GUIDELINES AND STRATEGIES FOR OIL SPILL WASTE MANAGEMENT IN ARCTIC REGIONS

FINAL REPORT

***Prepared for*:**

Joint Secretariat
Inuvialuit Renewable Resources Committees
PO Box 2120
Inuvik
NT, X0E 0T0, Canada

***Prepared by*:**

Polaris Applied Sciences, Inc.
755 Winslow Way, Suite 302
Bainbridge Island
WA 98110-2483, USA

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EXECUTIVE SUMMARY

The report describes key components of the decision process for oil spill waste management in the Arctic and describes a computer Job Aid that has been developed to assist managers and decision makers understand and compare basic response options.

The focus of the study is on those considerations that are integral to the selection of practical and feasible strategies and tactics for arctic regions and, in particular, for remote areas. The first sections of this report (Sections 3 though 5) present a summary of key information that is necessary for the oil spill waste management strategy decision process. This information includes: waste generation, waste types, and waste volumes. Elements of waste handling are summarized in Sections 6 though 8 and recommendations for the contents of an oil spill response waste management plan are discussed in Section 9. An interactive, graphic-oriented, computer Waste Management Calculator Job Aid has been developed for use by non-technical (or technical) managers and decision makers. This Job Aid provides comparative waste volumes that potentially would be generated by different cleanup techniques and using different treatment endpoint standards.

The amount of waste generated by oil spill response activities is not controlled by the size of the spill, nor the location, but rather is a direct function of the response objectives and the response methods selected by the spill management team. It is important therefore to provide the decision makers with relevant information regarding potential waste generation, waste types, and waste volumes upon which they can set the response objectives. One step in the decision process is an evaluation of operational practicality and feasibility, which includes the development of estimates of the types and volume of waste that would be generated by the proposed activities and the development of a strategy for waste segregation, handling, transfer, storage, and disposal.

Very little data exist on volumes of waste generated by shoreline treatment or cleanup except as gross or cumulative totals. Data sets reviewed in this study provide two maximum volumes for specific individual shoreline segments of mixed sand, pebble, cobble sediments:

- Mechanical removal:
  - based on linear oiled shoreline data - 4.0m^3/m
  - based on oiled area data - 1.3 m^3/m^2
- Manual removal:
  - based on linear oiled shoreline data - 2.5 m^3/m
  - based on oiled area data - 1.4 m^3/m^2.

In both of these cases, treatment end points required removal of almost all of the oiled sediments. Clearly, as these end point standards are relaxed the volumes generated would be reduced.

In one instance where the primary shoreline treatment tactics were manual scraping and wiping or washing, with very little removal of material, approximately 1 m^3 of waste was generated for every 24 m of oiled shoreline that was cleaned. This waste, the equivalent of 42 m^3/km, was primarily oiled PPE and sorbents. As in the other examples, this was an operation that involved removal of almost all of the oil from sediments and hard substrates.

For at-sea oil spill response operations in arctic regions the preferred response strategies are dispersants and burning, as these generate virtually no waste, whereas mechanical strategies result in the collection of oily wastes products that then require handling, transfer, storage, and disposal. Burning is the preferred treatment option for oil on solid sea ice and may be the only practical option for broken ice conditions.

If shoreline treatment or cleanup is required the preferred options are those *in situ* techniques that do not generate oil or oily wastes, only operational or logistics waste materials: Natural Recovery; Mixing; Sediment Relocation; Burning; Dispersants; and Bioremediation. These treatment options are particularly attractive for remote area operations where waste may have to be transported long distances for recycling or disposal.

Each response option generates different waste types that can include oiled and unoiled materials, both liquids and solids, and ice or snow. The waste management planning process involves estimates of the different types of materials that can be generated as these have to be stored, packaged, transported and disposed differently. The critical input parameters for waste generation from shoreline treatment are: substrate type; oil type; oil volume; and treatment end points. These parameters form the core of the Waste Management Calculator Job Aid that can be used to compare relative amounts of waste that would be generated by different response options.

An appendix to the report presents a summary of data and information on waste generation from shoreline treatment operations that have been collated from published and unpublished sources. Two additional appendices summarize waste management legislation for Arctic Canada and for Norway (including Svalbard).

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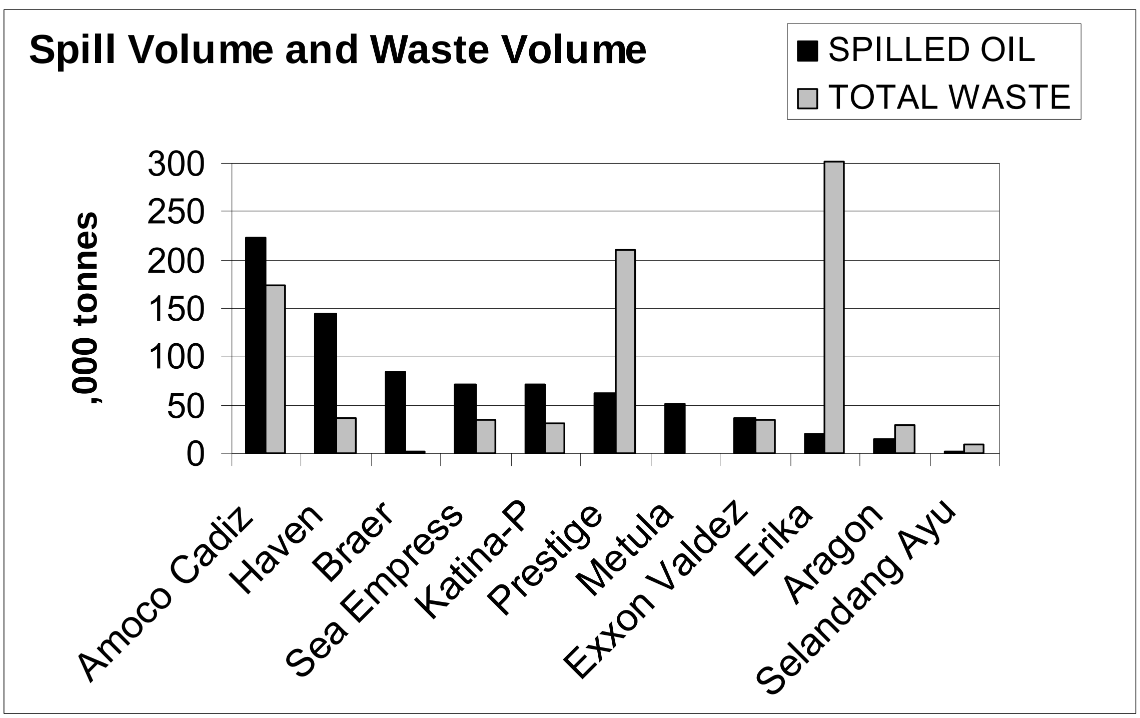
1.0 Introduction and Objectives

Waste generation is a fact of life for any oil spill response field operation. The amounts and types of waste that are generated and then must be managed and disposed vary with the activities. The volume of waste generated during an oil spill response operation is a function of the nature of the spill and the decisions made by spill managers who select the treatment and cleanup methods.

A review of past spill responses shows that there is no direct correlation between the volumes of waste generated and the original amount of spilled oil (Figure 1-1, Table 1-1). The response to the T/V *Erika* spill generated more waste as compared to that generated following the T/V *Amoco Cadiz*, although the volume spilled was an order of magnitude less.



(adapted and revised from IPIECA 2004)

Figure 1-1 Comparison of spill and waste volumes from marine oil spills

Table 1-1 Examples of liquid and solid wastes generated from marine oil spill response operations

INCIDENT	OIL LOST (tonnes)	LIQUID WASTES (tonnes)	SOLID WASTE (tonnes)
T/V Amoco Cadiz- 1978	223,000	8,500	165,000
T/V Haven – 1991	144,000	9,000	28,000
T/V Braer – 1993	85,000	0	2,000
T/V Sea Empress – 1996	72,000	22,000	12,000
T/V Katina-P – 1992	72,000	1,400	30,000
T/V Prestige – 2002	63,000	50,000	160,000
T/V Metula – 1974	54,000	0	0
T/V Exxon Valdez – 1989	37,000	1,300	33,000
T/V Erika – 1999	20,000	1,000	300,000
T/V Aragon – 1989	15,000	1,200	28,000
M/V Selandang Ayu – 2004/5	1,000	0	8,400

(in part from IPIECA 2004 and ITOPF[1])

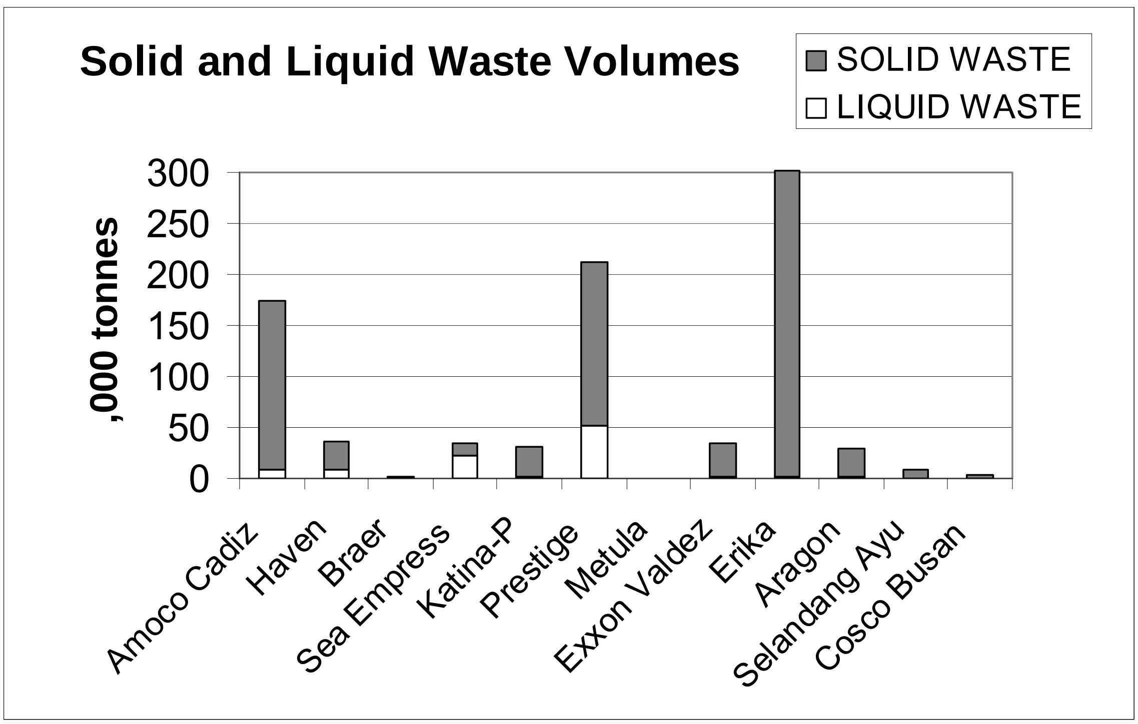


Figure 1-2 Examples of solid versus liquid waste generated

1 www.itopf.com

The 1999 T/V *Erika* response primarily involved operations in a densely populated and accessible region. This operation generated approximately 250,000 tons of oily waste and an additional approximately 50,000 tons of logistics related non-oiled material for disposal. By comparison, the 1989 T/V *Exxon Valdez* response was in a remote sparsely inhabited region and involved primarily shoreline washing rather than removal of oiled sediments. This operation generated approximately 45,000 tons of waste, most of which was associated with logistics support rather than treatment actions and all of which was transported 5,000 km from this remote area in Alaska by sea to Oregon. In the 1974 T/V *Metula* grounding approximately 54,000 tonnes of oil was spilled and stranded on approximately 250 km of coast in the Straits of Magellan, Chile. No cleanup was conducted in this remote location and so no waste was generated.

A relatively small spill of 1000 tonnes (1.8 million L) of fuel oil resulted from the grounding of M/V *Selandang Ayu* in 2004 in a remote northern region of Unalaska Island in the Aleutian Chain of Alaska. Approximately 50 km of oiled shoreline were treated and this operation generated 6,500 metric tons of waste, all of which was transported by barge over 8,000 km for disposal. The majority of this waste was generated by the cleanup by sediment removal of 20 km of "heavy" and "moderate" oil category[2] shorelines. The entire shoreline treatment operation was boat based in this remote island location, with no roads to the oiled shorelines. The decision to clean these remote oiled shorelines resulted in an operation that spanned an 18-month period before the response objective was achieved (Owens *et al*., 2008). The same decision process that characterized this incident is used in most oil spills to determine the level of effort that is required for an appropriate response.

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[2] These terms are defined in the Environment Canada SCAT Manuals (Owens and Sergy, 2001, 2004)

The case history data presented in Figures 1-1 and 1-2 and Table 1-1 illustrate a number of key points:

- The actual waste volume generated is not directly related to the amount of oil lost. Even relatively small spills, such as the *Selandang Ayu,* can generate a large volume of waste if an extensive shoreline cleanup operation is required. In this case, the volume of waste was approximately eight (8) times greater than the amount of oil lost. Similarly, in the response to the *Erika* spill the waste was more than ten (10) times the amount of oil lost. When extensive cleanup is required the volume of waste generated can exceed the volume of oil spilled, as occurred during the *Prestige, Erika*, *Aragon*, and *Selandang Ayu* response operations.
- Comparison of the volumes of liquid and solid waste shows that in seven of these ten cases (that is, except for the *Haven*, *Sea Empress*, and *Prestige*) the solid waste component was more than 95% of the wastes that were generated.
- The key factor in waste generation is neither the amount of oil spilled nor the amount of shoreline that is oiled. The volume of waste generated during a response operation is a function of the nature of the spill (type and volume of oil, natural weathering processes) and location and length of oiled shoreline, combined with the decisions made by spill managers who select the treatment and cleanup methods and the level of effort (treatment endpoints).

The first step in the oil spill response decision process is to conduct a risk analysis to develop the objectives of the response operation. Once these objectives are defined the overall response strategy is designed to meet those objectives and the recovery, treatment or cleanup methods (tactics) are selected to implement the strategy. One critical objective for spill response is waste minimization. In arctic regions, this objective carries considerable weight due to the remoteness of most locations and the distances that are involved in the logistics of both mounting a response and then in disposing of waste this operation generates. Linked to this waste minimization objective is the need to make decisions that are environmentally and socially appropriate, operationally feasible, and financially acceptable.

