selection process

In the decisions, a balance has to be found between environmental objectives and other project objectives related to e.g. cost, schedule, safety, technical performance and working environment. Also, when there are conflicting environmental objectives (e.g. reduction of discharges to sea at the expense of increased energy demand and air emissions), a balance has to be found between such objectives.

Finding the right balance is consistent with the The Framework Regulations and the Council Directive 96/61/EC, Article 2 and Annex IV. See Annex A which illustrates the factors that determine BAT.

4.3.3 Environmental budget

An environmental budget shall be established in order to compare and optimize alternative concepts, technical solutions and designs, or alternative decommissioning and disposal options. The budget shall include life cycle aspects such as expected energy demand and use of chemicals, and estimates for emissions to air and discharges to sea. When chemicals enter the product stream, downstream environmental consequences shall be considered. Annex B outlines the content of an environmental budget. The budget should be updated at appropriate stages in the project.

When a contractor is making an environmental budget during the execution phase, the boundaries of the system has to be clearly defined.

4.3.4 Cost-benefit evaluation

When specific minimum requirements are not established or when there is a need to consider measures beyond such minimum requirements, cost-benefit evaluations should be used to establish the proper level of environmental protection measures. The cost/benefit evaluations should include life cycle aspects. The operating company should establish methods and criteria for such evaluations. The recommended methods and criteria are shown in Annex D.

4.4 Project phases

4.4.1 General

Most operating companies have formally defined project phases and associated decision gate processes when passing from one phase to the next. Evaluation of environmental aspects of each option should be an integral part of each decision gate process. Figure 2 shows a generic project phase flow sheet and the associated decisions related to environment for each phase.

It is important to identify the key environmental aspects for each project phase and especially evaluate all possible concepts that could be relevant as early as possible in order to avoid later costly modifications. It is recommended to perform environmental design reviews at appropriate stages of the project development, e.g. in connection with concept selection, pre-engineering/FEED and during detail engineering. The main aspects to be looked at are listed below.

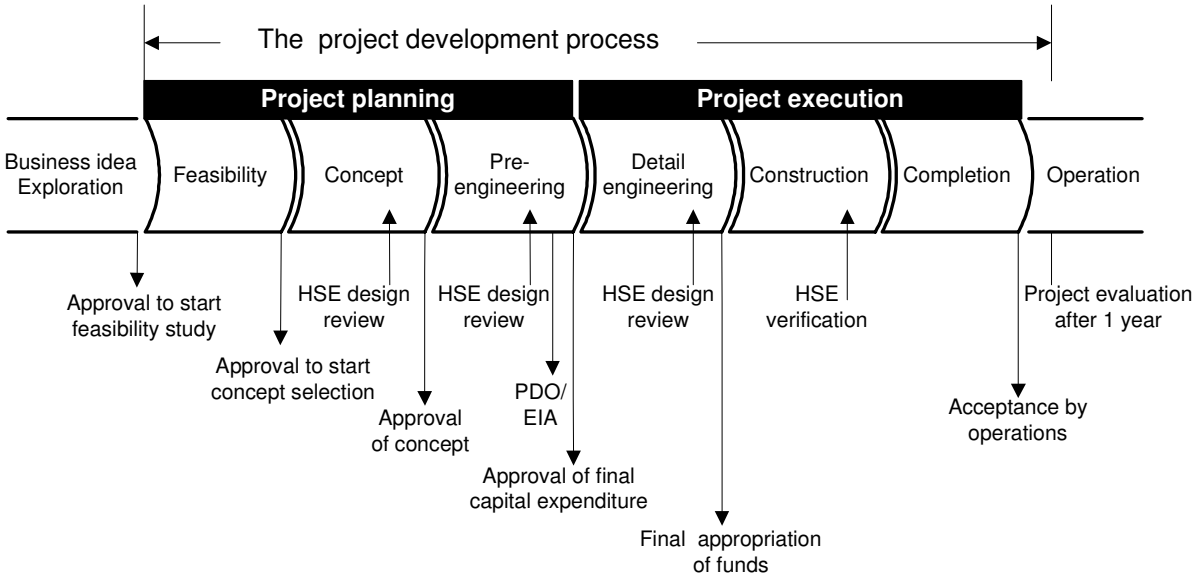


Figure 2 – The project development process

4.4.2 Concept selection

The selection of project concept shall include environmental considerations. The following are examples of main conceptual decisions that will have different impacts on the air emissions and discharges to sea:

- stand-alone development or subsea tie-in to existing platform(s);
- platform or subsea-to-land solution;
- integration with existing platform(s) or infrastructure, e.g. wellhead platform, partial processing, full processing;
- power from land or from other platforms;
- transport solution for oil (pipeline transport or offshore loading);
- transport solution for gas (compression demand, processing requirements);
- reservoir drainage strategy (water and/or gas injection, increased oil recovery, definition of plateau rate);
- possibilities for well stream energy conservation or utilization;
- platform concepts, e.g. floating or fixed, with and without drilling facilities;
- possibilities for injection of produced water, either as a part of pressure maintenance strategy or as a disposal option;
- possibilities for injection of cuttings and excess mud;
- design for easy decommissioning and removal.

The EIA shall document the evaluations and choices made in this phase, and the approval of the PDO/EIA will be an important confirmation of the decisions.

4.4.3 Pre-engineering or FEED

In the pre-engineering or FEED phase the chosen concept is elaborated further to a level of detail and confidence that is required for deciding on execution. The environmental aspects to be looked at this stage are typically related to

- main process design and energy balance,
- power supply configuration,
- flaring philosophy and flare system design,
- identification of main chemicals for e.g. hydrate control, corrosion control, emulsion breaking etc.,
- well program including types of drilling fluids to be used for each section,
- well testing and well clean-up strategy,
- sand control,
- basic design of produced water treatment or injection system,
- basic design of drain systems (segregation etc.),
- basic design of systems for injection or disposal of drilling wastes,
- VOC recovery systems (for offshore loading of oil),
- material quality selection (in order to minimize the use of corrosion inhibitors and other chemicals).

All conditions of the PDO approval and plan for installation and operation approval will have to be considered and implemented.

4.4.4 Detail design

In the detail design phase, the design is further detailed until fabrication drawings can be issued. In this phase the key issue is to avoid changes to the basis already established, and from an environmental point of view confirm that changes do not reduce the environmental performance level. Furthermore, some decisions with environmental significance are usually made, such as

- complete evaluation, selection and documentation of chemicals, including budgets for use and discharge (basis for discharge permit application),
- selection and design of sampling points,
- detailed design of wastewater treatment systems and drain systems,
- detailed spill prevention issues,
- design of waste handling systems.

5 Emissions to air

5.1 General

Emissions to air include CO_2, NOx, methane, NMVOC, and SOx. Field development concepts and technology that minimizes these emissions at the source shall be preferred. Focus shall be given to reduce atmospheric emissions by process design and through energy optimisation.

5.2 Energy management

Functional requirement	Conclusions/references
Good energy management is a key factor in achieving as low emissions as practical. A power and heat requirement analysis shall be performed comprising the process and utility systems over the lifetime of the production facility. The objective is to minimize emissions of CO_2 and NOx by • reducing energy requirements, • increasing the efficiency of energy generation and utilization.	
The following are examples of measures that should be considered for minimizing energy demand when relevant: • well design to minimize water cut and minimize pressure loss; • subsea or downhole separation; • subsea compression or pumping; • maximize operating pressure in first stage separator; • partly separate process trains for high and low pressure wells; • use of turbo-expanders to utilize well pressure; • correct sizing of power demanding equipment to achieve maximum efficiency; • use of variable speed drives on larger equipment with variable loads; • direct turbine drive on large compressors; • optimal sizing of long export pipelines for oil and gas to reduce pressure loss; • waste heat recovery/process integration to minimize the need for fired heaters or electrical heaters; • energy use monitoring and control systems to allow optimum operation and tuning; • multiphase pumping compared to gas-lift; • use of flow improvers for oil export pipelines.	
In order to increase the efficiency of energy production, the following measures should be considered: • gas turbine cycle enhancement, e.g. steam bottoming cycle; • integrated or shared power generation with other installations, as well as the possibility of power supply from shore; • selection of optimum number, size and make of turbines according to power demand profile.	

5.3 NOx control on turbines

Functional requirement	Conclusions/references
New gas turbines should be of low-NOx type to achieve an emission level of 25 ppmv (dry offgas, 15 % O_2) or better. Steam or water injection to achieve a similar level may be considered when this technology is proven for offshore application. The reasons for not achieving a low NOx emission level shall be clearly documented.	

5.4 NOx control on engines

Functional requirement	Conclusions/references
For larger engines (> 1 MW) that will normally be in operation (not stand-by or emergency use), NOx-reducing measures should be considered, such as • selection of engine make with a low NOx emission rate, • use of gas fuel when possible, • use of water emulsion in the diesel, • selective catalytic reduction or similar.	

5.5 Flaring

Functional requirement	Conclusions/references
The process system shall be designed to minimize flaring. This should include, but not be limited to, consideration of the following measures: • recycling of gas from high pressure relief systems during normal operation; • recycling of low pressure relief systems during normal operation (subject to cost-benefit evaluation); • process design that minimizes risk of tripping of compressors etc.; • control and condition monitoring systems to reduce the number of trips; • planning of start-up activities to reduce flaring.	

5.6 Oil storage and loading

Functional requirement	Conclusions/references
FPSO, floating storage units ,shuttle tankers, offshore and onshore loading systems shall be designed to minimize emissions of methane and NMVOC. The following measures should be considered, but not be limited to • sequential loading/unloading of oil, • optimized geometry of tanks with respect to evaporation of hydrocarbons, • loading/discharge rate with respect to evaporation, • use of hydrocarbon gas as blanket gas in floating storage tanks, with recovery, • installation of a VOC recovery plant to return NMVOC to crude oil,	

Functional requirement	Conclusions/references
• installation of a VOC recovery plant to condense NMVOC and use condensed liquid as fuel, • incineration of VOC during loading operations. The process system should be designed to optimize the Reid vapour pressure and true vapour pressure and temperature of the oil, in order to minimize emissions of methane and NMVOC.	

5.7 Fugitive emissions and cold vents

Fugitive emissions and cold vents include all emissions of hydrocarbons (CH_4 and NMVOC) other than combustion processes. The main sources on these emissions are principally linked to

- leakages at valves and flanges,
- emissions from the atmospheric vent system,
- emissions from miscellaneous decentralized systems, i.e. extinguished flare.

Functional requirement	Conclusions/references
The process system should be designed to minimize emissions to air of hydrocarbon gas from different sections of the system. The gas should be either contained or routed back to the process system, if the pressure level and safety considerations allow this. This applies, but is not limited to • gas from seal oil traps, • gas from sampling points, • purge gas and leak gas, • gas from start up of the fuel gas system, • gas from compressor seals, • gas from produced water.	
Emissions of hydrocarbon gas to the air, including glycol and BTEX, from stripping processes shall be minimized, e.g. by use of • systems that do not require stripping gas (e.g. trace water extraction process), • systems using low glycol concentrations, • glycol recycle systems, • systems that recover hydrocarbon stripping gas, • systems based on vacuum deaeration systems using inert gas.	
Cold venting should be avoided. Exceptions should be documented from a technical, economic and environmental point of view.	
Hydrocarbon gas used as a blanket gas shall be recovered.	
Selection of valves, flanges and packings should be based on due considerations in order to reduce gas leakages and fugitive emissions to air.	

5.8 Well testing

Functional requirement	Conclusions/references
Burning of well fluids and well clean-up residues from testing and restart of wells shall, as far as possible, be avoided. If unavoidable, this shall be documented from a technical, economic and environmental point of view. Incomplete burning shall be avoided. When testing or restarting wells on or with connection to a fixed installation, the well fluid should be routed to the production facilities.	
For testing on a mobile rig, at least the following options should be evaluated: • injection of the well fluid at location or at a nearby field, when test separators are designed to handle well stream from testing for this option; • use of facilities with possibility to collect the oil produced during testing; • gas produced during testing may be flared if there is no other cost effective alternative; • downhole testing and separation.	