Arctic operations involve a realignment of standard concepts and a shift from those strategies that typically apply to populated and/or accessible areas. Oil spill response in the Arctic could involve operations at sea, in ice conditions or on oiled shorelines, or all three environments, at any time of the year. Each of these operations involves different waste types. Typically there is a strong emphasis on *in situ* offshore and onshore treatment options to avoid generating oily wastes or to achieve waste minimization.

The concept applied in this project is the use of existing knowledge and information to provide practical tools for decision makers. This is achieved, in part, by illustrations of the consequences of different strategy decisions and by providing explanations of how policy decisions affect waste generation (e.g. with respect to shoreline treatment end points).

There are a number of oil spill waste management manuals and study reports that provide relevant information and guidelines for the implementation of spill response operations and in particular waste handling, transfer and disposal (CEDRE 2004, CONCAWE 1981, Environment Canada 2007, ExxonMobil 2005, IPIECA 2004, ITOPF 1984, Marty *et al.* 1993; NSEL, 2007, Stearns *et al*. 1997a and 1977b). This study does not replicate those manuals and guidelines.

The primary purpose of this project is to develop guidelines and strategies to assist decision makers and the spill response team with respect to waste management as no oily waste management manuals exist for remote and/or Arctic regions. The focus of this guide is two-fold:

1. on those specific elements of the decision process that affect the types and volumes of waste that are generated by shoreline treatment, rather than how waste is generated or handled, and
2. on those considerations that are integral to the selection of practical and feasible shoreline treatment strategies and tactics for arctic regions and, in particular, for remote areas.

The first sections of this report present information that is necessary for the waste management strategy decision process. This information includes:

Waste Generation (Section 3)

Waste Types (Section 4)

Waste Volumes (Section 5)

Elements of what happens to the waste that is generated are summarized in Sections 6 though 8 which briefly discuss:

Waste Handling (Section 6)

Secondary Processing and Packaging (Section 7)

Waste Transfer and Transport (Section 8)

Recommendations for the contents of a waste management plan are discussed in Section 9.

Waste Management Plans (Section 9)

An interactive, graphic-oriented computer Job Aid has been developed for use by non-technical (or technical) managers and decision makers.

Waste Management Calculator Job Aid (Section 10)

This Job Aid provides comparative waste volumes that potentially would be generated by different shoreline cleanup techniques and using different clean endpoint standards and can be used to evaluate response options.

Five Appendices support the report:

- A summary table of data and information on waste amounts generated by shoreline treatment operations (Appendix A).
- A set of definitions and descriptions for terms and parameters used in the Waste Management Calculator (Appendix B).
- Recommendations for the contents and layout of oil spill waste management plans (Appendix C).
- A summary of waste management legislation that relates to oil spills in Arctic Canada (Appendix D).
- A summary of waste management legislation that relates to oil spills in Norway, including Svalbard (Appendix E).

2.0 Oil Spill Management and the Decision Process

A key element of a spill response is management by objectives, which involves an orderly and systematic approach that enables the use of available response resources in the most effective manner. The development of response objectives requires:

a) knowledge on the type and volume of spilled oil,
b) an estimate of where the oil will go ("spill pathway and fate"),
c) knowledge of threats and risks in the spill path,
d) understanding the likely effects and impacts of the spilled oil, and
e) matching the planned response to minimize the effects of the oil.

Typical response objectives at the regional level can include:

- Control oil at, or as near as possible to, the source.
- (for spills on land) Prevent oil reaching moving water: e.g. rivers, or the coast.

- Minimize spreading and additional effects from the oil and the operations.
- Protect vulnerable resources at risk.
- Minimize waste generation.

An additional and very critical objective is the definition of the required, or desired, shoreline treatment end point(s) towards which the operation is targeted. In the case of the M/V *Selandang Ayu* incident noted above, the shoreline treatment objective defined by the spill management team involved the removal of virtually all of the oil stranded on the shorelines, which resulted in an intensive level of effort and the consequent generation of a large volume of waste. Although waste minimization was one of the operational objectives in this operation, this was subordinate to the shoreline treatment objective. By contrast, the response to the much larger spill (52,000 tons: 52 million L) from the T/V *Metula* in the Straits of Magellan, which oiled approximately 250 km of coast, did not involve shoreline cleanup and therefore generated virtually no waste.

The next critical decision following the definition of the treatment end-point(s) is the selection of the treatment strategy to achieve that objective (Sergy and Owens, 2007 and 2008). Oiled sediment removal typically generates large volumes of waste with very small concentrations of oil, often less than 1% by volume. By contrast the application of *in situ* shoreline treatment methods, such as mixing or sediment relocation, results in the generation of only operational waste materials with no oiled sediment disposal required. Similarly the decision whether to recover oil at sea or to use dispersants or burn the oil on the water, controls the volume of oily material that is generated.

These first two elements of the decision process, setting treatment objectives (end points) and selecting the response strategy, are crucial in determining the volume of waste generated by the response operation. <u>The amount of waste generated by the response is not controlled by the size of the spill, nor the</u>

location, but rather is a direct function of decisions made by the spill management team regarding the response objectives and response methods.

Based on the concept of management by objectives, the decision process can be viewed as an 8-step sequence.

1. Gather relevant ***INFORMATION*** to assess the situation.
2. Define the response ***OBJECTIVE(S)***.
3. Develop ***STRATEGIES*** to meet the objectives.
4. Select the appropriate ***TECHNIQUE(S)*** or method(s) to implement the strategy.
5. Evaluate the ***FEASIBILITY*** of the strategies and methods in view of the environmental conditions and the nature of the spill.
6. Prepare an action or response ***PLAN***.
7. Obtain appropriate ***APPROVALS, PERMISSION***, or ***PERMITS***.
8. Implement the field ***RESPONSE OPERATION***.

Spill managers develop a general plan to guide the response operation and specific plans that deal with the different components of the response, one of which is the Waste Management Plan.

3.0 Waste Generation

The types and volumes of waste generated by response activities are determined by the on-water and shoreline objectives set by the spill management team.

- If the decision is to allow natural recovery, as may be the case for a non-persistent oil in a high-energy marine environment, then no waste is generated.
- For a marine or broken ice spill in which a response is required or is appropriate, the key strategy decision in terms of waste generation is

whether to (i) mechanically contain and recover the oil or (ii) apply dispersants or burn the oil.

- For a spill on solid ice in which a response is required or is appropriate, the key strategy decision in terms of waste generation is whether to (i) mechanically contain and recover the oil or (ii) burn the oil.
- For oil stranded on shoreline in which a response is required or is appropriate, the key strategy decisions relate to (a) the treatment end points that are set and (b) the treatment or cleanup methods that are selected.

Once the objectives, strategies and tactics have been developed the next (fifth) step in the decision process is to evaluate the feasibility of proposed activities in the context of:

1. the level of effort required to implement the strategies and tactics,
2. the Net Environmental Benefit,
3. operational practicality and safety, and
4. the ability to achieve the objectives that have been set.

The operational practicality component of this evaluation process includes the development of planning estimates of the types and volumes of waste that would be generated by the proposed activities and the development of a strategy for waste segregation, handling, transfer, storage, and disposal.

This section reviews and summarizes the strategies and tactics for marine and broken, solid ice, and shoreline response operations to provide the relevant information that is used in this operational evaluation.

3.1 Waste Generation in Marine and Broken Ice Response Operations

A decision to minimize the spread of oil on the water surface or to minimize further effects from the spilled oil involves consideration of alternative strategies, which may be used singly or in combination:

- ***RECOVERY STRATEGY*** — minimize the spread and the effect of the oil using mechanical containment and recovery techniques: an offensive response objective
- ***ELIMINATION STRATEGY*** — minimize the spread and the effect of the oil using *in situ* (dispersant or burning) techniques: an offensive response objective
- ***PROTECTION STRATEGY*** — prevent or minimize contact between oil and a resource(s) at risk by either mechanical or *in situ* techniques: a defensive response objective

These strategies typically involve one or more of the three basic tactics: mechanical recovery, dispersant application, or burning.

A. MECHANICAL CONTAINMENT AND RECOVERY

The objective of a mechanical response is to remove spilled oil from the sea surface. Mechanical response strategies can be effective in situations where:

1) the oil is thick and slicks have not fragmented, providing for high encounter rates,
2) winds, wave heights and surface currents do not result in oil loss through boom failure (splash over, submergence, planing, drainage or entrainment), and
3) the presence of ice does not interfere with boom containment or recovery equipment (skimmers and transfer pumps).

A preference for a mechanical response is reduced in situations where containment and recovery becomes increasingly less efficient as the oil thickness becomes thin, as environmental conditions present currents greater than 0.5 m/s (1 knot), as ice interferes with booming operations, and when wave heights exceed 1 meter (Table 3-1).

Table 3-1 Generalized Operational Limits and Order of Magnitude Volume Control Rates

	Minimum Oil Thickness (mm)	Maximum Oil Thickness (mm)	Wave Height (m)	Maximum Potential Control Rate (L/min)	
Mechanical Recovery	0.01	n/a	< 1.0	Over the side skimming unit	100
				Skimming vessel	1,000
Dispersants	0.02	1.0	0.2 – 3.0	Vessel	1,000
				Helicopter	10,000
				Fixed wing	100,000
Burning	0.2	n/a	< 1.0		10,000

(after Allen 1988)

The basic mechanical recovery principles are: (1) adhesion or oleophilic devices (belt, brush, disc, drum, rope); (2) hydrodynamic devices (vortex, vane, submerged planes); (3) vacuum systems; and (4) weir skimmers.

Adhesion or oleophilic devices and hydrodynamic devices lift or drag oil from the water surface and typically recover little (10%) or no water with the oil. Vacuum systems or weir skimmers collect varying quantities of water with the oil which significantly increases the volume of liquid that is transferred and stored, unless an oil-water separator is an integral part of the recovery system (Table 3-2).

Table 3-2 Skimmer Oil/Water Pickup (per cent oil in recovered product)

GOOD	FAIR	POOR
Drum Disc Paddle belt Rope mop	Self-leveling weir Weir/screw auger Advancing weir Weir boom Brush Sorbent belt Water jet Submersion plane/belt Rotating vane	Simple weir

(ExxonMobil, 2005)

In terms of waste generation, mechanical recovery is a strategy that results in the collection of oily waste products that then that require handling, transfer, storage, and disposal.

B. DISPERSANTS

The objective of the application of a dispersant is to break the oil slick into droplets that are then biodegraded by naturally occurring bacteria in the water. A dispersant is a mixture of surface active agents (surfactants) and a solvent carrier. The surfactant lowers the interfacial tension between the oil and water and the solvent reduces the viscosity of surfactant to enhance penetration and mixing into the oil. The surfaces of the droplets that are created repel each other and do not coalesce. The objectives of dispersant use primarily are to:

- Remove oil from the sea surface: thereby reducing the risk to threatened resources, such as sea birds and waterfowl, fur bearing marine mammals, or vulnerable coastal habitats,
- Decrease the oil concentration by dilution: on the assumption that this lower concentration is less potentially damaging than surface oil,
- Enhance natural dispersion process and increase rates of biodegradation.

The application may result in a temporary (hours) increase in the toxicity in the near-surface water column until natural mixing processes dilute the concentration. The benefit of a dispersant response is limited in situations where calm waters reduce the oil-dispersant mixing energy, dilution is restricted by shallow waters or in embayments or lagoons with limited flushing, or if the viscosity of the oil is too great for dispersants to be effective. Dispersant effectiveness decreases as oil weathers and the lighter fractions are attenuated.

The use of dispersants can provide a net environmental benefit for oil spill response when used in areas where other response techniques can not provide a high spill encounter rate or where efficiencies are limited by other factors. Because various rapidly advancing boat or aerial spray systems can deliver dispersants, they offer opportunities to arrive at a spill site more quickly, as well as providing a significantly higher oil spill encounter rate at the spill site. Typically, dispersants would be preferred in areas where:

1) the oil slick has spread to cover large areas and has thinned to thickness of less than 0.5 mm (Table 3-1), and

2) wave heights, currents or the presence of broken ice are significant and reduce the effectiveness of mechanical response tactics.

In terms of waste generation, dispersant use is an oil elimination strategy that results in essentially no waste products other than those associated with the actual operation itself.

C. BURNING

The objective of burning at sea is to eliminate oil on the surface by igniting the oil. This strategy can remove large amounts of oil in a short time and can remove oil on water in broken ice. In reality, this may be the only practical choice in broken ice conditions.

Burning is possible if the slick is more the 2-3 mm thick and is continuous, so that combustion can be maintained. Burning may not be practical in high wave and strong wind conditions as the slick would be broken and lose continuity. Burn effectiveness can be as high as 100% in favourable circumstances

In terms of waste generation, burning is an oil elimination strategy that results in essentially no waste products other than those associated with the actual operation itself.

3.2 Waste Generation in Solid Sea Ice Response Operations

A decision to remove oil from solid sea ice could involve a range of options that include: (a) skimming from slots or leads; (b) vacuum and other skimming systems for oil on the ice surface; (c) manual or mechanical removal; and (d) burning. Recovered oiled snow or ice typically would undergo a first stage of on- or near-site treatment to melt the snow and/or ice for decanting and thus to minimize storage and transfer.

For waste management purposes, a value of 20% is quoted as being commonly used as the "static porosity" for diesel in snow and 40% for Alaskan North Slope crude oil in snow (ACS, 1999). That is the maximum volume of oil in ice or snow, though in practice the oil content is usually much less.

Burning would be the preferred option for remote area operations where waste may have to be transported long distances for disposal.

3.3 Waste Generation in Shoreline Response Operations

The selection of techniques or tactics following a decision to treat oiled shorelines is based on information on the physical character or site conditions and the oiling character. Information on the site conditions for a particular section or segment of shoreline includes:

Shoreline Characteristics	Oiling Characteristics
Substrate material	Oil type
Slope	State of weathering (fresh, mousse, asphalt)
Access and staging potential	Length, width, distribution, and thickness of the oil
Trafficability	Penetration or burial depth (if stranded on a sediment shore)

This information largely determines the treatment options available for that segment and, based on the defined treatment endpoints, the type and volume of waste that would be generated. Frequently more than one technique is used on a segment. If there is a phased approach to treatment this usually involves initial bulk oil removal (that oil which can be easily removed or would be easily remobilized) followed by a "polishing" to remove the residual coat or stain should that be necessary.

Table 3-3 lists the basic shoreline treatment or cleanup options and the types and volumes of waste that typically are generated, as well as the relative level of effort (i.e. manpower) that is involved.