5.9 Emission control and monitoring

Functional requirement	Conclusions/references
Relevant process parameters should be recorded and processed in order to allow on-line (or nearly online) reporting and trending of emission data for CO_2, NOx, VOC and methane., The information should be available for the operators in order to allow optimisation of the operation.	
CO_2 emissions shall be calculated based on the fuel gas composition, the amount of fuel utilized for power generation (gas and diesel) and the amount of gas being flared, which are measured according to authority requirements.	
NOx emissions may be calculated based on different methods with increasing degree of accuracy: • generic emission factors for turbines, engines and flares (independent of load); • emission factors that are specific for the equipment and the average load they operate at; • online calculation of emissions based on calibrated emission factors at different operating loads for the specific equipment.	
Non-methane volatile organic compounds and methane are usually calculated by use of emission factors for the different source categories. Significant point sources should be measured.	

6 Discharges to sea

6.1 General

Discharges to sea include discharges from drilling and well operations, produced water, drainage water, displacement water, cooling water, sanitary water as well as discharges from testing, cleaning and commissioning of pipelines,.

The overall goal is the zero discharge concept as specified by the authorities in several White Papers (among them White Paper No 21 (2004-2005). The goal is that there should be no discharges of the most hazardous substances, based on the substances' intrinsic properties and the authorities' lists of substances for priority action, and that there should be no disharges, or there should be a minimization of the discharges, of less hazardous substances, if the discharges may lead to adverse effects on the environment.

6.2 Produced water

The main objective is to minimize the environmental risk related to discharge of produced water.

Functional requirement	Conclusions/references
The expected composition of produced water shall be identified, and natural components and added chemicals known to contribute to the environmental risk shall be assessed in terms of concentration and load. The environmental risk should be calculated by the use of the DREAM model or similar tools. The result of the modelling should be used for selection of fitted technologies, including, but not limited to, the following options: • minimize water production by well management and/or downhole or subsea separation of water; • injection of the produced water by – subsea separation, – injection to reservoir to maintain pressure, – injection to disposal well. • maximize regularity of injection system when relevant; • treatment and discharge to sea.	
The concentration of dispersed oil in produced water shall be as low as practically possible and not exceed the regulatory requirement or company requirement.	
When treatment and discharge to sea is selected, the water treatment systems shall be designed and optimized to maintain the treatment efficiency regarding natural solutes, added chemicals and dispersed oil during load variations (e.g. high flow, low flow, during separator jetting), and to operate with a minimum of chemical addition. The following measures should be considered to optimize the treatment process: • minimize pressure drop and turbulence that create stable oil/water emulsions; • use of treatment systems that reduce the content of oil, BTEX, polycyclic aromatic hydrocarbons, and other components that contribute to the environmental risk. Such systems may include different combinations of some of the techniques listed below: – electrostatic oil/water separation;	

Functional requirement	Conclusions/references
– emulsion breaking and foam control; – flocculation; – hydrocyclones; – stripping; – extraction; – membrane filtration.	
The need for back-up systems for critical components in treatment systems, should be considered in order to maintain continuous operation during maintenance activities and keep discharges within limits specified in discharge permits, rules, regulations and company environmental targets.	

6.3 Drain system

Drain systems are classified according to the following applied terminology:

- open drain;
  - non-hazardous open drain;
  - hazardous open drain.
- closed drain.

Functional requirement	Conclusions/references
The open drain system is separated in two subsystems, one for hazardous (classified) areas and one for non-hazardous (non-classified) areas. The open drain system operate at atmospheric pressure and shall handle rainwater, fire water, wash-down water including spillage of liquids and solids from deck areas, equipment drip trays and bounded areas. Hydrocarbon liquid spill shall be recovered and only water meeting regulatory requirements may be dumped to sea. The hazardous and non-hazardous areas shall have dedicated collection systems kept apart from each other. However, the subsystems may have a common oily water treatment plant. Drains from non-polluted areas should be routed directly to sea.	
On a combined drilling and production facility there shall be no connection between the drilling and production open drain systems.	
Systems containing hydrocarbons or chemicals shall be designed to minimize spills. There shall be drains or drip-trays under all sampling points and all injection points. The measures listed in Table C.5 shall be considered to minimize risk of spills.	
Injection of contaminated drainage should be considered, especially drainage from the drilling area, which may be injected together with contaminated cuttings.	
The closed drain system shall collect hydrocarbon liquid drains from platform equipment and piping, and safely dispose and degas the liquid. The system shall operate at the same pressure as the flare header connected to the closed drain flash drum.	
Drain water discharges are subject to regulatory requirements for oil in water content.	

6.4 Displacement water

For platforms with offshore loading and storage of oil in e.g. gravity base structures, seawater is used as displacement water in the oil storage. The displacement water may be discharged without treatment.

Functional requirement	Conclusions/references
Control systems shall be in place to ensure that there is sufficient distance between the oil/water contact and the discharge point at all times. A risk evaluation of this system shall be carried out.	
The need for separate treatment of the emulsion/slop phase near the water/oil contact should be evaluated.	

6.5 Discharges from drilling and well operations

Functional requirement	Conclusions/references
Drilling- and well operations shall be planned with solutions that reduce discharges to sea to a zero harmful discharge level. The following represent examples of technologies that will minimize discharges of drilling waste to sea, and which should be evaluated for implementation: • slim hole drilling; • branched drilling; • batch drilling; • riser-less mud return system; • toe driven conductor; • injection of drill cuttings and used drilling mud; • injection of cementing chemicals (excess mix-water); • injection of completion chemicals; • injection of slop- and drainage water; • reuse of drilling mud; • alternative weighting materials; • heavy salt solutions; • heavy metal free pipe dope.	
The drilling fluid selection should be made following an environmental risk evaluation combined with an operational technical evaluation. Environmental risk management tools should be used where appropriate. Evaluations of alternative technologies shall be documented. The following drilling fluid systems should be evaluated in combination with relevant cuttings disposal options: • use of water based fluid and discharge of cuttings to sea; • use of non-aqueous based fluid and injection of cuttings; • use of non-aqueous based drilling fluid and treatment of cuttings at an approved onshore treatment plant. • use of non-aqueous based drilling fluid and treatment on-board to ultralow hydrocarbon content, discharge to sea.	
The need for back-up systems for critical components in treatment/injection systems should be considered in order to maintain continuous operation and keep discharges within limits specified in discharge permits, rules, regulations and company environmental targets.	
Mud and cuttings handling systems shall be designed to minimize risk of spills. The measures listed in Table C.1 shall be	

Functional requirement	Conclusions/references
considered.	
Discharges from cementing shall be minimized. The list of possible measures listed in Table C.3 shall be considered.	
Discharges from well clean-up and testing shall be minimized. Reference is made to 5.8 and to C.8.	

6.6 Risk of acute discharge/pollution

Functional requirement	Conclusions/references
Process, utility and drilling systems shall be designed to reduce the risk of spills. Hazard and operability study (HAZOP) or similar techniques shall be used to identify risks and risk reducing measures. The measures listed in tTable C.5 and Table C.7 shall be considered.	

6.7 Produced sand

Functional requirement	Conclusions/references
Production process design should include sand handling measures. Well design should aim at minimized sand production. The disposal options for produced sand to be considered include • injection into a subsea geological structure, • cleaning and discharge to sea, • shipment ashore for treatment and disposal. When discharged, the produced sand shall be treated to oil content less than the regulatory limit.	

6.8 Handling of chemicals

Functional requirement	Conclusions/references
The chemical storage system shall be designed to minimize risk of spills (e.g. breakage of sacks) and facilitate collection of spills. Spills of hazardous chemicals that cannot be recycled shall be collected for transportation to shore as hazardous waste.	
The transfer system between transport and storage tanks should be a closed system, which allows complete draining of transport tanks. Only unique couplings should be used on transfer systems in order to reduce risk of unintentional transfer to a wrong tank.	
A separate drain to a chemical spill tank should be provided from the chemical injection package/system. It should be possible to switch from the hazardous drain system to this system during filling and maintenance operations.	

6.9 Sanitary waste water and food waste

Functional requirement	Conclusions/references
Sanitary waste water may be discharged to sea. Food waste shall be macerated before discharged to sea.	

6.10 Cooling water

Functional requirement	Conclusions/references
The intake of cooling water (depth) should be optimized with respect to minimizing the need for use of chemicals to prevent marine fouling, i.e. growth of algae, mussels, etc. The use of copper-chlorination, which minimizes the doses of copper and free chlorine, should be considered.	

6.11 Discharge points

Functional requirement	Conclusions/references
All water discharge points shall be located and designed in order to minimize environmental effects. In order to design for an optimal discharge depth and location, an evaluation regarding dispersion of oil and chemicals, effects on marine species in different marine layers, as well as conflicts with seawater intakes (i.e. cooling water, fresh water production), should be performed.	

6.12 Sampling and monitoring of effluents

Functional requirement	Conclusions/references
Effluent streams shall be monitored as follows: • produced water streams shall be metered and sampled downstream the water treatment plant; • sampling points shall be installed easily accessible up - and downstream of the treatment units, and in the effluent lines, as well as between treatment stages; • access for sampling and visual control of holding tanks for drainage water shall be provided. Automatic samplers, analyzers and online monitoring should be considered when possible.	

6.13 Subsea systems

Functional requirement	Conclusions/references
Subsea systems shall be designed in order to minimize operational discharges and leaks to the environment.	
Hydraulic valve control systems, including BOP, may be based on closed loop systems with return line to the platform/FPSO, or open systems with discharge to the sea. Environmental aspects should be considered in the selection of system as follows: • an assessment of the risk of leakage from the closed system during installation, testing, commissioning and operation should be made based on the design and operational experience with similar systems; • a screening of available hydraulic fluids should be performed in order to investigate if hydraulic fluid(s) containing environmentally acceptable components is available and have the required properties; • the risk of harmful effects from the discharge from an open system should be evaluated based on the properties of the fluids and quantities expected to be discharged.	

6.14 Pipelines

Functional requirement	Conclusions/references
Inhibited water in connection with laying, cleaning, pressure-testing and start-up of pipelines may be discharged to sea subject to a discharge permit. The use of chemicals shall be minimized. The following options should be considered: • the sequence and duration of pipe laying, testing and start-up of the pipelines should be planned in order to minimize the duration between filling and discharge and hence reduce the need for chemicals; • the use of dye for pressure testing should be minimized, i.e. added at local level.	
Material selection shall be evaluated in order to minimize the use of chemicals in the operation phase.	

6.15 Tanks

Functional requirement	Conclusions/references
Drainage tanks and slop tanks shall be designed with sufficient capacity for foreseeable operating conditions.	
Systems to prevent overfilling shall be installed.	

7 Waste

7.1 General

Waste includes cuttings from drilling, wastes from production, drilling and utility areas, consumer waste and scrap metal, hazardous waste and NORM.

7.2 Waste management

Waste shall be minimized through the design and the choice of materials and chemicals in a cost effective manner.

Functional requirement	Conclusions/references
A waste management plan shall be developed to define categories of waste and plans for treatment, disposal, or shipment to shore. The objective should be to minimize the generation of waste and maximize the degree of reprocessing, reuse or recirculation, see OLF Guideline on waste management.	
The layout shall include space for waste containers for segregated collection of waste locally and centrally, and facilitate transport of the containers. Wastes, which cannot be reused at the installation, shall be collected for temporary storage and shipped ashore for reprocessing or destruction in accordance with authority requirements. The system design shall ensure safe handling without the risk of pollution.	
Reclaimed lube oil and other waste oils should preferably be disposed of by mixing into the crude stream. If this is not possible, then injection may be feasible.	
NORM shall be collected in special containers and handled according to regulations and in agreement with the authorities.	

8 Spill prevention and barrier philosophy

These issues are extensively covered in the regulations relating to health, safety and environment in the petroleum activities. Compliance with these regulations should be ensured through e.g. hazard and operability studies and design reviews.

Annex C contains lists of optional requirements to ensure spill prevention, which could be used as a check list for design reviews.

9 Decommissioning

9.1 General

When a field or installation faces the end of its production period, an alternative use shall be found or it shall be decommissioned according to relevant legislation. Both an EIA and a cessation plan shall be worked out well in advance of the end of the production period as required by the authorities, see Figure 3. The handling of oil contaminated cutting piles shall also be considered in this process.

As a general rule, all installations shall be designed so that all parts above the seabed can be entirely removed. Removal costs and potential for reuse shall be evaluated as part of the field development plan.

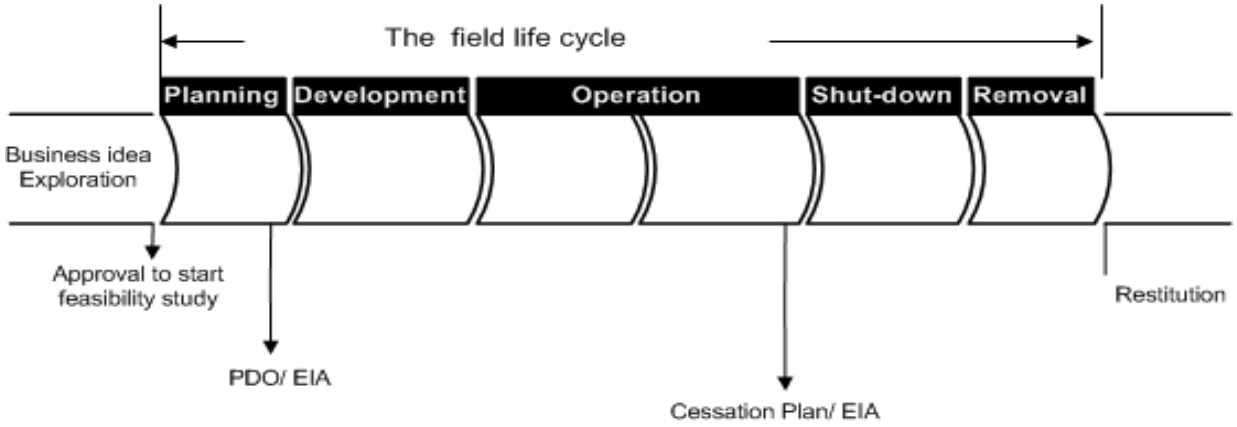


Figure 3 – The field life cycle

9.2 Cleaning operations and waste management

Functional requirement	Conclusions/references
An inventory should be made to map the amounts and characteristics of chemicals, wastes and hazardous materials in the installation and on this basis plan cleaning activities and disposal of the wastes present and created in this process.	
Tanks, pipelines or other equipment containing chemicals shall be emptied. Surplus chemicals (e.g. drilling and production chemicals) should be reused at another location or returned to vendor. Chemicals, which cannot be reused or returned to vendor, shall be taken ashore.	
Tanks, pipelines or other equipment containing oily waste should be cleaned as thoroughly as possible to remove oily waste, e.g. lube oils, hydraulic oils, oily sludge and sediments, wax deposits, etc.. Oily waste shall be taken ashore as hazardous waste.	
All components containing halons, chlorofluoro carbons/hydro chlorofluoro carbons or polychlorinated biphenyls shall be removed and taken ashore for disposal as hazardous waste.	
NORM shall be removed either offshore or onshore. NORM shall be handled and disposed according to authority requirements. Other equipment containing radioactive sources shall be handled safely according to authority requirements.	
Asbestos material requires encapsulation prior to removal. Asbestos material shall be handled and disposed according to authority requirements.	
Batteries shall be removed and taken ashore for disposal as hazardous waste.	
The degree of cleanliness shall be documented before removal and disposal.	

9.3 Options for disposal of offshore installations

Functional requirement	Conclusions/references
All disposal options should be evaluated, e.g. re-use in petroleum activity in place, other use in place, disposal in place, partly removal or complete removal for re-use or disposal. Some disposal options will be determined based on the water depth and the weight of the structure, see "OSPAR Decision 98/3" and "IMO Guidelines and Standards for The Removal of Offshore Installations and Structures on the Continental Shelf, Assembly Resolution A672, 1989".	
An environmental budget should be applied as a part of the overall criteria in selecting the final disposal option. Parameters to be included in the environmental budget are presented in the "OLF Handbook in Environmental Impact Assessment for Offshore Decommissioning and Disposal (2001)". In general, disposal options with a maximum degree of reuse should be aimed at.	

9.4 Oil contaminated drill cuttings on the seabed

The "UKOOA Drill Cuttings Inititive, Final Report, Feb. 2002" concludes that in general, to leave the piles undisturbed or cover the drill cuttings piles for protection are considered to have the lowest environmental impact and should therefore be aimed at. Covering may be required if the piles continue to be a source of new contamination in the area.

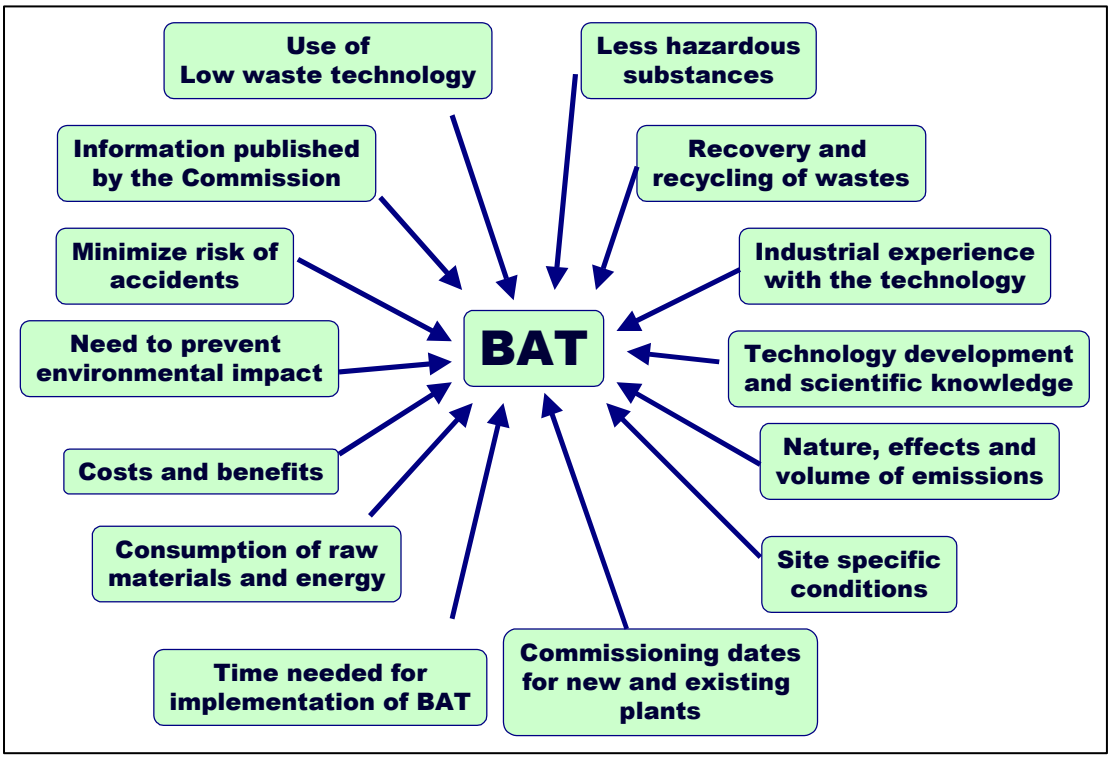
Other options that have been studied, and which were considered less attractive either due to environmental impact, costs, in-effectiveness or combinations of these criteria, are listed below:

- bioremediation;
- retrieval technology;
- removal and injection in a well;
- respreading on the sea floor;
- treatment/disposal offshore or onshore.

However, a case-by-case environmental assessment of each pile should be performed to define the preferred solution. This should include the effect of removing the installation on the cuttings pile.

Annex A
(Informative)
Best available technique (BAT) determining factors

Factors that are relevant in the determination of BAT are shown in the table below, see Council Directive 96/61/EC, Article 2 and Annex IV.



Annex B
(Informative)
Environmental budget

The objective of an environmental budget is to obtain emission and discharge data in order to enable implementation of the best possible technical solutions and practices regarding the environment.

Environmental budgets quantitatively describe the expected energy demand, use of chemicals, emissions to air, discharges to sea and waste generation. It may be reasonable to handle different phases of the project in separate due to individual characteristics, i.e. drilling, commissioning and start-up, production phase, de-commissioning.

The structure of an environmental budget is characterised by a dynamic set-up, which means that the data will change according to the calculation basis, i.e. production profile. Thus, the output of analysis based on present information may be changed due to design development and new knowledge.

An example of the "Contents" of an "Environmental Budget Report" concerning the operational phase is shown below (the setup has to be adjusted to reflect the specific development project):

1. Summary and conclusions

2. Introduction
   - 2.1 Objectives and scope of work
   - 2.2 General description of the project
   - 2.3 Environmental philosophy and requirements

3. Emissions to air
   - 3.1 Sources of emissions to air
     - 3.1. Emissions to air due to combustion processes
       - CO_2
       - NOx
       - CH_4
       - NMVOC
     - 3.2 Direct emissions of hydrocarbons
       - CH_4
       - NMVOC

4. Discharges to sea
   - 4.1 General
   - 4.2 Sources to discharges to sea
   - 4.3 Produced water profile, including injection profile, when relevant
   - 4.4 Produced water composition and calculation of EIF
   - 4.5 Production chemicals budget (including mass balance for use and discharge)
   - 4.6 Drainage water
   - 4.7 Produced sand
   - 4.8 Food waste and sanitary water
   - 4.9 Cooling water

5. Other consumption of chemicals
   (e.g. chemicals to be injected or transported by oil/gas/condensate to shore)
6. Waste
7. References
8. Appendices

Annex C
(Informative)
Environmental requirements for drilling rigs

C.1 Introduction

This annex provides lists of possible environmental requirements and recommentations related to drilling rigs in a tabular form. Depending on the location of the operation, the characteristics of the operation and other factors, not all of these requirements will be necessary to comply with in every case. The intention is that the operating company in the tender documents shall identify those requirements and measures that are compulsory by filling in the second columns of the tables, and that the rig operator may fill in the status of the rig in the third column as a part of the bid. Where compulsory requirements are not met, the rig operator shall describe how this deficiency may be compensated by other measures.

C.2 Policy

Planning and execution of drilling operations on the XX Field shall be based on the principle of zero harmful discharges to sea. Where possible, equipment with low NOx emission characteristics will be favoured, but no specific guidelines will be established for discharge to air.

Selection of rig shall include evaluation of environmental considerations with respect to technical arrangements to prevent spill and discharge to the sea.

The functional requirement is that zero harmful discharges and no un-intentional spill or discharge to sea shall occur. Certain functional and specific requirements are described in C.3 to C.11 in order to secure fulfilment of the philosophy and secure a green drilling unit. Other measures than those described in C.3 to C.11 can be accepted so long as the environmental policy is complied with. These measures shall be described in detail for company approval.

C.3 Rig size

The capacity of the rig to collect and store waste products is a function of its size and design. The rig should be of sufficient size to ensure that bulk and loading capacity are suitable for use of the various liquid systems and simultaneous storage of waste products for cleaning/back loading. Evaluation of a potential rig shall include environmental safety, disposal handling and storage capacity, e.g. in tanks, pits and deck size.

C.4 Use of chemicals

All chemicals shall be selected and used in accordance with governmental and company requirements.

Chemicals shall be selected with consideration to the environment and suitability for the purpose. Chemicals that are most environmentally friendly and at the same time fit for technical and climatic conditions shall be chosen. The climatic conditions have to be carefully considered to prevent situations, which may jeopardize operations or lead to situations that might represent safety or environmental risks.

C.5 Mud and cuttings handling system

The options listed in Table C.1 should be considered according to the types of drilling fluids to be used (water based or oil based), as well as the sensitivity of the drilling location.