The terms "High" and "Moderate" are intended only as a guide to indicate the relative amounts of oil and oiled wastes that can be generated directly by these activities. The term "None" refers to oily wastes and all treatment activities generate operational waste of one form or another.

From a waste minimization and management perspective, the preferred options are those *in situ* techniques that do not generate oil or oily wastes, only operational or logistics waste materials:

- Natural recovery
- Mixing
- Sediment relocation
- Burning
- Dispersants
- Bioremediation

Table 3-3 Oily Waste Generation and Labour Requirements for Shoreline Treatment Options

Treatment Option	Oily Waste Generation		Labour Requirements
	Amount	Type	
Natural Recovery	**None**	n/a	n/a
Physical Cleaning – Washing and Recovery			
Flooding-Deluge^	High	liquids	intensive
Low-Pressure Washing^	High	liquids	intensive
High-Pressure Washing^	High	liquids	intensive
Steam (“spot”) Cleaning^	Moderate	liquids	moderate
Sand Blasting	High	solids	moderate
Physical Cleaning – Removal			
Manual removal	Moderate/High	solids	intensive
Mechanical removal	High	solids	minimal
Vacuums^	High	liquids	intensive
Vegetation Cropping	Moderate/High	solids	intensive
Passive Sorbent collection	Moderate/High	solids	intensive
Physical Cleaning – *In Situ* Treatment			
Mixing	**None**	n/a	minimal
Sediment Relocation	**None**	n/a	minimal
Burning	**None**	n/a	minimal
Chemical – Biological Treatment			
Dispersants	**None**	n/a	minimal
Shoreline Cleaners	Moderate	liquids	minimal
Solidifiers	Moderate	solids	minimal
Bioremediation	**None**	n/a	minimal

^Oleophilic skimmers and oil-water separators may significantly reduce the high volumes of liquids from these treatment options.

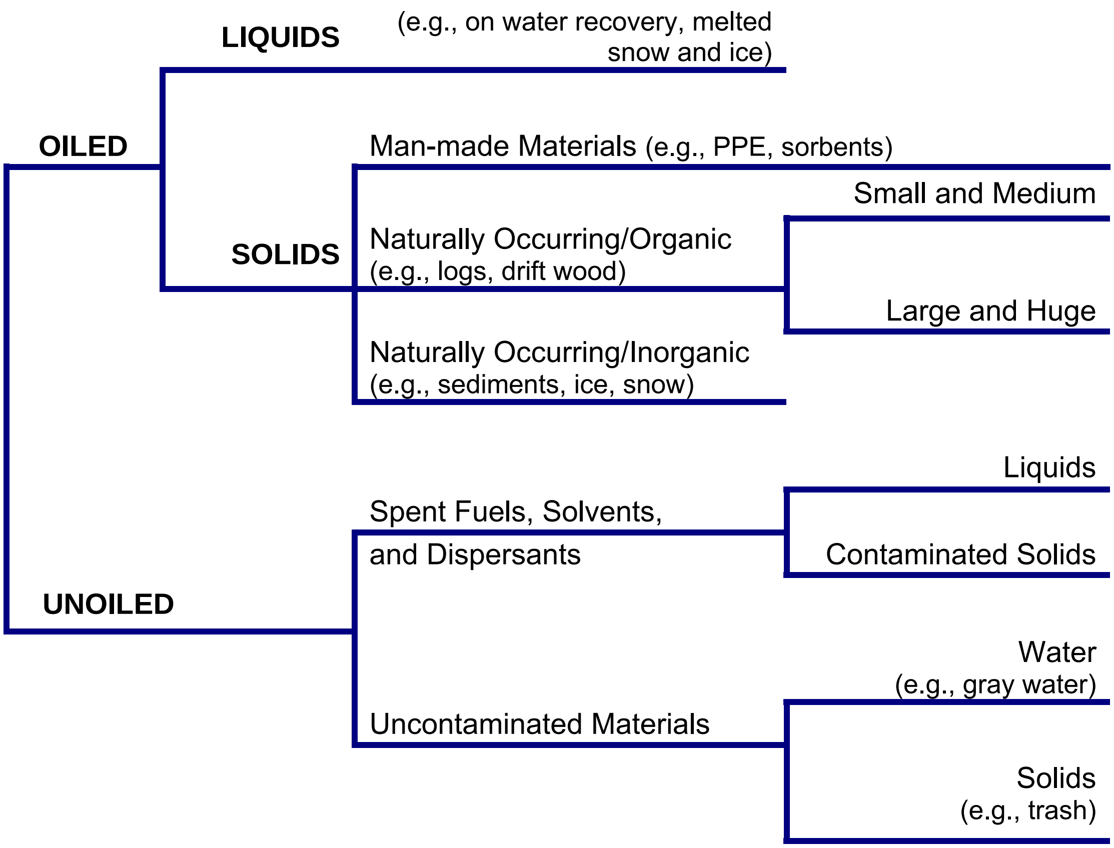
These treatment options are particularly attractive for remote area operations where waste may have to be transported long distances for disposal or recycling.

Shoreline treatment in arctic regions can involve the removal of oiled ice and snow. As noted above, for waste management purposes, a value of 20% is quoted as being commonly used as the "static porosity" for diesel in snow and 40% for Alaskan North Slope crude oil in snow (ACS, 1999). Typically, oiled snow or ice would have a first stage on- or near-site treatment to melt the snow and ice and decant oil before transfer.

4.0 Waste Types

Waste from an oil spill response operation includes both recovered oily wastes and the non-oily materials generated from the operational and supporting activities. In general, spills of persistent oils, such as crude oil or Bunker fuel, generate larger quantities of waste than less persistent oils, such as light crudes or products such as diesel (ITOPF, 1984). Oiled solids and liquids predominate in the waste stream, but typical operations also generate: (a) waste materials that have been contaminated with solvents, dispersants, and fuels; (b) grey water; and (c) unoiled trash.

The waste management planning process involves estimates of the different types of materials that can be generated as these will be stored, packaged, transported and disposed differently. The range of waste materials can be classified as described by Marty *et al*. 1993 (Figure 4-1).



(modified from Marty *et al*. 1993)

Figure 4-1 Waste types and segregation

Oiled snow and ice should be added to these lists for arctic operations. These would initially be oiled solids but if treated on site, for example by *in situ* burning or using snow melters, would become oily liquids.
The waste materials can be segregated initially as oiled versus non-oiled materials and then the oiled materials separated into liquids and solids (Figure 4-1).

Further subdivision within each category is possible: for example Oiled Man-made waste can be persistent (non-biodegradable) or non-persistent (biodegradable) (Table 4-1).

Table 4-1 Examples of Oiled Man-Made Waste Types

PERSISTENT (Non- Biodegradable)	**NON -PERSISTENT** (Biodegradable)
• synthetic sorbents • non-organic clothing - oilskins - plastic rain gear - rain boots • plastic bottles • fishing nets	• organic sorbents • organic clothes - cotton - wool • paper products

5.0 Waste Volumes

Very little data exist on volumes of waste generated by shoreline treatment or cleanup except as gross or cumulative totals. The results from a review of available data are presented in Appendix A to indicate, where possible, waste amounts generated from treatment activities as volumes per unit length or per unit area of shoreline. The only semi-quantitative data are for sediment removal on the T/V *Arrow* and M/V *Selandang Ayu* operations where it is possible to relate amounts of waste removed from individual segments of beach shorelines. In the case of the T/V *Arrow* these volumes are for oiled sediment only and are derived from the documentation of volumes removed to disposal landfills (Owens 1970). The data for the M/V *Selandang Ayu* are based on daily totals of bags removed from a segment and may include oiled operational waste, such as oiled PPE, in addition to oiled sediments. In general terms these two data sets provide two maximum volumes (Table 5-1 provides two maximum volumes for specific individual shoreline segments of mixed sand, pebble, cobble sediments:

- Mechanical removal:
    - based on linear oiled shoreline data - 4.0m^3/m
    - based on oiled area data - 1.3 m^3/m^2
- Manual removal:
    - based on linear oiled shoreline data - 2.5 m^3/m
    - based on oiled area data - 1.4 m^3/m^2.

DurIng the 1993 *Bouchard B-155* response in Tampa Bay, Florida (Owens *et al.,* 1995), 14.5 km of sand beach with surface and buried oil were cleaned by a combination of manual and mechanical tactics. The volume removed averaged to 1.9 m^3/m by length or 1.4 m^3/m^2 by area. The decision made by the spill management teams in each of these cases regarding treatment end points required removal of all, or almost all, of the oiled sediments. Clearly, as these end point standards are relaxed, waste volumes generated would be reduced.

Table 5-1 presents selected examples of waste generation data from a number of individual shoreline segments for which data exist for sediment removal on the T/V *Arrow* and M/V *Selandang Ayu* operations. These data include the known width of the oiled band so that it is possible to calculate the waste volume in terms of cubic meters/square meter of oiled shoreline. These data were selected to illustrate high values and are not representative of an operation that covers a long section of coast.

Waste generation data from operations as a whole are summarized in Table 5-2 and these data are more indicative of the overall picture from the response. This data set provides values of cubic meters/kilometer of oiled shoreline for cleanup operations as a whole as well as waste volume in terms of cubic meters/square meter of oiled shoreline based on a general average oiled width. It is interesting to note that a clean up which involved either manual scraping and wiping or sorbents to contain recover oil washed from shorelines (M/V *Cosco Busan*) generated over 40 m^3/km (USCG, 2008). This waste was almost exclusively oiled PPE and sorbents.

Table 5-1 Waste Generation from Sediment Removal on Individual Segments

RESPONSE	Length of Oiled Shoreline (m)	Volume of Waste Generated (m^3)	Waste Volume m^3/km	Oil Width (m)	Waste Volume m^3/m^2
T/V *Arrow: Indian Cove*	259	1046	4,039	3	12.1
M/V *Selandang Ayu: SKN-11*	710	1743	2,455	3	7.4
T/V *Arrow: Black Duck Cove*	1402	3410	2,432	3	7.3
M/V *Selandang Ayu: HMP-11*	440	756	1,718	3	5.2
T/V *Arrow: Hadleyville*	1372	3043	2,218	2	4.4
M/V *Selandang Ayu: HMP-12*	923	583	631	3	1.9
T/V *Arrow: Arichat*	1128	323	286	3	0.9
M/V *Selandang Ayu: SKN-14*	2000	421	210	3	0.6

Table 5- 2 Waste Generation from Shoreline Treatment Operations

RESPONSE	Length of Oiled Shoreline (m)	Volume of Waste Generated (m^3)	Waste Volume m^3/km	Oil Width (m)	Waste Volume m^3/m^2
T/B *Bouchard B-155*	14500	27000	1860	3	1.4 *
M/T *Pennant*	35000	6500	186	3	0.6
T/V *Exxon Valdez*	1770000	33000	19	6	0.1
T/V *Erika*	400000	21000	53	2	0.1
M/V *Cosco Busan*	100900	4200	42	2	0.08
M/V *Server*	39600	1300	33	1	0.03
M/V *Rocknes*	45000	640	14	1	0.01

* based on estimated oiled area rather than average oiled width

6.0 Waste Handling

Waste generation ideally involves immediate classification, segregation, packaging and labeling at source. Different response tactics generate different waste materials of which the two basic types are liquids and solids (Table 3-3). A more comprehensive classification and segregation separates oiled versus unoiled materials (Figure 3-1), as these can be disposed by different techniques. The selection of waste types to be segregated is an on-site decision. The decisions regarding response tactics will identify, for planning purposes, the primary types and amounts of waste that will be generated.

Recovery and removal involve an immediate on-site storage capacity and packaging at the collection point. Initial options are summarized in Table 6-1 and include an approximation of the range of volumes associated with each type of packaging. This first stage of waste management is typically a short-term (hours to days) activity prior to transfer to a temporary or longer-term (days to weeks) storage location or directly to the final disposal location.

Table 6-1 Examples of Packaging and Storage Capacity

	Packaging	Storage Capacity (m^3)
ON WATER	On board tankage	100 to >1,000
	Barges	10 to 1,000
	Flexible/towable bladders or tanks	500 to 15,000
SHORELINE	Plastic bags or sacks	0.25 to 0.5
	“Supersacks”	0.5 to 2.5
	Barrels or drums	~ 0.2
	Portable tanks	1 to 5
	Skips or dumpsters	10 to 40
	Lined pits	up to 200
	Vacuum trucks	7.5 to 20

All packaging or containers (sacks, dumpsters, etc.) should be labeled with the following information:

- Type of material (oiled boom, absorbent pads, etc.)
- Location (waste generation site)
- Date
- Include a description of the type of material, such as sand, PPE, debris etc

7.0 Secondary Processing and Packaging

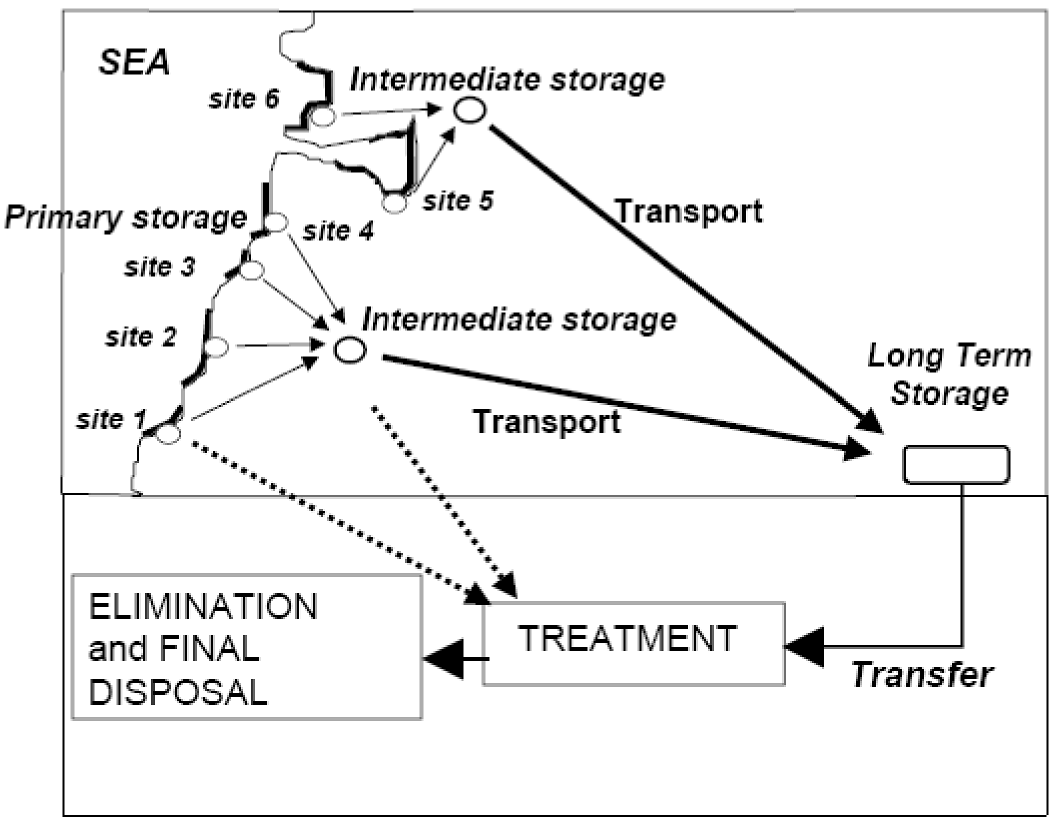
Waste reduction or repackaging at or near the collection site may minimize waste handling and transport requirements. Examples of these activities include:

- Oil/water separation
- Emulsion breaking
- Snow/ice melting with oil/water separation
- Portable incinerators

Separation of water (or melted snow and ice) from oil can significantly reduce the volume of oily liquids that would require transport. Decanting of separated water back into the environment, however, must be conducted only by approved techniques. Typically, decanted water is analyzed and passes screening levels for hydrocarbon and/or BTEX content prior to discharging to the environment. Alternatively, using oil/water separators with appropriate rated separation capacities may be sufficient for an approval to discharge the processed water.