Table C.1

Mud and cuttings handling system	Required (Y/N)	Status
Two physical barriers are required to prevent discharge or spill from loading/unloading lines, pits and tanks		
The rig contractor shall develop criteria for “clean tank” and permission to open a drain to sea.		
It shall be possible to back-load mud to the supply boat.		
It shall be possible to transfer slop from mud pits to closed drain/holding tank.		
The rig shall have equipment and capacity to collect, handle and store high solids mud for backloading.		
The shaker system shall be operated to effectively reduce the mud content on cuttings.		
The pits shall be fitted with minimum one dump valve (double secured) and be connected to the closed drain system.		
Double barriers to prevent discharge shall be installed on the mud tank and the drain connected to this tank. It shall be possible to clean the tank and the mud pipelines with spill/cleaning water routed directly to the closed drain system.		
All valves on the mud system, tanks included, shall be easily accessible.		
All pit drains and all outlets from the drilling fluid system to the environment shall be secured by double valves.		
Back loading to boat from tanks for barite and cement shall be possible.		
There shall be two barriers between drain collecting line and each mud pit.		
There shall be double barrier between collecting lines and mud pits. If e.g. pumping dirty water through the collecting line to one mud pit, there should be a double barrier between this line and the inlet to each mud pit.		
Diesel line into the mud pit room shall have double barriers.		

C.6 Cuttings disposal

Table C.2

Cuttings disposal	Required (Y/N)	Status
Cuttings with oil based muds shall be slurrified and injected.		
Cuttings with oil based muds shall be transported to shore for treatment and disposal.		
Cuttings with water based muds shall be slurrified and reinjected.		
Cuttings with water based muds shall be transported to shore for treatment and disposal.		
Cuttings with water based fluids may be discharged (subject to environmental assessment).		

C.7 Cementing

Table C.3

Requirements to cementing system	Required (Y/N)	Status
Two physical barriers are required in the loading/unloading lines and tanks to prevent discharge or spill.		
Rig procedures shall detail operation of the tank and criteria for «clean tank» status.		
Back loading from day tank for barite and cement tank shall be possible.		
It shall be possible, in an emergency situation, to route drain from cement unit either to drain system or direct to sea (option to direct overboard).		
It shall be possible to collect wash water, which contains cements after cleaning the cement unit and lines, into a transport tank.		
The closed drain system shall have the capacity to (e.g. pump capacity) to handle all cleaning water from the cement room.		
The dump line from the tank for cement mixing water shall have minimum one dump valve, padlocked and be connected to the closed drain system.		
The pits shall have minimum one dump valve with double valve and be connected to the closed drain system.		
The rig shall have liquid additive system for mixing cement chemicals.		
Double valves shall secure each pit drain and all other outlets from the drilling fluid system to the environment.		

C.8 Well testing and clean-up

(Alternative 1)
The wells are planned to be cleaned up and/or tested through test equipment on the drilling rig immediately after completion. The hydrocarbon well stream will be flared over the burner boom(s). Non-combustible fluid back flowed (e.g. brine) will be collected to a holding tank and cleaned to discharge standard or backloaded to land. Hydrocarbon contaminants (e.g. diesel, condensate) will go to the closed drain system.

Equipment shall be designed to ensure full burning and procedures shall be developed to govern contingency situations where problems are experienced.

Procedures shall be developed and implemented to prevent overflow of drain tanks due to use of rig cooling water during the test operations. Preventive measures such as cleaning of deck areas prior to testing shall be considered, to be able to route the test water directly to sea. This will minimize the possibility of unintentional discharge of oily water.

(Alternative 2)
The wells are planned to be cleaned up and/or tested through test equipment on the production platform.

(Alternative 3)
Well testing shall be performed by transferring the well fluids to a dedicated vessel.

Table C.4

Requirements to well testing system	Required (Y/N)	Status
Equipment shall be designed to ensure full burning and procedures shall be developed to control situations where problems are experienced.		
Procedures shall be developed and implemented to prevent overflow of drain tanks due to use of rig cooling water during the test operations.		

C.9 Drain system

The drain system should be designed to prevent any unintentional discharge to sea. Table C.5 gives the technical and organisational requirements for the drilling unit in order to secure a tight and "green rig". All drains shall be designed to be easily maintained open even at design minimum air temperature. Wherever a drain can be separately routed to closed drain system or to sea, it is very important that the valve can be operated at this temperature. In drain systems with a minor basin (0,5 m^3 to 1,0 m^3) and level-activated pump, it shall be ensured that the liquid in such basins does not freeze.

All decks shall be kept as dry as possible and ice-free. Water and ice on deck can cause increased risk for personnel injury and unintended spill to sea.

Table C.5

Requirements to drain system regarding external environment	Required (Y/N)	Status
Company shall at any time, upon request, be provided with an updated drawing of the drains/bilge system. Copy of updated drawings of the system shall be kept on the drilling unit.		
The requirement for two physical barriers to prevent discharge or spill is applicable for unloading lines and tanks.		
Moon pool area and other areas where spills can occur directly to sea, shall be fitted with a closed boundary. The height of the boundary shall be sufficient to prevent the fluid from spilling over the edge due to rig movement.		
All decks on the rig shall be closed and provided with a sufficient number of drains, which may be routed to tank or to sea. Valves for altering the routing position shall be installed at easily reachable locations.		
The drains from all areas where chemical/or oil spills may occur shall be connected to a closed drain system. The drain system shall have double barriers to sea.		
It shall be separated lines from hazardous drain and none hazardous drain and they shall be routed to separate storage tanks. The drain from none stabilized oil (e.g. from test area) shall not go into the line for stabilized oil in water. Closed drain system collecting to separate storage tank. Special precautions shall be taken to maintain zone integrity. The drain connected to closed drain system should have sufficient capacity to handle the amount of water entering the drain system. Regarding winterisation the closed drain system should also be usable at – XX °C.		
Valves connected to the closed drain system shall be designed so that the open/closed position can easily be observed and reached. The valves shall also be equipped in such a way that the valve can easily be opened/ in cold freezing weather - XX °C. Heating/insulation system should be		

evaluated.		
The deck areas should be designed in such a way that they are easily kept dry and free from ice. The use of de-icer shall be minimized.		
Drain from cellar deck shall be connected to a closed drain system.		
Drain from test unit shall be connected to a closed drain system.		
Drain from riser deck shall be connected to a closed drain system.		
Drain from pipe rack area shall be connected to a closed drain system.		
Drain from cement room shall be connected to a closed drain system.		
Drain from mud pit room shall be connected to a closed drain system.		
Drain from mud pump room shall be connected to a closed drain system.		
Drain from mud laboratory room shall be connected to a closed drain system and a open drain system.		
Drain from shaker room shall be connected to a closed drain system.		
Drain from sack store shall be connected to a closed drain system.		
Drain from BOP control room shall be connected to a closed drain system.		
Drains on the area below trip tank shall be connected to a closed drain system.		
The drains on area were chemicals or oil spill may occur (e.g. main deck) shall be connected to a closed drain system.		
Drain from cuttings collection area to closed drain system		
Drain from thrusters and engine rooms shall be connected to a closed drain system.		
Sufficient drainage shall be provided in all areas to prevent accumulation of ice.		
Emergency valves for drains in e.g. pump room, mud pit room, deck areas etc., shall be padlocked, and work permit required.		
All allowable outlets from the rig to the sea (e.g. bulk, cooling water, drain etc.) shall be routed to avoid spillage over supply vessel and personnel working on vessels.		

C.10 Oily water/bilge water discharge

When in position and preparing for and performing drilling and well operations, water discharged to sea shall as a minimum satisfy the discharge requirementstated in The Activity Regulations. During transit, the IMO Regulations apply.

Table C.6

Oily water/bilge water cleaning/sent to shore	Required (Y/N)	Status
The bilge water cleaning system shall be designed to clean emulsified oil in water.		
The rig shall have tank capacity to collect and process oily water for discharge or backloading to shore.		

Bilge water separator capacity in …(m^3/h) (only for cleaning oily water containing no emulsion).		
At least one ballast pump shall be connected to the bilge system or other alternative backup system.		
One dedicated pump (in each pontoon) is connected to the emergency switchboard.		
Company shall at any time, on request, be provided with an updated drawing of the drains/bilge system. Copy of updated drawings of the system shall be kept on the drilling unit.		
Calibration procedure should be checked and it should be verified that calibration of the online meter is included in the maintenance system.		
The company should forward data of control analyses performed onshore to verify the online meter measurement or other measurement performed on the rig.		
Oil-contaminated water shall be cleaned to meet regulatory limits before it is discharged to sea.		
All drilling rigs shall have a certificate related to oil discharge during transit that documents compliance with IMO requirements. Reference is made to IMO MEPC. 107(49) and IMO International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), Annex 1.		

C.11 Acute discharge and barriers

Table C.7

Requirements to physical barriers regarding external environment	Required (Y/N)	Status
Two physical barriers are required in the loading/unloading lines and pits.		
The helicopter fuel tank should be designed such that fluid spill from sample point does not go to sea.		
All mud, fuel and diesel hoses should be fitted with an Avery Hardall [1] valve, or other type of valve that has similar function.		
Hose supports are to be arranged to ensure proper storage and to avoid buckling of the loading hoses		
The transfer hoses should be equipped with sufficient floaters to keep the hose floating.		
The high pressure hoses should meet the requirement regarding pressure, strength and climate conditions down to – XX °C.		
The loading/unloading line for fuel, diesel, mud, base oil, cement and other chemicals shall be fitted with two valves. NOTE The valve on the hose connected to the loading station is not included.		
For slip joint shall activation of top/bottom seals be possible by two independent systems.		
Slip joint shall be designed to prevent all leakage of riser fluids		
The valves on loading station shall be designed so that the open/closed position can easily be observed. The valves shall also be equipped so that they easily can be opened/closed also in cold weather – XX °C. Provision of heating/insulation system should be evaluated.		

[1] Avery Hardall is an example of a suitable product available commercially. This information is given for the convenience of users of this NORSOK standard and does not constitute an endorsement by this NORSOK standard of this product.

Requirements to physical barriers regarding external environment	Required (Y/N)	Status
Valves connected to the closed drain system shall be designed so that the open/closed position can easily be observed. The valves shall also be equipped in such a way that the valve can easily be opened/in cold freezing weather – XX °C. Provision of heating/insulation system should be evaluated. The valves shall be padlocked and work permit required.		
The deck areas should be designed in a way that they are easily kept dry and free from ice. The use of de-icer shall be minimized.		
Valves in non-heated piping systems shall be designed such that internal ice plugging and ice build-up does not occur, e.g. loading station valves.		
BOP hydraulic fluid system should be contained in a closed system, e.g. no return to sea.		
BOP control unit should be designed in such a way that discharge of BOP control fluid to sea is minimized. Environmentally friendly BOP fluid shall be used.		
The discharge from boilers and other rig equipment which has been treated with chemicals, shall not be discharged to sea.		
Back loading from day tank for barite and cement tank shall be possible.		
Spill collectors/drip pans should be arranged at chemical pods, machinery and equipment where leakage of chemicals, oil, fuel or mud might occur. Spill is to be routed to closed drain.		
Each mud pit drain and all other outlets from the drilling fluid system and dirty drain system to the environment shall be secured by double valves.		
Trip tank and system return/overflow line are to be capable of handling maximum flow to avoid mud spill from trip tank.		

Annex D
(Informative)
Summary of analytical tools

D.1 Dose related risk and effects assessment model (DREAM)

The DREAM was developed in the period 1998 to 2001 as a result of co-operation between SINTEF and the oil industry.

DREAM accounts for releases of complex mixtures of chemicals such as those associated with produced water.

The dynamic model allows calculation of environmental risk throughout the entire recipient. This calculation is based on the ratio between the predicted environmental concentration and the predicted no effect concentration of each component in the effluent as a function of dilution. Simplified, the EIF is a measure of the volume of receiving water where predicted environmental concentration is greater than predicted no effect concentration .

Furthermore, the model is fitted to identify the contribution of each component in a complex effluent to the total EIF, hence allowing to focus on the most effective measures to reduce the EIF. Note that EIF is mainly a tool for relative ranking of environmental impact/risk of various reduction measures, and not a tool for quantifying actual environmental impact/risk.

Reference:
http://ewe1.sintef.no/static/ch/environment/dream/Dream_web_input.pdf

D.2 Cost-benefit evaluation - Methods and criteria

Costs should be established according to the level of detail available at the time of the evaluation, and as necessary be further elaborated in order to reach a level of accuracy needed for decision. If the alternative solutions have an effect on production profiles (e.g. deferred or enhanced production), the effect of this should be incorporated in the evaluation.

The benefits of reduced emissions may be quantified either in term of tonnes per year for emissions or in terms of some measure of the environmental effect. The former parameter is most relevant in relation to air emissions, where the effects are global or regional, and where the marginal environmental effect of a unit of emission is constant for a given platform. For discharges to sea, where the potential effects are mostly local, the most appropriate measure of the benefit would be the EIF which integrates the effects of all components in the discharge.

In order to compare the cost-benefit ratio of a measure with similar figures from analyses done by the authorities, the same approach as used by the authorities should be taken. In simple cases, when a measure only has an effect on one environmental parameter, the cost-benefit (C/B) ratio can be established as the net annual additional cost divided by the annual reduction in emissions (or EIF):

$$C/B = (A_I + O_A + M_A - S) / R_E \quad (D.1)$$

where

A_I is the annuity of additional investment costs over the lifetime of the project
O_A is the additional annual operating costs
M_A is the annual additional maintenance costs
S is the annual savings
R_E is the annual reduction in emissions

For comparison with cost-benefit studies of similar measures performed by the authorities, a discount rate of 7 % should be used.

For emissions that are subject to taxation (i.e CO_2), the tax should be excluded from the calculation. However, when the cost-benefit (C/B) ratio is below the equivalent tax level, the measure would be expected to be economically feasible. An alternative method in this case would be to calculate the NPV of costs and savings over the lifetime of the measure, including the tax, and then choose the alternative with the best NPV. Depending on company policy, other discount rates than 7 % may then be chosen.

In cases with cross-media effects, i.e. when a measure affects more than one environmental parameter (e.g. if CO_2 increases as a consequence of low-NOx technology or injection of produced water), a possible method is to assign a certain economic unit value (i.e. a virtual tax) on each of the environmental parameters that are affected, and see which alternative gives the best present value:

$$NPV\ (7\%) = NPV_I + NPV_{O\&M} - NPV_S + NPV(\Sigma\ P_i * C_i) \quad (D.2)$$

where

NPV_I is the present value of investments
$NPV_{O\&M}$ is the present value of operating and maintenance costs
NPV_S is the net present value of sales incomes
P_i is the emission per year of parameter *i*
C_i is the assigned economic value per unit emitted of this parameter (or EIF unit)

The last element of the equation will therefore represent the discounted environmental costs of the project alternative.

There are currently no official guidelines for establishing economical values on environmental parameters, but some guidance can be found in cost-benefit analyses performed by authorities (e.g. Norwegian Petroleum Directorate report on low-NOx technology) and by the operating companies, e.g. zero discharge reports.

DISPOSAL OF OIL CONTAMINATED DRILL CUTTINGS

SUMMARY REPORT

Drill cuttings that through the years have been discharged from installations on the Shelf are today located on the seabed. This booklet provides a brief summary of the current information about drill cuttings gathered in piles on the seabed. In addition, the booklet describes the various solutions considered by the oil industry for disposal of the piles of cuttings. The objective of the industry is to ensure optimum handling based on environmental, safety and cost considerations.

During the last five years, the oil industries in Norway and the UK have made a considerable effort as regards research and development related to drill cuttings. The work has resulted in increased knowledge about environmental impact and technological disposal solutions. At the same time, the industry has attempted to map the amount of drill cuttings on the Shelf, as well as which alternatives are relevant for disposal. There is still some uncertainty concerning which is the best overall disposal solution. The booklet provides insight into the issues that the industry will look into in more detail.

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What are Drill Cuttings?

Background
The Norwegian Oil Industry Association (OLF) has since 1995, both solely, and in co-operation with the United Kingdom Offshore Operators Association (UKOOA) and internationally (OGP) , funded R&D efforts to study impacts and solutions related to accumulated drill cuttings beneath offshore installations in the North Sea.

The combined efforts of OLF and UKOOA has the ultimate goal to identify the best environmental practices and techniques available for dealing with these accumulations, in accordance with the principles set out by the OSPAR Convention.

The purpose of this booklet is to summarise the current knowledge and understanding surrounding drill cuttings, drill cutting disposal options and their associated environmental impacts.

Cuttings piles comprise the following:

- *Solid phase material*
- *Liquid phase mud components*
- *Hydrocarbons (in oil-based muds)*
- *Sand and cement from casing operations*
- *Seawater*
- *Heavy metals from mud components and the reservoir*
- *H2S from anaerobic bacteria*
- *Low specific activity scale (LSA) –(low activity naturally occurring radioactive material, NORM)*
- *Debris*

Drill cuttings are fragments of rock created when a well is drilled into the seabed and underlying rock to reach oil and gas trapped below. These cuttings can vary in size and texture, from fine silt to gravel.

The cuttings are carried back to the surface by the drilling mud, a special fluid used to lubricate and cool the drill bit, and to balance down hole formation pressures to prevent blow-outs of oil and gas. At the rig the cuttings are separated from the mud; the mud is recycled to be used again and the small rock cuttings are discharged to the seabed, taken onshore for treatment or re-injected into wells depending on environmental properties and permits from relevant authorities.

In the seventies and eighties the majority of cuttings were discharged to sea in accordance with the regulatory regimes in operation at the time. From drilling of the lower sections of the well, these cuttings were often contaminated with diesel or oil based mud. Since the early 1990's regulatory changes have prohibited the use of oil based muds in favour of water based muds. In real terms this means that oil contaminated cuttings are no longer discharged.

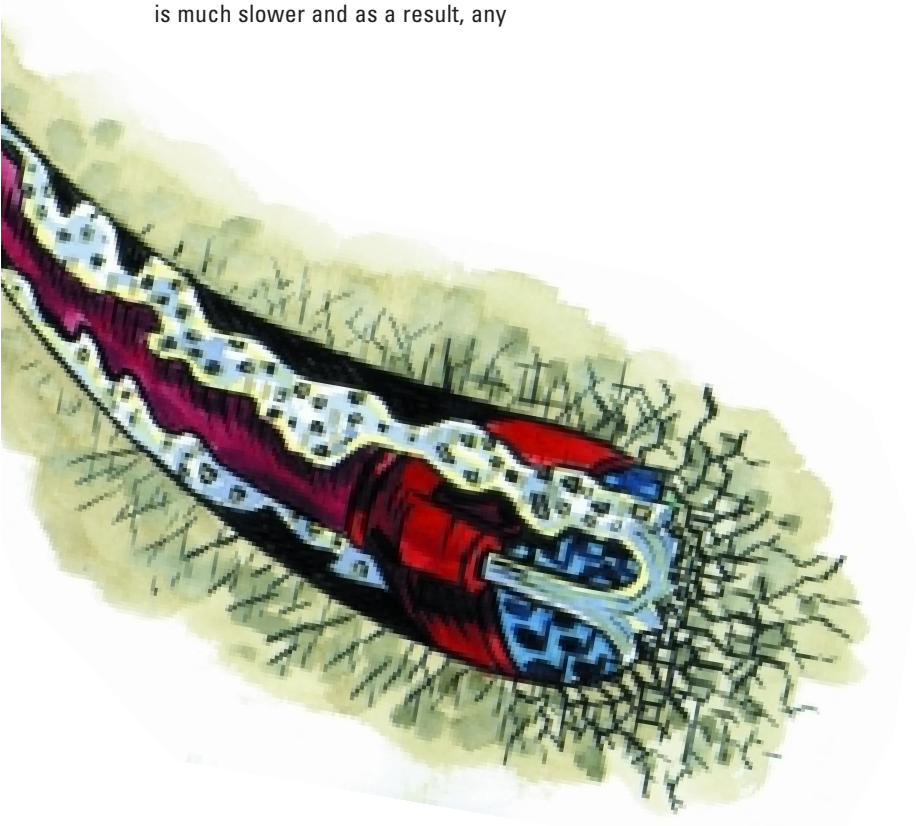
The drill bit is eating its way into the bedrock. The drilled rock fragments - drill cuttings - are transported up to the drilling rig by means of the drilling fluid.

Discharge of Drill Cuttings

The accumulation of cuttings around installations depends on several factors including mud type used, water depth, current flow regime, erosion, etc. Drilling at a field normally takes place in different campaigns during the field life. The cuttings produced accumulate on top of each other, and reflect the drilling history of the field.

Since different mud types may have been used over the field life, the type and composition of cuttings will be complexly layered with depth. Such variation in covering may prevent oxygen and other seawater constituents from penetrating to those below. The lack of oxygen within these accumulations means that bio-degradation is much slower and as a result, any trace hydrocarbons will take much longer to break down.

In order to assess the environmental impacts associated with drill cuttings piles it is therefore important to understand their underlying physical and chemical composition and structure. For this reason, the current drill cuttings initiative has focused on gathering this information from a variety of different cuttings piles exhibiting varying degrees of oil based and water based mud usage. OLF has also supported the development of a transparent system for surveying and monitoring cuttings piles. This is further described in this issue.



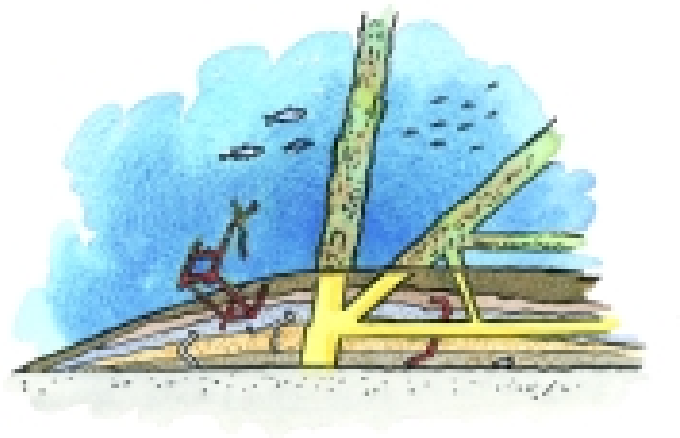
Norwegian regulations relevant to drill cuttings

Until September 1991 it was generally permitted to discharge 100 grams oil per kilo cuttings.

In September 1991 however, regulations on the discharge of oil contaminated cuttings came into force. The 1991 regulations prohibited the discharge of cuttings with any oily residues over 10g/kilo. The exception was where it was permitted to discharge up to 10 grams per kilo, and in a transition period until 1993 a content of 60 grams per kilo was permitted. Since 1994 this limit has been 1 gram of oil per kilo cuttings for exploration drilling. In real terms this means that no such discharges longer take place.

There are no specific regulations covering previously consented drill cuttings discharges that now lie on the seabed. However, the Pollution Control Act (1981) prohibits activities which can induce secondary pollution by disturbing the drill cuttings. A primary concern for disturbing cuttings piles is associated with offshore decommissioning. This issue is referred to in the OSPAR Conventions decision on offshore decommissioning, and will be reviewed again in 2002.

Issues of Concern



When the drill cuttings initiative started in 1995 knowledge about cutting accumulations and their impact on the environment was limited. The work performed has improved the understanding about the volume of cuttings on the continental shelf, both physical and chemical characteristics of the accumulations as well as the feasibility of various options for dealing with the piles and their impact on the environment.

There is still some uncertainty in understanding which of the following options would be best for the environment:

- to leave alone undisturbed on the sea bed
- to treat in-situ using, for example, bio-remediation
- to relocate or cover or
- to remove for onshore treatment and disposal

The ongoing UKOOA/OLF research programme initiated in 2000 has attempted to find answers to the following questions, fundamental to delivering a practicable environmental solution to the problem of accumulated cuttings:

- What is down there?
- Are the accumulations toxic to the environment?
- Is the food chain affected?
- What are the environmental impacts in the context of the North Sea?
- How do cuttings piles characteristics change over time?