8.0 Transfer and Transport

Waste transfer involves a step-wise procedure beginning with initial collection and temporary, short-term (days) storage at or near the work location ("Primary storage" – Figure 8-1). Materials are then transferred to an intermediate or long-term (weeks to months) storage location where they are consolidated prior to treatment, recycling and final disposal (CEDRE 2004, IPIECA 2004).



(after CEDRE 2004)

Figure 8-1 Typical waste management and transfer model

This typical model does not apply for most remote area operations as roads or overland access from villages, communities, or support bases to a spill response operations area would be rare. The most likely and viable transport options for waste transport in remote (arctic) regions can entail one or more of:

- Snow-mobiles or track vehicles
- Helicopter sling loads
- Landing craft
- Barge

Helicopters can be used to lift accumulated waste to interim collection sites for transfer to long-range transportation. In remote arctic areas, the primary transportation route is by sea. Typically, barges would be the primary transfer mechanism from the spill operations area or interim collection site to a second temporary or a long-term storage location, or directly to the final disposal location. Transfers in the few arctic locations where roads exist could entail one or more consolidating steps to collect waste materials at interim storage sites before transport to the final disposal location. Transportation of oily wastes must, however, adhere to regulatory requirements including classification and special handling for situations in which waste may be classified as hazardous (see Appendix D).

Waste transfer and transport costs will depend significantly on the systems required or used for waste management. Table 7-1 provides a sample overview of the performance characteristics for various helicopters and associated sling or hook load limits. Minimum long-term charter rates for single-engine helicopters in northern North America are on the order of between US$3,000 and $5,000/day (excluding fuel costs) rising to more than US$10,000/day for twin-engine aircraft. The larger helicopters, such as the S-92 or the Boeing Chinook, may cost as much as US$50,000/day plus fuel. Fuel and other support costs (for example, additional pilots for long days of flying) typically double the day rate for aircraft. One or more helicopters may be required to transport waste loads from cleanup operations sites to lined temporary holding areas. Packaging of oily wastes must consider payload for the helicopter(s) as well as handling at the originating and receiving points.

Barge costs vary depending on the operator, barge size, and tug and crew complement. As an example, a 100,000 bbl oil-certified barge and tug combination can cost approximately $20,000 to $24,000 USD/day plus fuel to operate. While stationed on-site, the barge can serve as a work platform and limited staging at approximately the day rate cost. Fuel costs for transport underway could typically double the day rate for the tug and barge combination.

Table 8-1 Helicopter Operational Characteristics

Helicopter	Useful Load (kg)	Maximum Sling Load (kg)	Maximum Range ** (km)
Single Engine Aircraft			
Agusta 119	1300		650
AS350 BA	1020	1140	650
Bell 206 L1	965	880	600
Bell 407	1065	1200	610
EC120	750	700	725
EC130B4	1060	1160	610
MD 500E	700	800	450
MD 600N	910	950	630
Schweizer 333	600		575
Multi Engine Aircraft			
Agusta109 Grand	1410	910	660
AS 332 L2	4600	5000	830
AW 139	2800	2500	810
Bell 412 EP	2285	2040	750
Bell 429	1200	1000	650
EC 145	1780	1500	685
EC 225	5750	5000	820
MD 902	1300	1360	475
S-76C++	2130	1500	700
S-92	4400	4500	1100
Boeing 234 -Chinook	12700		750

Data summarized in part from http://www.helinews.com/turbinecomparison.shtml

**Range depends on load. As a rule of thumb, a full load cuts the maximum operating range in half.

9.0 Recommended Contents of a Waste Management Plan

There are two very distinct and different aspects of waste management planning:

- waste management plans that are part of contingency planning, and
- a waste management plan for a specific spill situation.

Typically, the information gathered prior to spills as part of contingency planning addresses policy, guidelines, and best practices. A spill contingency plan should be compatible with existing policies and any applicable overarching contingency plans. Appendix C.1 provides an example of the recommended contents for this type of plan.

Waste management and disposal at the spill contingency planning phase entails:

- establish policy, typically for waste minimization and segregation practices,
- define waste types, classifications, and regulatory requirements for handling,
- identify procedures and equipment for temporary waste storage and transportation, and
- list of contractors or vendors that can aid with waste transport and disposal.

Examples of the types of material and information that would be used in the development of a plan are described in the Environment Canada Marine Oil Spill Waste Management Study (Environment Canada 2007; NESL 2007).

The second aspect of waste management planning is the situation-specific plan developed for a particular spill. Appendix C.2 provides an example of the recommended contents for this type of plan. The incident-specific waste management plan, developed at the time of a spill, is generally the responsibility of the Planning Section with input from the Operations Section. Prior to implementation, the plan must be approved by the Incident or Unified Command. As the spill management team comes together for a spill event (or exercise), the role of a Waste Group Supervisor typically is identified early in the process. This individual is tasked to work with the Planning and Operations sections to identify spill activities, locations where logistical support is available, and then to identify:

- likely storage requirements for receiving recovered oil and waste
- temporary storage locations, as required,
- waste transporters, and
- final disposal options and locations.

This information is documented in the Disposal Plan specific to the spill incident. Furthermore, the plan identifies how all wastes are tracked and documented, typically through waste manifests at collection points and tracked through the handling process to final disposal.

Typical contents for both of these types of plans are provided in Appendix C. This guidance is intended to be generic and does not necessarily address regulatory requirements that may be applicable for different countries and regions. Application of these recommendations should involve review of the legal and regulatory requirements for waste management planning to ensure documents and proposed actions meet compliance with established procedures, applicable plans, and laws.

References for additional information and example plans are provided in Appendix C.3 along with tools for waste management on scene in Appendix C.4. The latter are a checklist of roles and responsibilities for the Waste or Disposal Supervisor within the spill management team and example forms for waste shipping.

10.0 Waste Management Calculator Job Aid

The objective of one component of this project was to develop a simple, interactive, graphic-oriented computer tool for use by non-technical (or technical) managers, decision makers, and planners. This tool, or Job Aid, is intended to be used to evaluate shoreline treatment response options in light of the types and approximate volumes of wastes that potentially would be generated by different response techniques and using different treatment endpoint standards. The "Waste Management Calculator" Job Aid was developed jointly between Polaris Applied Sciences, Inc. and The Oil Spill Training Company Ltd (TOSTC).

The Job Aid software and a User's Guide and can be downloaded from http://www.oilspilltraining.com/downloads/freetoolkits.asp.

Inputs to the program are:

1. substrate (shoreline) type,
2. oil type,
3. degree of oiling (surface oiling category), and
4. shoreline length (optional).

The outputs provide:

A. preferred treatment options,
B. oily waste volumes – shoreline treatment endpoints, and
C. waste types.

10.1 Input Parameters

1. Substrate (shoreline) Type

Shoreline treatment or cleanup manuals describe the physical character of the shore zone in different ways but typically most are based on the primary character of the substrate type, as this parameter controls both the behavior of the oil and the selection of treatment tactics. Seven substrate types are used are described in Appendix B.1:

- Sand and Mixed Sediment beach
- Coarse sediment beach
- Cobble/Boulder sediment (includes most breakwaters)
- Bedrock or solid (includes ice)
- Wetland - Vegetation

- Oiled debris
- Snow

"Oiled debris" and "Snow" are added as both of these materials may exist in conjunction with any of the five other substrates and, where present, constitute an important element of the response and waste management decision process.

2. Oil Type

The five oil types used in this Job Aid (Volatile: Light: Medium: Heavy: Solid) are defined in Appendix B.2

3. Surface Oil Category

All planning decisions are based on an estimate of the amount of oil that on the shoreline and the size of the oiled area. The standard procedure for the assessment of oil stranded on shorelines follows the Shoreline Clean Assessment Technique (SCAT) process (Owens and Sergy 2000 and 2004: MCA 2007: NOAA 2007). The width of the oiled zone and the distribution of oil, expressed as the per cent of the substrate surface that is covered by oil, are combined to provide four categories that define the degree of oiling. The definitions of these categories are provided in Appendix B.3.

- Heavy
- Moderate
- Light
- Very Light

4. Shoreline Treatment Endpoint

The selection of the shoreline treatment end point or end points is an essential and critical element of the decision and planning process as this controls the level of effort that is required to meet the treatment objective and in turn the volume of waste that is generated by the treatment activities (Sergy and Owens 2007, 2008). Two commonly used end point standards were used for this Job Aid and are defined in Appendix B.4:

- Removal of bulk oil, and
- Reduction to a stain.

5. Treatment Tactic

There are many shoreline treatment or cleanup manuals and each describe the treatment options in slightly different ways. For example, the Environment Canada Shoreline Treatment Manuals define and describe a total of twenty individual shoreline response tactics. For this project these twenty tactics have been grouped on the basis of the seven primary treatment strategies listed below.

- Natural recovery
- Washing and recovery
- Manual removal
- Mechanical removal
- In situ sediment mixing or relocation
- In situ burning
- Bioremediation

Each of these treatment strategies is described in Appendix B.5 and the key efficiency factors (resource requirements: treatment rate: single-step or multi-step activity: relative amount of waste generated) that would be considered in the decision process are summarized for each option. These summaries have been consolidated in Table 10-1.

6. Shoreline Length (optional)

The waste volumes are calculated as a standard unit volume (cubic meters per length of oiled shoreline - m^3/m) based on the selected degree of oiling using one of four surface oil categories (very light: light: moderate: heavy) that best represents the character of the stranded oil. These four surface oil categories are defined by a combination of the width of the oiled area and the surface oil distribution (Owens and Sergy 2000, 2004) as described in Appendix B.6.

An option is to calculate a waste volume (m^3) for a specific length of oiled shoreline. This calculation is involves the selection of:

- Oil width (m),
- Oil distribution (%),

Table 10-1 Summary of Efficiency Factors for Shoreline Treatment Tactics

Technique	Resource Requirements	Treatment Rate^	Single- or Multiple-Step Activity	Relative Volume of Waste Generated
NATURAL RECOVERY				
Natural Recovery	only monitoring	not applicable	not applicable	none
WASHING AND RECOVERY TECHNIQUES				
Flooding	labour intensive	slow	multiple	Can be high if collection is done with sorbents
Washing				
Spot Washing				low-moderate
MANUAL REMOVAL TECHNIQUES				
Shovels, rakes	labour intensive	slow	multiple	low-moderate
Vacuums				moderate
Vegetation Cutting				can be high
Sorbents	labour intensive if used extensively with large amounts of oil			can be high if frequent change-outs required
MECHANICAL REMOVAL TECHNIQUES				
Grader	minimal labour support	very rapid	multiple	moderate
Bulldozer		rapid		very high
Scraper		very rapid	single	moderate
Front-end Loader		rapid		high
Backhoe / Excavator		medium		
Dragline/ Clamshell				
IN SITU TREATMENT				
Dry Mixing	minimal labour support	very rapid	single	minimal
Wet Mixing				
Sediment Relocation				
IN SITU BURNING				
In Situ Burning	minimal labour support	very rapid	single	minimal
BIOREMEDIATION				
Bioremediation	minimal labour support	very rapid	Single to multiple	minimal

^Treatment rate refers to the time required to undertake the operational aspect of the treatment.

- Oil thickness (cm), and
- Shoreline length (various units from which to choose).

These parameters are selected using drop down menus that follow standard SCAT terminology. The results of field surveys can be entered to calculate Waste Volumes for specific oiling conditions during a spill operation or for a drill scenario.

10.2 Assumptions and Calculations

The output is based on approximately 2000 separate calculations that follow the assumptions and calculations described in the User's Guide.

The initial step in the process involved the creation of a matrix (Table 10-2) to define the applicability of the 5 substrate types and the 5 oil types. "**YS**" indicates that the tactic applies but typically for only small amounts of oil (i.e. localized amounts rather than Very Light or Light oil categories).

Selected waste volume data from Appendix A and operational experience were then used to creation of a set of tables combining the waste data with the degree of oiling (width and distribution) to generate solid and liquid volumes for manual removal, mechanical removal, manual (vegetation) cutting, and washing/recovery. These calculations take into consideration:

- the penetration of oil for different sediment types and oil types,
- depth of cut for removal of oiled sediments types for manual versus mechanical treatment,
- liquid recovery rates from washing, and
- the generation of operational waste (oiled PPE and packing etc.).

Table 10-2 Applicability of Treatment Options

SUBSTRATE TYPE	TREATMENT TACTIC - VOLATILE OIL						
	Natural Recovery	Washing-Recovery	Manual Removal	Mechanical Removal	In Situ Mixing-Relocation	In Situ Burning	Bio-remediation
sand-mixed	Y	Y	N	N	N	N	N
coarse sediment	Y	YS	N	N	N	N	N
cobble-boulder	Y	Y	N	N	N	N	N
bedrock-solid	Y	Y	YS	N	N	N	N
vegetation	Y	Y	N	N	N	Y	N
oiled debris	Y	N	Y	Y	N	Y	N
snow	Y	Y	YS	Y	Y	Y	N

SUBSTRATE TYPE	TREATMENT TACTIC - LIGHT OIL						
	Natural Recovery	Washing-Recovery	Manual Removal	Mechanical Removal	In Situ Mixing-Relocation	In Situ Burning	Bio-remediation
sand-mixed	Y	Y	YS	Y	Y	N	YS
coarse sediment	Y	Y	YS	Y	Y	N	YS
cobble-boulder	Y	Y	YS	Y	Y	N	YS
bedrock-solid	Y	Y	YS	N	N	N	YS
vegetation	Y	Y	N	N	N	Y	N
oiled debris	Y	N	YS	Y	N	Y	N
snow	Y	Y	YS	Y	Y	Y	N

SUBSTRATE TYPE	TREATMENT TACTIC - MEDIUM OIL						
	Natural Recovery	Washing-Recovery	Manual Removal	Mechanical Removal	In Situ Mixing-Relocation	In Situ Burning	Bio-remediation
sand-mixed	Y	Y	YS	Y	Y	N	YS
coarse sediment	Y	Y	YS	Y	Y	N	YS
cobble-boulder	Y	Y	YS	Y	Y	N	YS
bedrock-solid	Y	Y	YS	N	N	N	YS
vegetation	Y	Y	YS	N	N	Y	N
oiled debris	Y	N	YS	Y	N	Y	N
snow	YS	Y	YS	Y	Y	Y	N

SUBSTRATE TYPE	TREATMENT TACTIC - HEAVY OIL						
	Natural Recovery	Washing-Recovery	Manual Removal	Mechanical Removal	In Situ Mixing-Relocation	In Situ Burning	Bio-remediation
sand-mixed	N	N	YS	Y	Y	N	YS
coarse sediment	N	N	YS	Y	Y	N	YS
cobble-boulder	N	N	YS	Y	N	N	YS
bedrock-solid	YS	Y	YS	N	N	N	YS
vegetation	YS	N	YS	N	N	Y	N
oiled debris	Y	N	YS	Y	N	Y	N
snow	N	N	YS	Y	N	N	N

SUBSTRATE TYPE	TREATMENT TACTIC - SOLID OIL						
	Natural Recovery	Washing-Recovery	Manual Removal	Mechanical Removal	In Situ Mixing-Relocation	In Situ Burning	Bio-remediation
sand-mixed	N	N	YS	Y	N	N	N
coarse sediment	N	N	YS	Y	N	N	N
cobble-boulder	N	N	YS	N	N	N	N
bedrock-solid	YS	Y	YS	N	N	N	N
vegetation	N	N	YS	N	N	N	N
oiled debris	Y	N	YS	Y	N	N	N
snow	N	N	YS	Y	N	N	N

The result is a series of values of cubic meters of waste generated per meter length of oiled shoreline (m^3/m). These values were then used to create a set of three-way matrices of:

(1) substrate type,

(2) degree of oiling, and

(3) treatment option.

Separate matrices were developed for (a) the five oil types and (b) the two treatment end points. Table 10-3 is an example of part of the three-way matrix table with the results of the calculations. A blank cell indicates that the treatment option does not apply for that substrate type and/or degree of oiling.

Table 10-3 Estimated Waste Volumes (m^3/m) Generated based on a Bulk Oil Removal Treatment Endpoint for Light Oil

SUBSTRATE TYPE	Natural Recovery	Washing-Recovery				Manual Removal				Mechanical Removal			
		VL	L	M	H	VL	L	M	H	VL	L	M	H
sand-mixed	0	0.04	0.04	0.05	0.06	0.26	0.39	0.64	1.14	0.5	0.75	1.25	2.25
coarse sediment	0	0.04	0.04	0.05	0.06	0.11	0.16	0.26	0.46	0.5	0.75	1.25	2.25
cobble-boulder	0	0.04	0.04	0.05	0.06	0.14	0.2	0.32	0.57	1.0	1.5	2.5	4.5
bedrock-solid	0	0.04	0.04	0.05	0.06	0.05	0.06	0.10	0.18				
vegetation	0	0.04	0.04	0.05	0.06								
oiled debris	0					0.05	0.06	0.10	0.18	0.05	0.06	0.10	0.18
snow	0	0.04	0.04	0.05	0.06	0.5	0.75	1.25	2.25	1.0	1.5	2.5	4.5

10.3 Output

For the selected input parameters, the Job Aid:

(i) identifies the preferred shoreline treatment options,

(ii) calculates the estimated amount of waste that typically would be generated, and

(iii) identifies the amount and percent of the type(s) of waste that are associated with each treatment option.

The numerical values generated by the calculator represent a reasonable estimate of the amount and type of waste as compared to actual data obtained from response operations. Table 10-4 presents volumes derived from spill response operations compared to waste volumes generated by the calculator. Clearly the calculated volumes do not replicate the many facets of a response operation and using a single value for "Width of Oiled Zone" is a gross generalization. Nevertheless, the volumes are sufficiently similar to provide a level of confidence for decision makers and planners that the Job Aid provides a reasonable approximation of the amounts of waste that could be generated by the shoreline treatment activities and the treatment end points that are used as input to the calculations.

Table 10-4 Comparison of Operational Data and Calculated Volumes

RESPONSE * selected sites only	**Waste Volume Generated**	**Width of Oiled Zone (m)**	**Documented Waste Volume (m^3/m)**	**Waste Management Calculated Volume (m^3/m)**
T/V *Arrow* * mechanical removal	4,000 m^3/km	3	2.2 – 4.0	1.8 – 4.5
M/V *Selandang Ayu* * mechanical removal	2,500 m^3/km	1.5	3.5	1.8 – 4.5
T/B *Bouchard B-155* mechanical removal	1,860 m^3/km	3	1.9	1.8
M/V *Cosco Busan* washing + manual removal	42 m^3/km	2	0.02	0.05 – 0.2
M/S *Server* washing + manual	33 m^3/km	?	~0.03	0.05 – 0.2
T/V *Exxon Valdez* washing	19 m^3/km	>3	0.02	0.02 – 0.07

The results of the calculations for the selected input parameters are presented as bar graphs and in tabular form. In both cases, the treatment options are grouped into:

- Preferred Options,
- For Small Amounts Only, and
- Not Applicable.

In the graphic format the bars associated with each treatment option represent the two Treatment End Points, with the upper bar representing the values associated with Bulk Oil Removal and the lower bar the treatment reduction to a Stain (Figure 10-1). The bars can be viewed either as a Compressed Scale presentation or as the Actual Scale using a scroll bar. The Waste Volume value is shown at the end of each bar. These values are either cubic meters per length of oiled shoreline (m^3/m) if only the surface oil category is selected or are cubic meters (m^3) if the shoreline length, width, distribution and thickness values are used for the calculation (Section 10.1 – paragraph 6).

In the Compressed Scale format the subsections on the X-axis are not in proportion and are not to scale, however, the full chart can be seen. The X-axis subsections are based on the following four categories of Waste Volumes:

Very High	≥ 1.0 m^3/m
High	0.1 to 0.99
Low	0.01 to 0.099
Very Low	< 0.01.

In the Actual Scale format each subsection on the X-axis is of equal size and the output is shown in proportion. The full chart can be viewed by scrolling

Figure 10-1 provides an example of the output from the Waste Management Calculator when viewed in “Print” mode. The values generated by the calculations are presented as a table (“View Summary”) in the upper half of the screen and as a bar chart (“Results”) in the lower half. Individual bars are subdivided to show the proportion of the total estimated waste volume that is Oily, Oil/Snow, Solid, or Operational Waste, as appropriate.

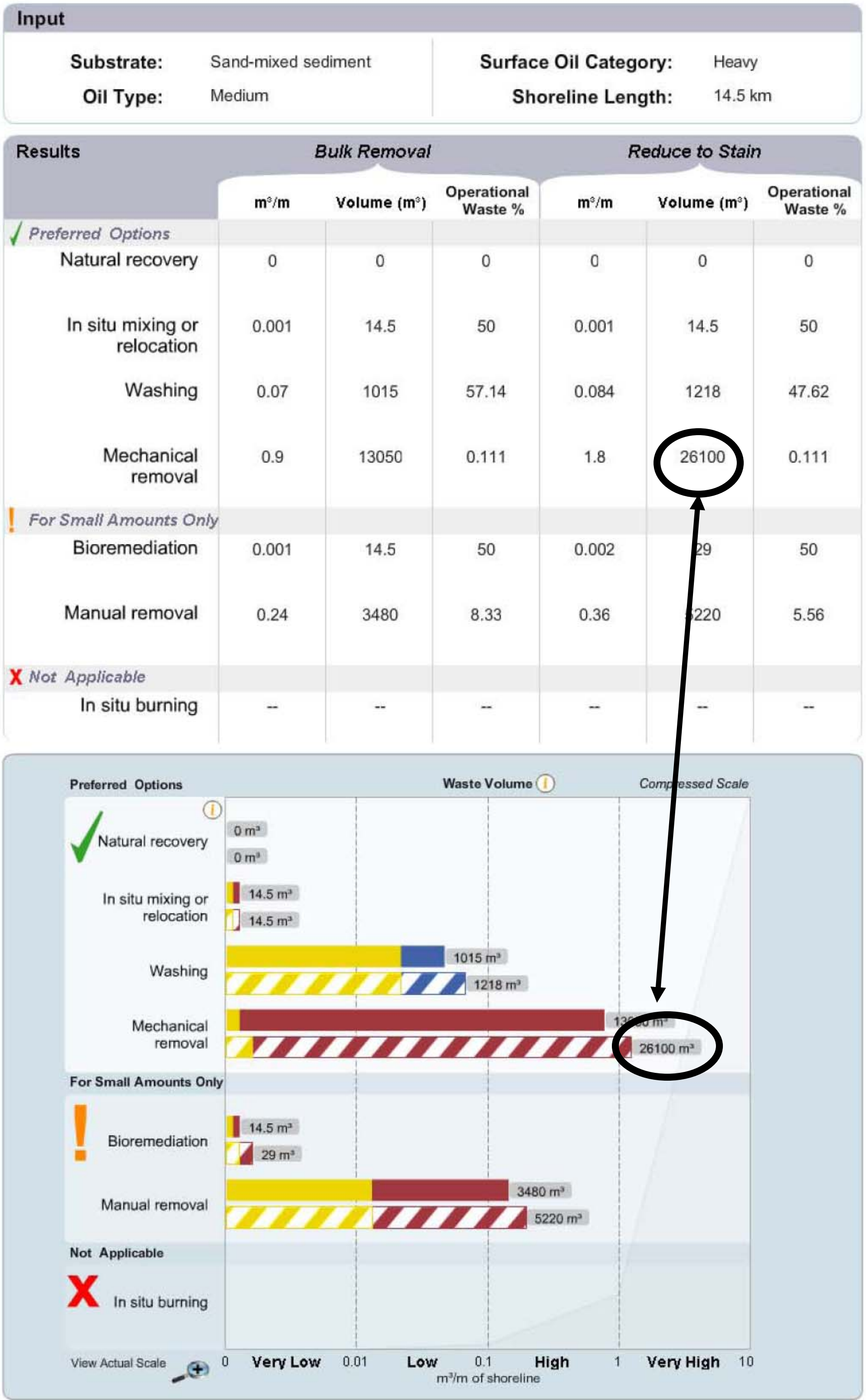


Figure 10-1 Waste Management Calculator Output – *Bouchard B-155* Data

Placing the cursor on any one of the bars triggers a pop up table that lists the estimated:

- Unit volume of each waste type (m^3/m)
- Percent (%) of the total waste represented by that waste type

Total combined waste volume (m^3/m).

If the Calculated Surfaced oil option is used (Step 3b) a second table displays the actual Waste Volumes (m^3).

The tabular format is obtained by clicking on "View Summary" at the top of the graph. This table (Figure 10-1) contains:

- a list of the input parameters
- the following for each treatment option and for each of the two treatment end points:
    - o the unit volume of each waste type in m^3/m of oiled shoreline,
    - o the percent (%) of the total waste represented by that waste type
    - o total combined waste volume (m^3/m)
    - o actual waste volume (m^3) if Step 3b is used.

The example In Figure 10-1 is a calculation using the *Bouchard B-155* data input of 14.5 km of a heavily oiled sand beach and a medium oil type. These input data generate a waste volume of 26,100 m^3 and a waste amount of 1.8 m^3/m of shoreline for Mechanical Removal combined with a "Reduce to Stain" treatment end point, as compared to the documented values of 27,000 m^3 and 1.9 m^3/m from the actual spill data (Tables 5-1 and 5-2). This close correspondence between calculated and documented waste volumes provides a degree of confidence in the reasonableness of the Waste Management Calculator output.

10.4 Operation of the Job Aid

The first three steps enter the input parameters for the calculations.

STEP	SELECT
1	Substrate Type – choice of 7
2	Oil Type – choice of 5
3a	Surface Oil Category – choice of 4 OR…
3b	OPTIONAL: Calculated Surface Oil • Oil width (m), • Oil distribution (%), • Oil thickness (cm), and • Shoreline length (various units).

Step 3a generates a default standard unit volume (m^3/m).

Step 3b generates waste volume estimates for specific shoreline oiling conditions and lengths of oiled shoreline.

The calculations are performed for each of the Treatment Options that are appropriate ("preferred") for the substrate type and for both of the Treatment End Points

A bar graph that presents the consequences of the selected input parameters is displayed automatically upon completion of the first 3 steps (Figure 10-1).

The results can be printed out using the Print function in the "File" menu.

STEP	ACTION	OUTPUT
4	Place cursor on any one of the horizontal bars	• unit volume of each waste type (m^3/m) • percent (%) of the total waste represented by that waste type • total combined waste volume (m^3/m) NOTE – if the Calculated Surface Oil option is used (STEP 3b) a second table will display the actual Waste Volumes (m^3)
5	Click on “View Summary“ above the graph	• list of the input parameters • for each treatment option and for each of the two treatment end points provides: o unit volume of each waste type (m^3/m) o percent (%) of the total waste represented by that waste type o total combined waste volume (m^3/m) o actual waste volume (m^3) if the STEP 3b option is used
6	Click on any one of the “***i***” icon boxes	• Information on that parameter or a definition of the term(s) • For example, first click on the icon box just below “**Results – Preferred Options**” in the graphic and then on the thumbnail to view text for each of the seven treatment tactics with pages on Objective; Description; Applications, and Summary table of “efficiency factors” • Similarly, for **Substrate Type** pages will be displayed on the Definition and Character for each of the seven types. • Information is also provided on: ➢ Oil Types ➢ Surface Oil Category ➢ Waste Volumes ➢ Waste Types ➢ End Points • This information can be accessed through the “Help” folder

11.0 Summary and Conclusions

1. Waste Generation as a Function of Spill Size

The amount of waste generated by the response activities is not controlled by the size of the oil spill, nor the location, but rather is a direct function of the response objectives and the response activities selected by the spill management team. It is important therefore to provide managers and planners with relevant information regarding potential waste types and waste volumes that would be generated as a consequence of decisions regarding the selection of treatment options and treatment endpoints.