In addition, research is being conducted to shed light on the fundamental processes and effectiveness of a number of treatment options including natural degradation, enhanced bio-remediation, covering and lifting, treatment and onward disposal (including landfill).

Characteristics of Cuttings Piles and Sampling Procedures

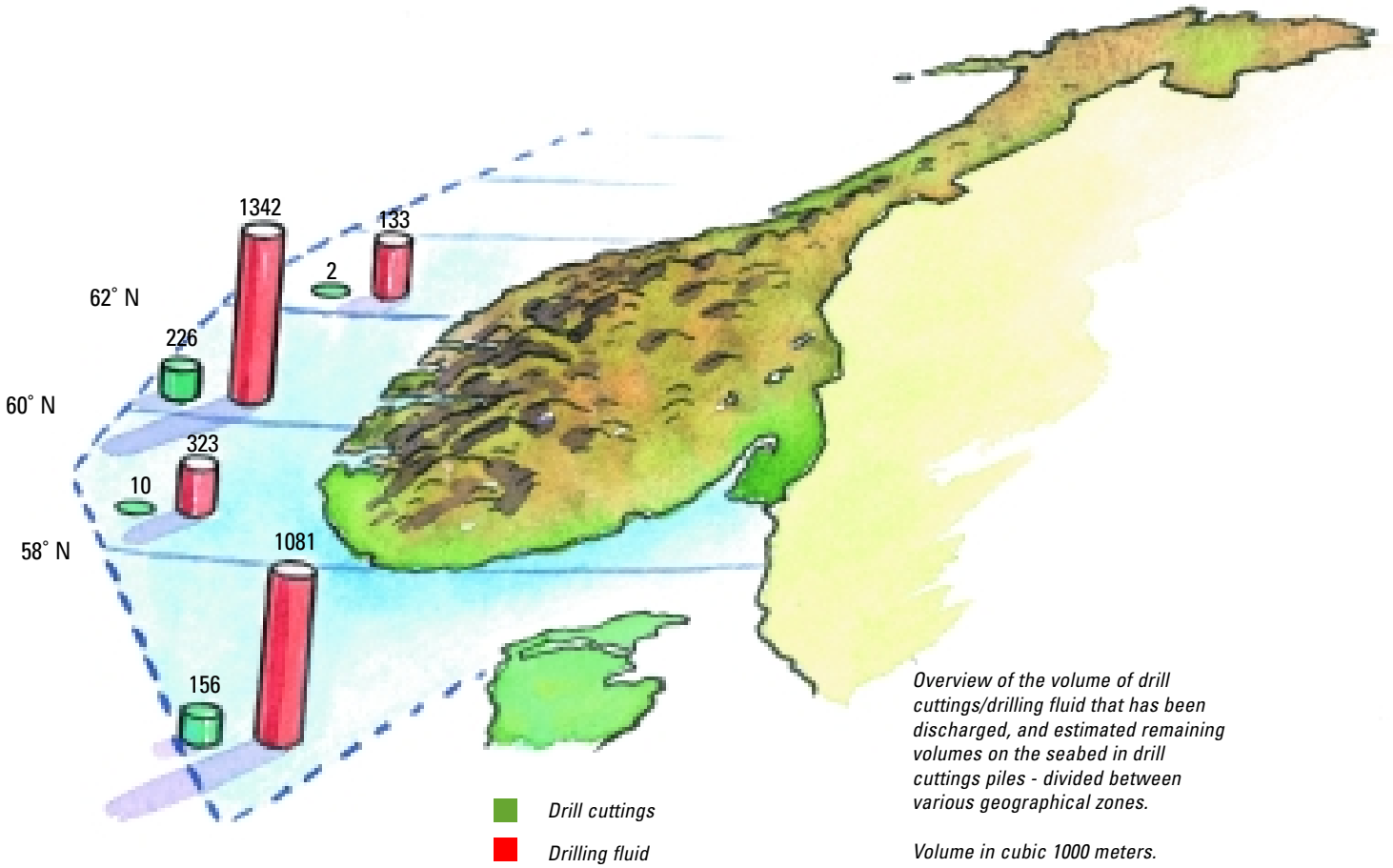
In order to evaluate impacts and relevant disposal options for a drill cuttings pile it is important to have reliable information about the pile, with respect to size, chemical composition, physical structure, stability etc. Presently, such information is generally lacking, and where information is available it is often inconsistent making it difficult to draw definitive conclusions. In order to overcome the problem of inconsistency, a guidance document for standardising the sampling and characterisation of drill cuttings piles has been developed by Norwegian Institute for Water Research (NIVA) and Norwegian Geotechnical Institute (NGI) on behalf of OLF.

This document gives guidance for the different levels of sampling to be undertaken for different types or classes of cuttings piles. The most thorough investigation should be carried out for all piles that contain drilling with diesel or mineral oil based muds and for all large piles from drilling with synthetic muds. The elements of investigation include:

a) Acoustic/seismic profiling to determine the extent and topography of the cuttings piles.
b) ROV – remotely operated vehicle – video recording to support and verify findings under a), and to identify objects that may create problems for point sampling, or later removal.
c) A point testing and sampling programme with subsequent analyses of the samples to determine the geotechnical, chemical and biological structure of the pile.

The strategy and extent of point testing and sampling must be evaluated in each case on the basis of historical and profiling data. This guidance document is considered important in obtaining reliable, comparable and reproducible information about cuttings piles in the Norwegian Sector of the North Sea. Several operators are already planning to carry out such surveys. The guidelines are available at OLF's home page *www.olf.no*

Cuttings on the Norwegian Continental Shelf



Overview of the volume of drill cuttings/drilling fluid that has been discharged, and estimated remaining volumes on the seabed in drill cuttings piles - divided between various geographical zones.

Volume in cubic 1000 meters.

Cuttings on the Norwegian Continental Shelf

A study was performed by Rogalandsforskning in 2000 to estimate the volume and distribution of cuttings piles on the seabed on the Norwegian Continental Shelf. The aim of the study has been to estimate the volume of drill cuttings and muds discharged during the entire drilling history. The study concluded that the total volume of mud and cuttings discharged mounts to about 2.9 million m^3. For some fields (17 piles), on site mapping is performed to establish remaining volumes. For the remaining piles modelling techniques have been used to estimate the volume of cuttings on the seabed. The total volume of remaining cuttings deposits is estimated to be in the range of 480,000 – 960,000 m^3.

Since the cuttings pile issue is mainly driven by deposits containing remains of oil based mud or synthetic mud, DNV has estimated how much these cuttings piles contribute to the total cuttings material. The total volume of cuttings piles associated with these muds is estimated to be about 450,000 m^3, or about 16% of the volume discharged.

Words and abbreviations

Drill cuttings pile:
A mound of solids material gathered on the seabed underneath and around an offshore installation due to the deposition of drilling waste material. Also referred to as "Cuttings deposits".

Fresh cuttings:
Drill cuttings from the drilling operation that has not been discharged to sea.

Old cuttings:
Drill cuttings that have been discharged to sea.

Drilling mud:
Base drilling fluid with different chemical additives. The base fluid is normally water, oils, synthetic chemicals or chemicals as ester, ether, etc.

Contaminant:
A chemical compound introduced to the environment from human activities.

OGP
International Association of Oil & Gas Producers
http://www.ogp.org.uk

OLF
The Norwegian Oil Industry Association

UKOOA
United Kingdom Offshore Operators Association

OSPAR Convention
Convention for the protection of the marine environment of the North-East Atlantic

R&D
Research and Development

Further details concerning drill cuttings can be found on the UKOOA web page, ***http://www.ukooa.co.uk/issues***

Alternative Options for Disposing Old Cuttings

A feasibility study was performed in 1997/98 (Rogalandsforskning), to identify and evaluate the possible solutions for dealing with cuttings accumulations.

The main options for treatment and disposal considered by the study included:

- leave undisturbed as is
- in situ treatment or covering
- offshore re-injection
- offshore treatment
- onshore treatment/disposal/reuse

In order to evaluate the suitability of each of the above options, a common evaluation framework was developed, which included consideration of the following criteria:

- technical/operational feasibility
- safety
- environmental impact
- cost
- potential liability

The findings of the study are now described below:

In-Situ Disposal Options

The in-situ options considered were:

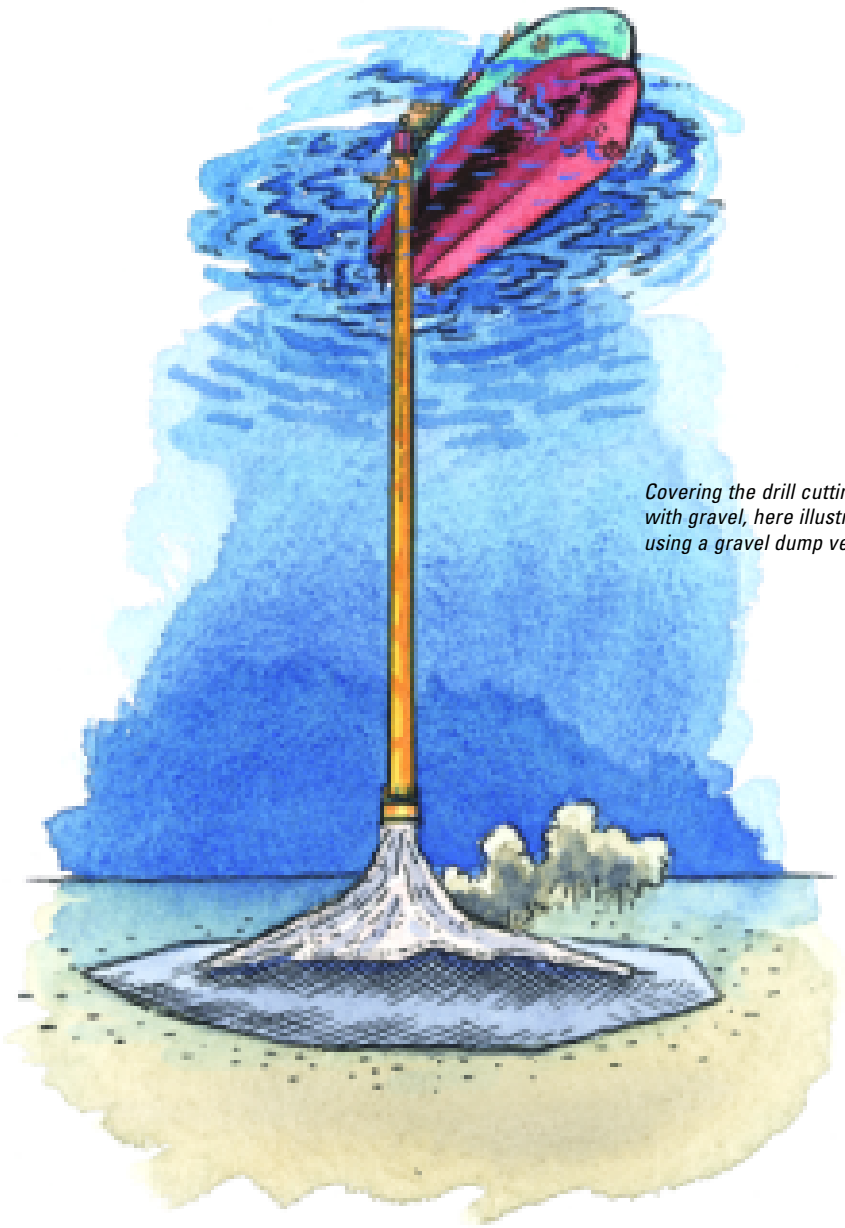
a) Leave undisturbed as is
b) Bio-remediation
c) Covering or Capping
d) Spreading
e) Sub-sea entombment

a) Leaving the pile in place arise questions as to the acceptability of risks to the environment and trawling. Currently there is no universal answer to these questions since no two piles exhibit the same physical and chemical characteristics. For large cuttings piles it may be questionable whether it is possible to leave the cuttings undisturbed if the field installation(s) has to be removed. An evaluation is then important to identify what will disturb least, leaving or removal. Generally the environmental impact is related to

the level of hydrocarbons found in the cuttings pile which can vary from negligible for recent cuttings piles to considerable for older piles. UKOOA is currently researching the effects of hydrocarbons from drill cuttings piles on the marine environment for a range of drill cuttings pile types. The research is also considering whether non-hydrocarbon components within deposits have measurable effects. At present this option is evaluated on a case by case basis.

b) Bio-remediation techniques introduce microbes and sometimes nutrients to the cuttings piles in order to accelerate the natural breakdown of the hydrocarbons present. Although the technique of bio-remediation has proven successful for some applications on land, its potential use in the deep waters of the North Sea is as yet unknown. A potential limitation of the method is that it can only be used to treat organic contaminants. Studies performed by UKOOA report that reduced oxygen availability could limit the degradation process, and that more research is necessary before final conclusions can be made on the overall feasibility of in-situ bio-remediation.

c) Covering the cuttings with gravel, concrete mats or capping with impermeable material to close them off are among the "covering" options that are being studied. UKOOA has ongoing research related to such options, and the results are expected later in 2001. It is most likely that the installation substructure, or its upper parts, will have to be removed prior to covering the cuttings material. Placing mats will have some safety concerns for divers, but is considered to be technically feasible. Environmental impacts will be related to the degree of re-suspension of cuttings and from the removal and disposal of the installation. Generally the level of disturbance during placing of mats and/or gravel is considered small, and leaching from the encapsulated material should be minimal. A question to be answered is how the covered pile will affect or be affected by fishing gear from trawling operations. The option is considered very expensive and will most probably be relevant only in particularly sensitive areas.