2. Waste Transfers and Waste Management

Waste management in remote areas does not follow the typical model that begins with the initial collection and temporary or short-term (days) storage of recovered waste at or near to the work location ("Primary Storage"), followed by transfer to an intermediate or long-term (weeks to months) storage location where materials are consolidated prior to treatment, recycling and final disposal. Roads or overland access from villages or communities to a spill response operations area are rare in remote arctic areas and the primary transportation route is by sea. Typically, barges are the primary transfer vehicle from the spill operations area to a temporary or long-term storage location or directly to the final disposal location. Intermediate transfers by helicopter or All-Terrain Vehicles may support the consolidation of the waste materials but are not suitable for large volume waste management.

3. Waste Management Data

Very little data exist on volumes of waste generated by shoreline treatment except as gross or cumulative totals. The reviewed data sets (Appendix A) provide two maximum volumes for specific individual shoreline segments of mixed sand, pebble, cobble sediments:

- Mechanical removal:
    - based on linear oiled shoreline data – 4.0 m^3/m

- based on oiled area data - 1.3 m^3/m^2

- Manual removal:
    - based on linear oiled shoreline data – 2.5 m^3/m
    - based on oiled area data – 1.4 m^3/m^2.

In each of these cases, treatment end points required removal of almost all of the oiled sediments. Clearly, as these end point standards are relaxed the waste volumes generated would be reduced.

In one instance (M/V *Cosco Busan* response) where the primary shoreline treatment tactics were either manual scraping and wiping or washing, with very little removal of material, approximately 1 m^3 of waste was generated for every 24 m length of oiled shoreline that was cleaned. This waste, the equivalent of 42 m^3/km, was primarily oiled PPE and sorbents. This operation involved removal of almost all of the oil from sediments and hard substrates.

4. Preferred Oil Spill Response Options

For marine spill response operations in arctic regions the preferred response strategies are dispersants and burning, as these generate virtually no waste, whereas mechanical strategies result in the collection of oily wastes products that then require handling, transfer, storage, and disposal. Burning is the preferred treatment option for oil on solid sea ice and may be the only practical option for broken ice conditions.

If shoreline treatment or cleanup is required the preferred options are those *in situ* techniques that do not generate oil or oily wastes, only operational or logistics waste materials: Natural Recovery; Mixing; Sediment Relocation; Burning; Dispersants; and Bioremediation. Each response option generates different waste types that can include oiled and unoiled materials, both liquids and solids, and ice or snow.

5. Waste Amounts, Waste Types and the “Waste Management Calculator” Job Aid

The waste management planning process involves estimates of the different types of materials that can be generated as these will be stored, packaged, transported and disposed differently. The critical input parameters for waste generation from shoreline treatment are substrate type, oil type, oil volume, and treatment end points. These parameters form the core of the “Waste Management Calculator” Job Aid that can be used to compare relative amounts of waste that would be generated by different response options.

12.0 References Cited and Bibliography

ACS 1999. Alaska Clean Seas Technical Manual, Volume 1 – Tactics Descriptions. Alaska Clean Seas, Anchorage, AK.

ADEC 2006. Unified Command: M/V Selandang Ayu. Alaska Department of Environmental Conservation, State of Alaska, Juneau, AK.[3]

Allen A.A. 1988. Comparison of response options for offshore spills. *Proceedings AMOP Technical Seminar*, Environment Canada, Ottawa, ON, 289-306.

Carpenter, A.D., R.G. Dragnich and M.T. Smith 1991. Marine Operations and Logistics during the "Exxon Valdez Spill" Cleanup. *Proc. International Oil Spill Conference*, American Petroleum Institute, Washington, D.C., Publication No. 4529, 205-211.

CEDRE 2004. Oily Waste Management. Centre de Documentation de Recherche et d'expérimentations sur les pollutions accidentelles des Eaux, Brest, 59 pp.

Colcomb, K., D. Bedborough, et al. 1997. Shoreline cleanup and waste disposal issues during the *Sea Empress* incident. *Proceedings International Oil Spill Conference*, American Petroleum Institute, Washington, DC, Publication No.4651, 195-203.

CONCAWE 1981. Disposal techniques for spilt oil. Oil Spill Cleanup Report No. 9/80, Technology Special Task Force No. 1, Den Haag, 52 pp.

Environment Canada 2007. Marine Oil Spill Waste Management Study (Part 1). Final Report for Environment Canada prepared by Jacques Whitford, Dartmouth, NS, 52 pp + appendices.

ExxonMobil 2005. Oil Spill Response Field Manual. ExxonMobil Research and Engineering Co., Fairfax, VA, 300 pp.

IPIECA 2004. Guidelines for Oil Spill Waste Minimization and Management. International Petroleum Industry Environmental Conservation Association, London, Report Series Vol. 12, 19 pp.

ITOPF 1984. Disposal of oil and debris. Technical Information Paper, No. 8, International Tanker Owners Pollution Federation, London, 7 pp.

Jones, R.G. 1975. Disposal of oil spill debris. *Proceedings Conference on Prevention and Control of Oil Pollution*, American Petroleum Institute, Washington, DC, 231-232.

Kelly, C.M., W.K. Upton III, and A. Budzichowski 1997. Shipboard Solid Waste Management Equipment Guide. U.S. Navy, Survivability, Structures and

[3] http://www.dec.state.ak.us/spar/perp/response/sum_fy05/041207201/041207201_index.htm

Materials Directorate, Naval Surface Warfare Center, Report NSWCCD-TR-63-97/25, West Bethesda MD, 97 pp. [4]

Lunel, T. and A.J. Elliott 1998. Fate of oil and the impact of response. In: Edwards, R. and H. Sime, eds. Proceedings of the International Conference on the *Sea Empress* oil spill, The Chartered Institution of Water and Environmental Management, Terence Dalton Publishers, 51-72.

MCA 2007. The UK SCAT Manual: A Field Guide to the Documentation of Oiled Shorelines in the UK. Maritime & Coastguard Agency, Southampton, UK, 47 pages + vi.

Marty, R.C., E.H. Owens and D.E. Howes 1993. Waste management guidelines for marine oil spill response in British Columbia. Environmental Emergencies Branch, Ministry of Environment, Lands and Parks, Province of British Columbia, Victoria, BC, 101 pp. (see also: 1993 *Proceedings 16th AMOP Technical Seminar*, Environment Canada, Ottawa, ON, 1169–1185).

NOAA 2007. Shoreline Assessment Job Aid. National Oceanographic and Atmospheric Administration, Office or Response and Restoration, Seattle, WA, 35 pp. [5]

NSEL 2007. Marine Oil Spill Waste Management Study (Part 2). Final Report for NS Department of Environment and Labour prepared by Jacques Whitford, Dartmouth, NS, 66 pp plus appendices.

Owens, E.H. 1970. Geological Aspects of the Beach Restoration Programme in Chedabucto Bay, Nova Scotia, 1970. Marine Sciences Branch, Dept. of Energy, Mines, and Resources, Ottawa, Unpublished report to the Scientific Coordination Team, Project Oil Task Force, Dartmouth, NS, 85 pp plus Appendix.

Owens, E.H. 1971. The restoration of beaches contaminated by oil in Chedabucto Bay, Nova Scotia. Manuscript Report Series No. 19. Marine Sciences Branch. Department of Energy, Mines and Resources. Ottawa, Ontario, 75pp.

Owens, E.H. 1973. The cleaning of gravel beaches polluted by oil. *Proc. 13th International Conference on Coastal Engineering*, American Society of Civil Engineers, NY, II, 2549-2556.

Owens, E.H., Davis, R.A., Jr., Michel, J., and Stritzke, K. 1995. Beach cleaning and the role of technical support in the 1993 Tampa Bay spill: *Proc. International Oil Spill Conference*, American Petroleum Institute, Washington, D.C., Pub. No. 4620, 627-634.

[4] http://www.p2pays.org/ref/21/20771.pdf

[5] http://response.restoration.noaa.gov/book_shelf/71_jobaid_shore_assess.pdf

Owens, E.H. and G. Drapeau 1973. Changes in beach profiles at Chedabucto Bay, Nova Scotia, following large-scale removal of sediments. Canadian Journal of Earth Sciences, 10(8), 1226-1232.

Owens, E.H., Engles, J.W., Lehmann, S., Parker-Hall, H.A., Reimer, P.D. and Whitney, J., 2008. M/V Selendang Ayu Response: Shoreline Surveys and Data Management; Treatment Recommendations; and the Completion Inspection Process. Proceedings International Oil Spill Conference, Amer. Petr. Institute, Washington DC, 1193-1199.

Owens, E.H. and G.A. Sergy 2000. The SCAT Manual - A Field Guide to the Documentation and Description of Oiled Shorelines (Second Edition). Environment Canada, Edmonton AB, 108 pp.

Owens, E.H. and G.A. Sergy 2004. The Arctic *SCAT Manual – A Field Guide to the Documentation of Oiled Shorelines in Arctic Regions*. Environment Canada, Edmonton AB, 172 pages.

Poupon, E. and M. Girin 2003. *Prestige* versus *Erika* waste management in France. Proceedings Newfoundland and Labrador Environmental Industry Association (NEIA) Oil Spill Conference, St. John's, NL.

Purnell, K.J. 1999. Comparative costs of low technology shoreline cleaning methods. *Proceedings International Oil Spill Conference*, American Petroleum Institute. Washington, DC, Publication No. 4686B, 459-465.

Ramstad, S. and G. Pedersen 2008. Nearshore and Shoreline Oil Spill Response: Current Status and Need for Future Development. Presentation at 3rd Norway-Russia Arctic Offshore Workshop, St. Petersburg.[6]

Scherrer, P. and J.F. Couvreur 2001. Treatment of waste from the *Erika* spill. *Proceedings International Oil Spill Conference*. American Petroleum Institute. Washington, DC, Publication No. 14710, 745-749.

Sergy, G.A. and E.H. Owens 2007. Guidelines for Selecting Shoreline Treatment Endpoints for Oil Spill Response. Emergencies Science and Technology Division, Environment Canada, Ottawa, ON, 30 pp.

Sergy, G.A. and E.H. Owens 2008. Selection and Use of Shoreline Treatment Endpoints for Oil Spill Response. *Proceedings International Oil Spill Conference,* Amer. Petr. Institute, Washington DC, 435-441.

Spikkerud, C.S., G.M. Skeie, Hansen, T.W., O. Hansen, S. Jensen 2008. Management of Information Flow in Complex Shoreline Clean-Up Operations

6 http://www.forskningsradet.no/servlet/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition%3A&blobheadervalue1=+attachment%3B+filename%3D04SveinRamstadSINTEF.pdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1214457583247&ssbinary=true

through a Common System for Situation Overview and Reporting in the "M/S Server" Incident. *Proceedings International Oil Spill Conference,* Amer. Petr. Institute, Washington DC, 609-613.

Stearns, R.P., D.E. Ross and R. Morrison 1977a. Oil spill: decisions for debris disposal. Volume I – Procedures manual. SCS Engineers. Long Beach, California. Prepared for: Industrial Environmental Research Laboratory. Office of Research and Development. U.S. Environmental Protection Agency. Cincinnati, OH.

Stearns, R.P., D.E. Ross and R. Morrison 1977b. Oil spill: decisions for debris disposal. Volume II – Literature review and case study reports. SCS Engineers. Long Beach, California. Prepared for: Industrial Environmental Research Laboratory. Office of Research and Development. U.S. Environmental Protection Agency. Cincinnati, OH.

USCG, 2008. Incident Specific Preparedness Review (ISPOR) M/V Cosco Busan Oil Spill in San Francisco Bay – Report on Initial Response Phase. US Coast Guard http://www.uscg.mil/foia/CoscoBuscan/CoscoBusanISPRFinal.pdf

Wang, Z., M. Fingas and G. Sergy 1994. Study of 22-year old *Arrow* oil samples using biomarker compounds by GC/MS. *Environmental Science and Technology*, 28, 1733-1746.

Appendix A Waste Generation from Shoreline Treatment Operations

A.1 Literature search

A literature search was conducted to locate data from various oil spill incidents that provide the following types of information or data:

1) shoreline segment lengths and areas;
2) oiling conditions for the identified shoreline segments;
3) shoreline treatment methods and oiled waste removal techniques employed for the identified shoreline segments, and
4) the volume (or weight) of oiled waste removed per shoreline segment.

Bibliographic computer searches, internet searches, library searches, email inquiries, a search of the proceedings of the International Oil Spill Conference articles, and a review of in-house references were conducted as a part of this process.

After searching for, obtaining and reviewing numerous articles, references and data sets from different sources, it became evident that only a limited number of oil spill incidents have the appropriate detailed records that provide all the above information. The information obtained as a result of this process is summarized in Table A-1. The two incidents with the most detailed records are: 1) T/V *Arrow* oil spill on February 4, 1970 in Chedabucto Bay, Nova Scotia, Canada, and 2) M/V *Selandang Ayu* oil spill on December 8, 2004 on Unalaska Island, Alaska, USA.

A.2 Results

A.2.1 T/V ARROW oil spill

Information on the T/V *Arrow* oil spill was obtained from Owens (1970; 1971) and Wang *et al*. (1994). Data on the sediment type, oiling conditions, shoreline treatment and waste generated for five shoreline segments established during the

Arrow oil spill are summarized in Table A-1. The shoreline treatment employed on all of these heavily oiled segments consisted of mechanical removal.

The volume of oiled waste generated per kilometer of shoreline varied from 286.35 m^3 (Arichat) to 4,038.61 m^3 per km (Indian Cove). The volume of waste generated per square meter of shoreline varied from 0.09 (Arichat) to 1.32 m^3 per m^2 (Indian Cove). All beaches were mixed sediment (sand, pebble, cobble).