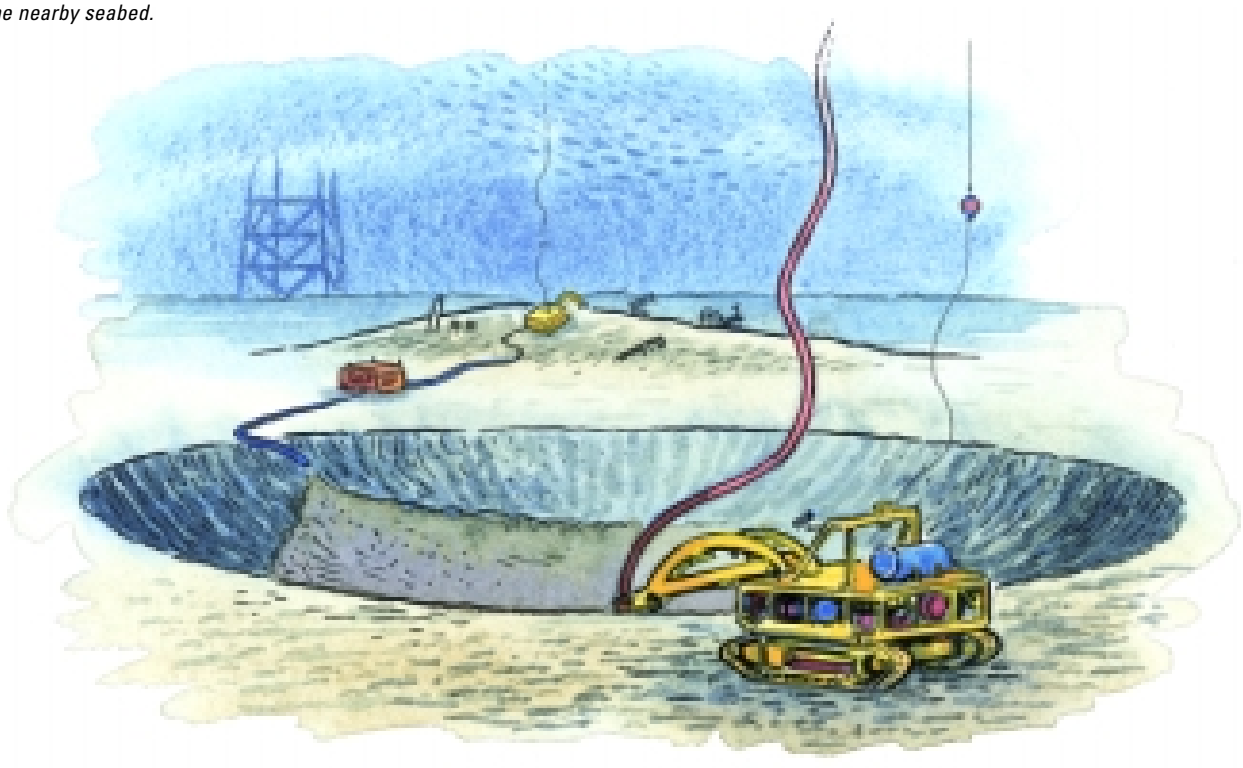


Covering the drill cuttings with gravel, here illustrated using a gravel dump vessel.

d) Spreading the cuttings piles in the vicinity of the field by trawler was an option that was tried in the UK sector (Crawford field) in the early 1990's. A disadvantage of the process was that most of the material were re-distributed which led to a high degree of re-suspension of fines and dispersion of contaminants to the surrounding water column with uptake by marine biota. This solution is currently out of favour by the industry and the authorities since the potential environmental risk is high.

e) Sub-sea entombment in a specially dug pit was suggested as an option in the first feasibility study performed by Rogaland Research for OLF. This involves excavating seabed trenches, pits or silos of sufficient dimensions to accommodate the drill cuttings. This approach has been used in clay seabeds in the US Gulf of Mexico and is therefore technically feasible at shallow water depths. Technical challenges related to the construction (seabed conditions and size), and removal at large water depths found in North Sea operations are still to be resolved. The operation will be energy intensive and will disturb the marine environment locally. Impacts were, however, not studied in detail. Costs were considered to be high.

Entombment of the drill cuttings in a pre-dug pit on the nearby seabed.



Alternative Options for Disposing Old Cuttings

Disposal Options Following Removal

The removal options considered are:

a) Complete removal with subsequent treatment offshore

b) Complete removal with subsequent re-injection into a disused or purpose-built well

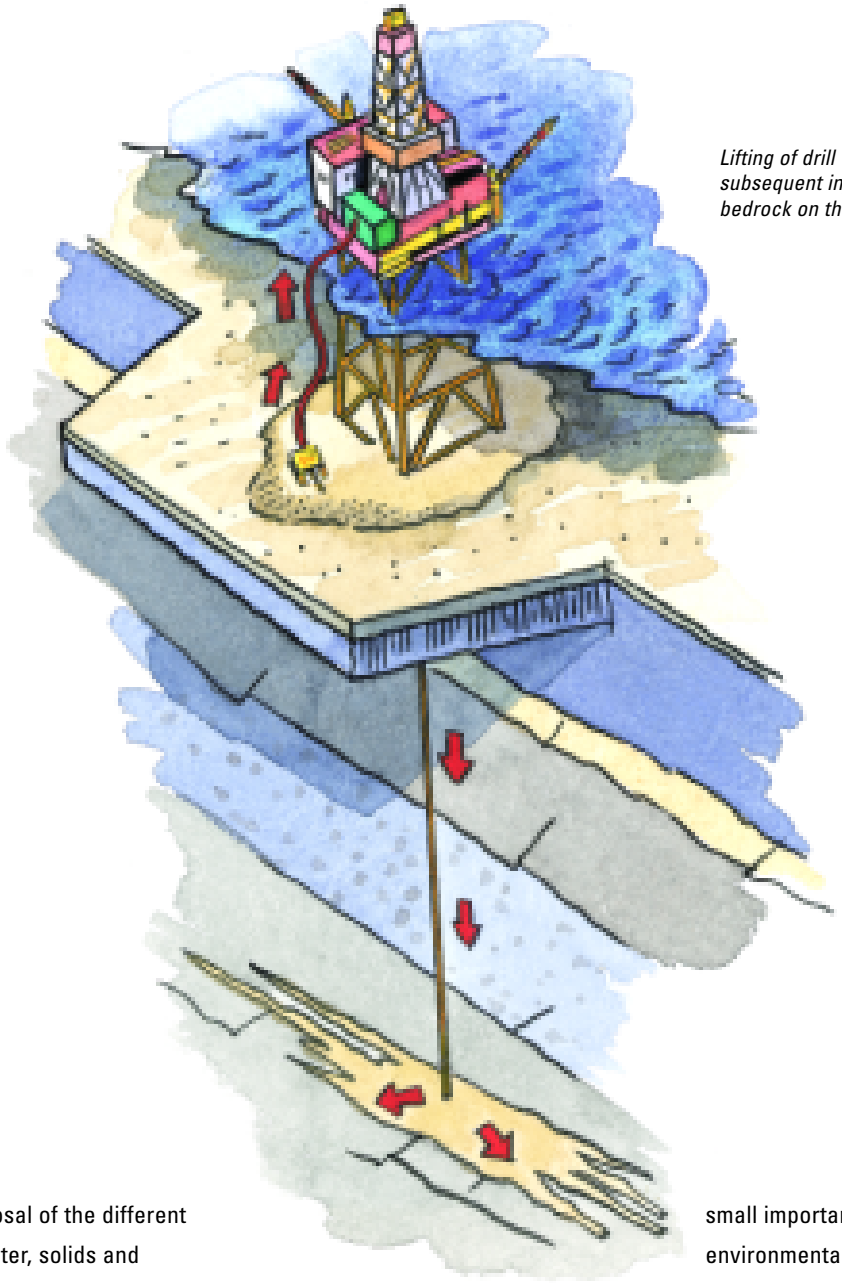
c) Complete removal with subsequent treatment onshore

Lifting of drill cuttings for local treatment on an installation.

Complete removal requires cutting, pumping, dredging, or the use of specially designed underwater vehicles to recover the cuttings material. Studies have been undertaken to identify and assess different removal technologies. So far, no large volumes of material have been removed, and none of the equipment used so far has proven feasible or efficient for removing large quantities of cuttings. It is found that recovery systems are capable of achieving more than 90% recovery of the cuttings. Onshore trials of potential lifting systems in the UK have confirmed that there is equipment capable of overcoming water pressure at depth but that significant volumes of seawater would also be raised along with the solids. The efficiency, impacts and costs of different removal options have not yet been studied. A lifting trial at BP North West Hutton field will be carried out by UKOOA in spring 2001 to assess the practicality of removing pile material with existing equipment and the environmental impacts that result. It is considered very likely that recovery of the cuttings will lead to substantial infusion of seawater with the necessity of dewatering the removed cuttings together with the treatment and disposal of any recovered seawater.

a) Offshore treatment of freshly drilled wet cuttings was studied particularly in the early 1990's in Norway as a consequence of the new regulations on the discharge of oily cuttings. For operative installations, mainly space and weight problems limited such an option. For a decommissioned installation such an option is also considered to be unlikely since it will require the expensive re-commissioning of certain equipment and installation of purpose built treatment facilities. A mobile unit placed on an installation or a vessel is possible, but thought to be less attractive than a land-based option.

Offshore treatment will also be expensive. Environmental impacts will be related to energy use and corresponding atmospheric emissions, and



Lifting of drill cuttings with subsequent injection in the bedrock on the field.

from the final disposal of the different waste streams (water, solids and mud).

b) Re-injection of fresh cuttings is an attractive option, commonly used for disposing of freshly produced cuttings at some existing fields. For old cuttings, however, several conditions are different, which may limit such an option. International conventions, which restrict the re-injection of waste, could be relevant. Re-injection also requires an operative re-injection well and well-system on the drilling platform at the field. This is not always the situation for a field being de-commissioned. It should also be remembered that not all fields have bedrock that allows for re-injection. The option has high costs and will emit exhaust gases to air from the recovery and disposal processes, however magnitude considered of small importance. No long-term environmental impacts are foreseen.

c) Onshore treatment and disposal options have been evaluated as part of a study assessing the possible removal of all the remaining cuttings piles material on the Norwegian Continental Shelf that have remains of synthetic or oil based mud. In Norway, there are today three operational thermal treatment plants for fresh cuttings. Although never tested, it is considered technically feasible to

Receipt and treatment of drill cuttings and disposal of residual waste in a landfill.

treat old cuttings at these plants (as long as technical challenges with lifting and transport of the cuttings to shore are overcome). It is generally found that the capability at these plants is sufficient to process the old cuttings. A potential limitation of this option is the requirement for temporary storage before processing. This issue can be readily solved by additional capital investment.