A.2 M/V SELANDANG AYU oil spill

Information for the M/V *Selandang Ayu* oil spill was obtained from in-house records, field information, maps, and spreadsheets; and the M/V *Selandang Ayu* Unified Command (ADEC 2006) internet site. Data on the sediment type, oiling conditions, shoreline treatment and waste generated for four shoreline segments established during the M/V *Selandang Ayu* oil spill is summarized in Table A-1. The types of shoreline treatments employed on these heavily oiled segments consisted of mechanical and manual removal, dry tilling, vegetation cutting (SKN-14), and berm relocation (test site on HMP-12). All beaches were mixed sediment (sand, pebble, cobble).

The volume of oiled waste generated per kilometer of shoreline varied from 631.20 m^3 (HMP-12) to 2,454.79 m^3 per km (SKN-11). The volume of waste generated per square meter of shoreline varied from 0.10 (HMP-11) to 1.43 m^3 per m^2 (SKN-11).

A.3 Other oil spill incidents

Information from a spill offshore of San Francisco Bay in February 1971 and the M/T *Pennant* spill on April 9, 1973 in Narragansett Bay, Rhode Island was obtained from Stearns *et al*. (1977b) and Jones (1975). The 1971 San Francisco Bay spill generated 4,000 cubic yards (3,060 cubic meters) of oiled waste, but no information was located on the length and area of oiled shorelines (Table A-1). The M/T *Pennant* spill, which was cleaned up using manual and mechanical removal, generated 183.59 m^3 of oiled waste per kilometer.

General information in Table A-1 shown for: 1) The T/V *Bouchard B-155* spill in Tamp Bay, Florida, in August 1993; 2) the T/V *Sea Empress* spill in Milford Haven, UK in February 1996; 3) the T/V *Erika* spill on the Brittany coast of France in December 1999; and 4) the T/V *Prestige* spill in the Bay of Biscay in Spain and France in November 2002 was obtained from Owens *et al*. (19595), Lunel and Elliott (1998), Colcomb *et al*. (1997), Scherrer and Couvreur (2001), and Poupon and Girin (2003).

The BP pipeline spill in March 2006 on the Alaskan North Slope oiled a terrestrial area of 0.8 hectares of arctic tundra (Table A-1). An estimated total of 201,000 gallons (760,000 L) (+/-33%) of crude oil was spilled[7] and 244,520 liters of oil was recovered, plus 8,247 m^3 of oiled snow and soil, and 370 m^3 of oiled gravel.

[7] http://www.dec.state.ak.us/spar/perp/response/sum_fy06/060302301/sitreps/060302301_sr_22.pdf

Table A-1 Waste Generation Data from Shoreline Treatment Operations

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
T/V *Arrow* February 4, 1970 Chedabucto Bay, Nova Scotia, Canada Shoreline Section: Arichat	Bunker C oil 2.5 million gallons Mechanical removal: Fixed blade bulldozer, skid shovel Manual removal	Sediment type: Gravel-cobble; till derived; few boulders Overall length: 305 km Section length: 3700 feet (1128 meters) Oiled area (assuming 10 ft width): 37,000 square feet (3437 m^2)	"All of the contract area was badly oiled and the beach zone was effectively paralyzed; that is, oil prevented the normal movement of sediments by wave action." [Owens, 1971]	422 cubic yards (323 cubic meters) removed [40 cubic yards (30.6 cubic meters) Replaced]	286.35 m^3 per km 0.09 m^3 per m^2	Owens 1970; 1971 Wang *et al*. 1994 No oiled width data
T/V *Arrow* Shoreline Section: Black Duck Cove	(see above) Mechanical removal: Fixed blade bulldozer, wheeled front end loader	Sediment type: Medium to coarse sand; vegetated berm behind beach; brackish marsh; silt/sand with boulders Section length: 4600 feet (1402 meters) Oiled area (assuming 10 ft width): 46,000 square feet (4274 m^2)	"The oil on the sand beach had 'paralyzed' the sediments above high water and though some self-cleaning had taken place in the intertidal zone, oil had mixed with sand and seaweed to form large immobile cakes." [Owens, 1971]	4460 cubic yards (3410 cubic meters) removed [360 cubic yards (275 cubic meters) Replaced]	2432.24 m^3 per km 0.80 m^3 per m^2	(see references above) No oiled width data
T/V *Arrow*	(see above)	Sediment type: Coarse sand to cobbles	"The oil was confined to an area above normal high water level	1368 cubic yards (1046 cubic	4038.61 m^3 per km	(see above)

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
Shoreline Section: Indian Cove	Mechanical removal: wheeled front end loader	Section length: 850 feet (259 meters) Oiled area (assuming 10 ft width): 8,500 square feet (790 m^2)	as a 6 to 12 inch thick caked layer approximately 10 feet wide which extended for almost the entire length of the beach" [Owens, 1971]	meters) removed	1.32 m^3 per m^2	
T/V *Arrow* Shoreline Section: Half Island Cove	(see above) Mechanical removal: wheeled front end loader	Sediment type: Fines, gravel; shingle Section length: 1500 feet (457 meters)	"No oil patches were visible on the surface as all the contaminated material had been reworked by wave action and in parts had been buried to a depth of three feet." [Owens, 1971]	1761 cubic yards (1346 cubic meters) removed		(see above)
T/V *Arrow* Shoreline Section: Hadleyville No. 1	(see above) Mechanical removal: Fixed blade bulldozer, wheeled front end loader	Sediment type: Steep shingle beach; fines in lower zones Section length: 4500 feet (1372 meters) Oiled area (assuming 10 ft width): 45,000 square feet (4181 m^2)	"There was very little contaminated material visible on the surface of this beach. The oiled sediments had been reworked by wave action and were buried to a maximum depth of 4 feet." [Owens, 1971]	3980 cubic yards (3043 cubic meters)	2217.93 m^3 per km 0.73 m^3 per m^2	(see above)

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
February 1971 Spill offshore; N of San Francisco Bay, CA USA	Bunker Fuel 1000 gallons (approx.) Removal of oil-coated beach sand; stockpiled in parking lot pending disposal decisions			4000 cubic yards (3060 cubic meters) Bunker fuel, oil-coated beach sand, oily straw, and seaweed		Stearns *et al*. 1977b
M/T Pennant April 9, 1973 Narragansett Bay, Rhode Island, USA	No. 6 fuel oil 100,000 gallons Manual and mechanical removal; Raking into windrows; picking up with shovels and front-end loaders	22 miles (35.4 km)		8500 cubic yards (6499 cubic meters) Primarily oiled sand and gravel, logs, tires, oil drums, large rocks	183.59 m^3 per km	Stearns *et al*. 1977b Jones 1975
Bouchard B-155 August 10, 1993 Tampa Bay, Florida, USA	No. 6 fuel oil 328,000 gallons Manual and mechanical	fine- to medium grained sand beaches intertidal zone 4m wide	Continuous (>90% distribution) surface oil on 9 km max. width from 5	27,000 m^3 removed during a 5-day operation	total oiled shoreline length 14,500 m volume removed = 1.9 m^3/m by length	Owens *et al.* 1995

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
	removal; Mechanical graders and manual raking into windrows; picking up with shovels and front-end loaders	supratidal zone up to 200m wide	to 25 m subsurface oil on 12 km ave, width of buried oil band 3.0 m, ave. depth varied up to 23 cm		est. total oiled area 37,625 m^2 volume removed = 1.4 m^3/m^2 by area	
T/V Sea Empress February 15, 1996 Milford Haven, SW Wales, UK	Forties blend crude oil 72,000 metric tons	198 km (123 miles)	98 km heavily oiled 34 km moderately oiled 66 km lightly oiled	***[various]***		Lunel and Elliott 1998 Colcomb *et al.* 1997 Purnell 1999
T/V Erika December 12, 1999 Brittany coast, France	No. 6 heavy fuel oil 20,000 metric tons ***[various]***	400 km (249 miles)		210,000 metric tons Sand, other minerals, sea water, macrowaste	525 MT per km	Scherrer and Couvreur 2001 Poupon and Girin 2003
T/V Prestige November 2002 Bay of Biscay;	No. 6 heavy fuel oil ***[various]***	2000 km [France] (1243 miles)				Poupon and Girin 2003

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
Spain and France						
M/V Selandang Ayu December 8, 2004 Unalaska Island, Alaska, USA Shoreline Segment: HMP-11	Intermediate fuel oil 321,000 gallons Marine diesel 14,680 gallons Manual removal Mechanical removal Dry tilling	Oiled length: 440 meters Oiled area: 7780 m^2	Heavy	988.60 cubic yards (755.8 cubic meters) Oiled sediments (pebble-cobble)	1717.73 m^3 per km 0.10 m^3 per m^2	Segment oiling condition spreadsheet; Solid waste recovery report spreadsheet; SCAT documents for segments; EHO treatment records (Polaris); Data from Unified Command internet site
M/V Selandang Ayu Shoreline Segment: HMP-12	(see above) Manual removal Dry tilling Berm relocation test site	Oiled length: 923 meters Oiled area: 3050 m^2	Heavy	761.98 cubic yards (582.6 cubic meters) Oiled sediments (pebble-cobble)	631.20 m^3 per km 0.19 m^3 per m^2	(see above)
M/V Selandang Ayu	(see above) Manual removal	Oiled length: 710 meters	Heavy	2256.14 cubic yards (1742.9 cu.	2454.79 m^3 per km	(see above)

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
Shoreline Segment: SKN-11	Dry tilling	Oiled area: 1220 m^2		meters) Oiled sediments (pebble-cobble) Oiled vegetation	1.43 m^3 per m^2	
M/V Selandang Ayu Shoreline Segment: SKN-14	(see above) Vegetation cutting Manual removal	Oiled length: 2000 meters Oiled area: 57000 m^2	Heavy	550.56 cubic yards (420.9 cubic meters) Oiled cut vegetation	210.450 m^3 per km 0.01 m^3 per m^2	(see above)
BP pipeline spill March 2006 North Slope, Alaska, USA	Alaska North Slope crude oil 200,000 gallons (760,000 liters)	Oiled area: 0.8 hectares (terrestrial spill)		244,520 liters free flowing oil recovered; 8,247 m^3 oiled snow and soil recovered; 370 m^3 oiled gravel recovered		ADEC 2006

Incident Name; Date; Location	Oil Spilled Volume Spilled; Shoreline Treatment	Beach Type and Dimensions	Oiling Condition	Volume and Type of Waste Generated	Waste volume per unit length and area	Reference(s) Notes
M/S Server January 2007 Fedje, Norway	380 tonnes IFO 380 bunker oil manual removal flushing	Length of oiled shoreline: 39.6 km • 20.3 bedrock • 8.0 coarse sediment • 4.5 sand • 1.4 mud • 5.4 manmade		1,300 m^3	0.03 m^3 per m	Ramstad and Pedersen 2008 Spikkerud *et al*. 2008
M/V Cosco Busan November 7, 2007 San Francisco Bay, CA, USA	Manual removal (primarily scraping and wiping – little sediment removal)l and washing using sorbents for recovery	Length of Oiled shoreline: 100.9 km	Heavy: 2.0 km Moderate: 6.2 km Light: 27.2 km Very Lt.: 65.5 km	On water recovery (decanted) (not related to shoreline cleanup): 19,466 gal Rinsate and Decon Water: 115,110 gal Oily solids: 5,500 $yards^3$ (4200 m^3)	From shoreline cleanup: average 42 m^3 per km = approx. 1 cu m^3 every 24 m	USCG 2008 and unpublished data

Appendix B Definitions and Descriptions

Appendix B.1 Substrate Types

B.1.1 Sand and mixed sediment beaches

DEFINITION

- Beaches composed of sand or a combination of sand, granules, pebbles and cobbles.
- Where coarser sediments (granule, pebble and/or cobble) are present the spaces between these larger particles are in-filled with sand: this feature distinguishes a sand or mixed sediment beach from a coarse-sediment beach.
- In some cases there is veneer layer of the coarser cobble or pebble on the surface without the in-filled sand.

CHARACTER

- Sand and mixed sediment beaches typically are very dynamic with a mobile, unstable surface layer.
- Even relatively little wave action (e.g., wave heights of 10 to 30 cm) can easily change the surface level on a sand beach by as much as 10 cm in one tidal cycle.
- Large waves, as would be expected during storms, can lower or raise a beach surface by as much as 1.0 m in a few hours. These processes can result in erosion, mixing, or burial of stranded oil.
- Permeable for some medium and all light oils
- Pore spaces are small, which restricts oil penetration so that medium and heavy oils are unlikely to penetrate more than 25 cm.

B.1.2 Coarse sediment beach

DEFINITION

- A beach where the clearly dominant material is pebbles and/or cobbles. Pebbles have a grain-size diameter of 4-64 mm; cobbles are in the 64-256 mm range.
- The interstitial spaces are relatively open and not in-filled with finer material. Some sand may be present e.g. $\leq$10%. Granules (diameter 2 to 4 mm) usually are included in the pebble category.
- For comparison, 4 mm is about the width of a pencil, 64 mm is approximately the size of a tennis ball, and 256 mm is a little larger than a soccer ball (225 mm) or a basketball (240 mm).

CHARACTER

- Pebble-cobble beaches are very permeable and have a dynamic, mobile, unstable surface layer.

- The interstitial or pore spaces between the individual pebbles or cobbles are open.
- The supply of coarse sediment usually is very slow. Sediment that is removed may be replaced only at a very slow rate (decades), or not at all.
- Coarse sediment beaches are permeable to all but the semi-solid oils so that subsurface oiling would be expected.
- Depth of oil penetration is a function of the oil type (viscosity) and the sediment size. The larger the particle size the easier it is for oil to penetrate. However, retention also is relatively low so that the oil can be flushed naturally from these coarse sediments.
- Oil-in-sediment amounts (by weight or by volume) are usually very low, often less than 1% unless the oil is pooled or very thick.
- Light or non-sticky oils may be easily flushed out of the surface or subsurface sediments by tidal pumping.
- Usually, only the surface layer of sediments is reworked by normal wave action. Oil that penetrates below the surface may not be physically reworked except during infrequent, high-energy storms or run-off events.

B.1.3 Cobble/Boulder beach

DEFINITION

- A beach where the clearly dominant material is cobbles and/or boulders. Cobbles are in the 64-256 mm range and boulders are greater than 256 mm.
- The interstitial spaces are relatively open and not in-filled with finer material. Some sand may be present e.g. ≤10%. Granules (diameter 2 to 4 mm) usually are included in the pebble category.
- For comparison, 4 mm is about the width of a pencil, 64 mm is approximately the size of a tennis ball, and 256 mm is a little larger than a soccer ball (225 mm) or a basketball (240 mm).