The performance at the processing plants is found to meet the requirements for land-filling of treated solids. Landfill capacity for the volumes in question is currently not a limitation. The environmental performance at the processing plants is also considered good, and only minor environmental impacts are expected from both processing and land-filling. Similarly, impacts on local communities will be minimal. The main negative environmental impacts will be associated with lifting and transport of the cuttings to shore (spreading of contaminants, emissions to air, etc.). The main negative aspect of this option is however found to be the cost. Processing and land-filling the waste material is found to have a cost in the range of NOK 1,500-3,000 per tonne, while the entire loop including recovery from seabed and transport to shore could rise the cost to in the order of NOK 30,000 per tonne.

The opportunity for reuse of treated solids rather than disposal of it has also been considered. Some possibilities are identified with positive prospects (construction bricks, roofing tiles, asphalt production), however no single option is identified that could guarantee success.

The main obstruction to reuse is the chemical characteristics (mainly salt, but also hydrocarbons and metals). However, cost aspects and market needs are also considered important, though yet not investigated in detail.

Conclusions

Lifting of drill cuttings using a subsea vessel. Water is removed from the drill cuttings prior to transportation from the field in a ship.

The Norwegian and UK oil industries have during the last 5-6 years spent considerable effort and resources in studying the impacts and disposal alternatives associated with drill cuttings accumulations beneath offshore installations.
The main conclusions from the work performed are:

- Only about 15-20% of the material discharged has accumulated into what is considered a cuttings pile.
- The chemical and physical properties of cutting piles vary considerably between different piles and also within each pile. Some piles have high contents of hydrocarbons and other contaminants (including synthetic muds, heavy metals, etc.), while others have very low hydrocarbon and contaminant levels.
- The risk associated with leaving piles undisturbed in situ is variable due to this large difference in physical and chemical characteristics, and should be considered on a case by case basis.
- Sampling and analysis of cuttings deposits is essential to evaluate the environmental risks associated with their treatment and disposal. A system for a sampling strategy and characterisation of piles has been proposed in Norway and is currently being implemented in OLF and UKOOA characterisation programmes.
- There are several in situ and removal options for disposing of cuttings. None of these have been tried in real terms, and there is therefore still uncertainty related both to the feasibility of these options and associated impacts.

Current research findings suggest that no universal solution exists for the best environmental practices and techniques available for dealing with drill cutting accumulations. Existing knowledge suggests that any drill cuttings management decision for environmental protection should be based on a case by case evaluation until more knowledge and experience is gained.

Based on present understanding leaving in place, covering/capping and sub-sea entombment are all feasible in situ treatment options. The issues of concern for "leaving as is in place" are related to environmental or fishing aspects. Capping may represent some issues of concern related to personnel safety, and could also, depending on technical solution represent some environmental impacts. Sub-sea entombment has some technical uncertainties related to placing the material in the pit, but also some environmental issues of concern.
From an economic perspective both capping and sub-sea entombment are considered expensive options.

In summary, onshore treatment and disposal is considered a technical feasible disposal option. Impacts are generally small, but large energy consumption and high costs are in disfavour. Re-injection whilst considered technically feasible for some fields is unlikely to be a universal option. Offshore treatment is generally considered less feasible than the other two options.

The UKOOA Phase 2 drill cuttings R&D programme supported by OLF is planned to continue to the end of 2001. The knowledge on disposal of cuttings and associated impacts is foreseen to improve also in the future, improving the basis for making recommendations.

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Appendix C

Brief Descriptions of Waste Management Methods

Landfills

Landfills are facilities designed to dispose of waste materials (solid) in an excavation or earthen structure. Modern landfills are typically designed with engineered liners, leachate collection and capping structures to keep the waste materials contained within the structure. In Alberta, where several landfills have been constructed and operated to accept various waste types, including those from the oil and gas sector, three main classifications have been established:

- Class I Landfills (Ia and Ib) – can be used for disposal of both dangerous and non-dangerous wastes, and have the most stringent design criteria for liners, leachate collection and leak detection;
- Class II Landfills – can be used for the disposal of non-dangerous wastes, and includes an engineered geosynthetic or compacted clay liner and leachate collection; and
- Class III Landfills – can only be used for non-dangerous, inert and non-leachable wastes.

Modern landfill operation requirements typically require regular cover placement over wastes, which in a northern climate may pose challenges. Alternative operational requirements specific to the site, climate and waste types proposed for disposal may need investigation.

Injection Wells

Injection wells are facilities designed to dispose of waste fluids down hole into a suitable underground formation. In Alberta, the following classification system has been established for the oil and gas sector, and is based on the characterization of the fluid being injected:

- Class Ia – used for disposal of oilfield or industrial waste fluids;
- Class Ib – used for the disposal of produced water, specific common oilfield waste streams and waste streams meeting specific criteria;
- Class II – used for the disposal of produced water (brine) or brine equivalent fluids;
- Class III – used for injection of hydrocarbons, or inert or other gases, for the purpose of storage in or enhanced recovery from a reservoir matrix; and
- Class IV – used for injection of potable water, steam from potable water or recycled water.

Most injection wells used for disposal are categorized as Class Ia or Ib. Various requirements exist for each class of injection well, including those for cement casing, logging requirements and pressure testing.

Mobile Treatment Technologies

Mobile Treatment Technologies can allow for the treatment of waste streams without the need to construct or utilize a temporary or permanent facility for treatment. This can be especially useful in remote areas or locations that do not have the desired waste treatment or disposal

infrastructure in place. Some common examples of mobile technologies are thermal desorption units, incinerators, or mobile wastewater treatment systems. There are also newer advanced thermal technologies such as pyrolysis and gasification that have seen mobile uses in remote areas for the treatment and disposal of wastes.

When considering oil and gas or mining activities in the Beaufort region, the disposal of wastes can often involve the transport of material significant distances. This can negatively impact factors such as carbon footprint, health and safety for both people and environment as well as cost. The ability to treat materials close to the source and therefore minimize final wastes can have significant impacts on project metrics and/or feasibility.

Mobile treatment options can also have an impact on costs from the construction and operations perspective. Typically constructing large centralized treatment facilities involves significant initial capital investment as well as long running operation and maintenance costs. Mobile technologies often require mob/demobilization costs which can be significant for remote sites and have larger operational costs depending on the technology and requirements such as fuel. The upside as mentioned above is the avoidance of large capital costs involved in the design, permitting, and construction of facilities. Volume of source wastes is another consideration when using mobile technologies.

When compared to large facilities, mobile technologies maybe limited in terms of throughput or capacity when treating wastes. This may impact feasibility, timing, costs etc. and would require consideration before using these types of options. Another potential drawback to mobile technologies is partial treatment of wastes, in which a technology may be useful in treating a certain physical or chemical characteristic of the waste streams while being insufficient for another (e.g. using thermal desorption to treat hydrocarbon contaminated soil with heavy metals). In a scenario such as this, an additional treatment technology or differing final disposal option may be required.

Treatment, Recovery, Disposal

Treatment, Recovery, Disposal (TRD) is a process by which wastes products and by products are treated so as to recover the reusable or recyclable components as well as the unusable by-products which can then be properly disposed of (Tervita). In the oil and gas industry, these methods can be used to handle waste streams from drilling through production/operations. The process takes advantage of centrifuges to separate wastes based on physical properties (specific gravity) to break the waste into three main waste streams: hydrocarbons, wastewater, and solids.

This treatment/disposal option requires a central facility (or several) with site capacity for several large tanks and associated equipment and infrastructure. Waste streams will typically be transported to a central facility where the treatment and processing can occur. In the Beaufort region this would require specific siting and transportation of wastes (potentially over large distances). While this process does produce reusable and recyclable products, the undesired waste by-products will still require disposal (e.g. disposal well or landfill).

Biocell

Biocell or biopile techniques refer to the processes where oilfield wastes are biologically degraded in a contained and controlled environment, whether it is in an impermeable cell structure or piled on an impermeable liner. These techniques should be considered as alternatives to land treatment. Biocell may be appropriate when:

- site conditions are not suitable for land treatment;
- the volume of waste precludes on-time, on-site land treatment;
- biodegradation of the organic contaminant is an intermediate step to make the waste suitable for another treatment or disposal option; or
- the waste is intended to be used as fill material after successful biodegradation.

Once the biodegradation process is complete the material must be removed from the contained system and forwarded for further treatment or disposal, or returned to the originating site to be used as fill material if it meets acceptable criteria (i.e. a biocell is not a final disposal option).

Waste to Energy

Waste to Energy is a process by which energy is created in the form of heat or electricity through the thermal destruction of waste. The thermal component has traditionally been in the form of incineration, however there are other thermal options available. Advanced thermal technologies such as pyrolysis, gasification, and plasma gasification have also been used, however the effectiveness on a commercial scale is not clear when compared to traditional burning methods.

The process of burning (whether conventional or advanced) in conjunction with boilers or turbines can create the steam or gas required for energy recovery. The waste heat created during the process is often used in heating applications. The thermal breakdown of wastes using conventional burning methods does create bottom and fly ash, while the use of advance methods creates ash, slag, or other char/residues. The electricity output is dependent on the characteristics of the feedstock.

Considerations must be given to the siting of the facility as the size and nature would require it to be centralized. For an area such as the Beaufort, increased distances to waste sources would increase the cost as well as need for a large enough base of waste products for viability. Consideration must also be given to facility emissions as the process is dependent on the burning or thermal destruction of wastes. This would have to happen through design standards or potentially greenhouse gas credits or offsets for example. As with all large or centralized facilities, the initial capital costs may be very high as well as the need to consider ongoing maintenance or operating costs.

Plasma Gasification

Plasma gasification is the conversion of waste streams to synthesis gas (syngas) which can then be further altered to produce alternate forms of energy. A plasma gasifier is described as an oxygen starved vessel where various feedstocks can be gasified using the high temperatures realizable with plasma. This is not incineration which requires oxygen in order to function and operates at far lower temperatures. The second stage of the process involves cleaning or removing unwanted components of the syngas, which may include particulates, sulphur, and mercury or other heavy metals. A study undertaken by Scientific Certification Systems (SCS) in 2010 indicated that the Plasma Gasification Combined Cycle system achieved lower greenhouse gas emissions than a modern incineration facility and a landfill with energy capture technology.

The process does produce a by-product referred to as ‘slag’. This product is inert and is used as aggregate or other related applications. Testing has shown it will not contaminate soil or water, and is considered a non leaching product. In comparison, the fly ash produced by incineration plants typically requires disposal and is classified in many cases as hazardous. Estimates show that this process reduces material (process via the plant versus a landfill) down to as low as 2%.

The process typically involves larger capital investment (facility and equipment) and operational maintenance but does offer advantages in being able to safely destroy hazardous waste and do so without hazardous emissions. Like many disposal options, financial viability increases with access to more garbage or waste products for the process. For remote areas such as the Beaufort, there may not be enough waste products available for processing. Geography will also have an impact, as wastes would likely have to be transported large distances to a single central facility.

Thermal Desorption

Thermal desorption removes organic contaminants from soil, sludge or sediment by heating them in a machine called a “thermal desorber” to evaporate the contaminants. Evaporation changes the contaminants into vapors (gases) and separates them from the solid material. Many organic contaminants can be removed by thermal desorption. These include volatile organic compounds or “VOCs” and some semi-volatile organic compounds or “SVOCs.” VOCs such as solvents and gasoline evaporate easily when heated – thus a low-temperature desorption treatment is appropriate (200-600 degrees Fahrenheit) . SVOCs require higher temperatures to evaporate and include diesel fuel, creosote (a wood preservative), coal tar, and several pesticides – and would use a high-temperature process (600-1000 degrees Fahrenheit). Thermal desorption generally is not used to treat metals but can partially remove metals like mercury and arsenic, which evaporate at the temperatures sometimes reached in thermal desorption. A thermal desorber is not the same as an incinerator, which heats contaminated materials to temperatures high enough to destroy the contaminants.

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