CHARACTER

- Cobble/boulder beaches are very permeable and the interstitial or pore spaces between the individual cobbles or boulders are open.
- Sediment supply to this type of beach usually is very slow. Sediment that is removed may be replaced only at a very slow rate (decades), or not at all.
- Cobble-boulder beaches are permeable to all but the semi-solid oils so that subsurface oiling would be expected.
- Depth of oil penetration is a function of the oil type (viscosity) and the sediment size. The larger the particle size the easier it is for oil to penetrate. However, retention also is relatively low so that the oil can be flushed naturally from these coarse sediments.
- Oil-in-sediment amounts (by weight or by volume) are usually very low, often less than 1% unless the oil is pooled or very thick.
- Oil residence time or *persistence* is primarily a function of the oil type, depth of penetration, retention factors, and wave-energy levels on the beach.

- Light or non-sticky oils may be easily flushed out of the surface or subsurface sediments by tidal pumping.
- Usually, only the surface layer of sediments is reworked by normal wave action. Oil that penetrates below the surface may not be physically reworked except during infrequent, high-energy storms or run-off events.

B.1.4 Bedrock or solid (includes ice)

DEFINITION

- Bedrock shorelines are impermeable outcrops of consolidated native rock.
- Ice shorelines occur where glaciers or ice shelves reach the coast, where permafrost is exposed, or where solid seasonal ice forms on the shore.

CHARACTER

- Resistant bedrock outcrops, such as granites, are stable whereas non-resistant bedrock types, such as the sandstones or chalk, are easily abraded by wave and ice action and the surface may erode at rates on the order of several cm/year.
- A stable surface on which a zonation of plants and animals in the intertidal zone is common. Biological communities usually are more prolific in the subtidal or lower intertidal zones. On coasts where ice is common, there are few attached intertidal organisms or plants due to the reduced growing season and to ice abrasion. This is particularly true on exposed bedrock shorelines with steep slopes. The biological community usually is scraped off the bedrock each year so that plants and animals only survive in cracks and crevices where they are protected from scouring.
- Bedrock is impermeable so that stranded oil remains on the surface of the outcrop.
- The presence of an ice foot or a frozen ice layer prevents oil from making contact with the shoreline substrate.

B.1.5 Wetland Vegetation

DEFINITION

- A coastal zone that is covered at least once a month by a salt or brackish water at high tide and which supports significant (>15% cover) of non-vascular salt-tolerant plants (e.g. grasses, rushes, reeds, sedges).
- The primary type of marine wetland is a salt marsh and the following material focus on this variation. Other marine wetlands include mangroves (found in tropical locations) and supratidal meadows.

CHARACTER

Salt water marshes are common in sheltered wave-energy environments, such as estuaries, lagoons, deltas, or behind barrier beaches. Marshes usually:

- develop above the high tide level and are only flooded during spring high tides or wind-driven surges,
- support a stable surface vegetation cover and root system, the leafy portion of which dies-back during winter months, and
- are characterized by a surface accumulation of organic matter deposited in water, although inorganic sediments dominate the substratum.

- Oil can impact the fringe of a wetland, during neap high tides or normal water levels, or can be deposited on higher interior meadow areas during periods of spring tides or higher water levels. Fringe oiling may be washed by subsequent tides and weathered more rapidly, depending on energy levels. Oil on the meadow area, which experiences little or no current and wave action, would weather slowly.
- Most oil types readily adhere to, and are retained on the stems and leaves of vegetation; the width (i.e. height) of an oiling coating band would vary depending on the tidal stages. Oil may or may not adhere to the sediments.
- Light oils can penetrate into marsh sediments or fill animal burrows and cracks.
- Medium to heavy oils tend to pool on the sediments, frequently creating a tenacious tarry surface cover as they weather. Due to the low wave energy level, the oil may persist for very long periods. The fine mud substrate prevents penetration.
- The presence of the frost
- Natural recovery rates vary depending on the oil type, total area affected, oil thickness, plant type, growth rates, and season during which the oiling occurred. Recovery may take as little as a few years following light oiling but can take decades in extreme circumstances (extensive, thick deposits of viscous oil).

B.1.6 Oiled debris

DEFINITION

Scattered organic or inorganic materials that have washed up onto the shore. These materials are not part of the normal shore zone substrate, such as sediments, attached animals (e.g. mussels or barnacles), live sea grasses or marsh plants.

CHARACTER

- Organic debris can range in size and character from small twigs or leaf material, to shells, seaweed mats, branches, and logs.
- Debris can include inorganic or synthetic materials, such as plastic bottles, cans, metal, rubber, styrofoam, or trash.
- Debris typically is deposited in the same (upper intertidal) zone where floating oil strands on shorelines, so that mixing of oil and debris is likely.
- Large accumulations of shells or logs can dominate the shore zone character and in effect become the substrate type. In these cases the behaviour of

stranded oil is similar to the size range of the naturally occurring equivalent material.

- Oil stranded on a shore dominated by shell fragments would behave in a similar manner to oil on a sand beach, with little penetration potential but could be easily mixed with the shells or buried by wave action.
- Oil stranded on large log accumulations would behave in the same way as oil on a boulder shore and subsurface oiling would be expected as logs debris is permeable to all but the semi-solid oils.

B.1.7 Snow

DEFINITION

A shoreline composed of seasonal snow that covers the underlying substrate.

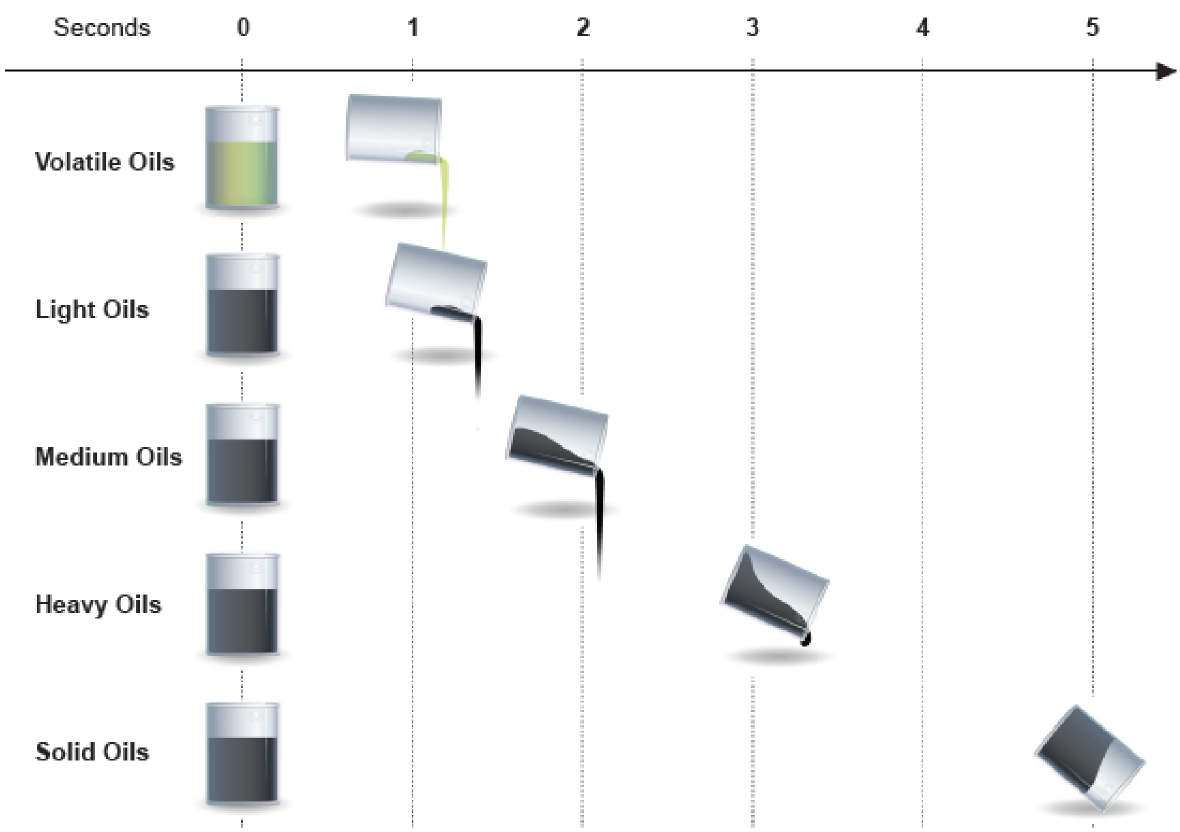
CHARACTER

- The character of the snow surface can be highly variable, ranging from:
  - Fresh powder with a soft surface or drifting snow,
  - A loose granular surface that results after powder or packed powder thaws, then refreezes and recrystalizes, or from an accumulation of sleet.
  - A hard dry crusty surface, to
  - Wet slush.
- Snow can accumulate with a simple vertical variation in density and porosity. Typically, this steady accumulation is interrupted by the effects of freeze-thaw cycles and wind. As air temperature oscillate around the freezing point, ice layers are generated as snow melts during daylight warm temperatures and freezes at night when temperatures drop below zero. If this freeze-thaw cycle is accompanied by precipitation, a range of features can form that may include alternate layers of snow and ice.
- Snow accumulates on another substrate so that, in practice, response planning considers both the snow layer and the underlying substrate of the shoreline.
- The behaviour of oil on a snow-covered shore depends on:
  - the type of snow (fresh, compacted, or contains ice layers)
  - the air temperature, and
  - the surface character of the shore (flat or sloping).

  Snow falling onto oil tends to accumulate on the oil surface.
- Snow is good, natural oil sorbent. The oil content may be very low (less than 1%) in the case of light oils or if the oil has spread over a wide area.
- Oil-snow proportions depend on the oil type and the snow character, the oil content being highest for medium oil rather than for light products.
- Oil content is lowest on firm compacted snow surfaces in below-freezing temperatures and highest for fresh snow conditions.

Appendix B.2 Oil Types

VOLATILE OILS	(gasoline products – viscosity like water)
LIGHT OILS	(diesel and light crudes – viscosity like water)
MEDIUM OILS	(intermediate products and medium crudes)
HEAVY OILS	(residual products and heavy crudes – viscosity like molasses)
SOLID OILS	(bitumen, tar, asphalt – does not pour)



Appendix B.3 Degree of Oiling (Surface Oil Category)

Terminology based on the SCAT procedures for the documentation of oiled shorelines (Owens and Sergy 2002 and MCA 2007[8]).

		Width of Oiled Area			
		Wide >6m	**Medium >3-6m**	**Narrow 0.5 – 3m**	**Very Narrow <0.5m**
Oil Distribution	**Continuous 91-100%**	Heavy	Heavy	Moderate	Light
	Broken 51-90%	Heavy	Heavy	Moderate	Light
	Patchy 11-50%	Moderate	Moderate	Light	Very Light
	Sporadic 1-10%	Light	Light	Very Light	Very Light
	Trace <1%	Very Light	Very Light	Very Light	Very Light

<u>Surface Oil Category:</u>

HEAVY 3 m wide and >50% Distribution

MODERATE 0.5 m to 3m wide and generally 10 to 50%

LIGHT <3 m wide and generally <10% Distribution
tar balls: >10 cm diameter and >1/m^2 *<u>or</u>* <1cm and >10/m^2

VERY LIGHT <0.5 m wide and generally <10% Distribution
tar balls: >10 cm diameter and <1/m^2 *<u>or</u>* <1cm and <10/m

[8] Owens, E.H. and G.A. Sergy, 2000. The SCAT Manual - A Field Guide to the Documentation and Description of Oiled Shorelines (Second Edition). Environment Canada, Edmonton AB, 108 pp.

MCA 2007. The UK SCAT Manual: A Field Guide to the Documentation of Oiled Shorelines in the UK. Maritime & Coastguard Agency, Southampton, UK, 47 pages + vi.

Appendix B.4 Treatment End Points

BULK OIL REMOVAL
Involves the safe removal of the heavy oil concentrations that could be remobilized to oil previously unaffected or reoil cleaned shorelines.

REMOVAL TO A STAIN
Involves removal of thick oil and oil cover and allowing the oil stain residues to weather naturally.

Category	**Definition**
Pooled or Thick Oil	Generally consists of fresh oil or mousse accumulations > 1.0 cm thick
Cover	≤ 1.0 cm and > 0.1 cm thick
Coat	≤ 0.1 cm and > 0.01 cm thick, can be scratched off with a fingernail on coarse sediments/bedrock
Stain	≤ 0.1 cm and > 0.01 cm thick, cannot be scratched off easily on coarse sediments/bedrock
Film	Transparent or translucent film or sheen

(Owens and Sergy 2000)

Appendix B.5 Treatment Tactics

B.5.1 Natural recovery

Objective
To leave stranded oil to natural weathering and oil removal processes and allow the oiled shoreline to recover without intervention.

Description
Evaluation of this option requires knowledge of the oiling conditions, the coastal process and physical character of the shoreline, and the resources at risk in order to evaluate the likely consequences of allowing the oil to be removed or degraded naturally. In many circumstances, it is appropriate to monitor the location to ensure that the assessment is correct or that the rate of weathering and natural oil removal proceeds as anticipated.

Applications
Natural recovery can be applicable on any spill incident and for any type of coastal environment or shoreline type. Natural recovery is generally more applicable for:

- ***small*** rather than large amounts of oil,
- ***non-persistent*** rather than persistent oil,
- ***exposed shorelines***, rather than sheltered, low energy environments, and
- ***remote*** or ***inaccessible*** areas.

Selection of the natural recovery strategy may result from an evaluation which concludes that:

- to treat or clean stranded oil may ***cause more damage*** than leaving the environment to recovery naturally, or
- response techniques ***cannot accelerate natural recovery***, or
- ***safety*** considerations could place response personnel in danger either from the oil (itself) or from environmental conditions (weather, access, hazards, etc.).

Natural recovery always should be considered the preferred option, particularly for small amounts of oil. The trade-off or net environmental benefit analysis for each segment typically considers:

- the predicted fate and persistence of the residual oil
- the estimated rate of natural recovery,
- the possible benefits of a response to accelerate recovery,
- the risks associated with the presence of the oil as it weathers, and
- the possible delays to recovery that may be caused by response activities.

Summary of Efficiency Factors for Natural Recovery

Technique	Resource Requirements	Relative Cleanup Rate	Single- or Multiple-Step	Waste Generation
NATURAL RECOVERY				
Natural Recovery	only monitoring	not applicable	not applicable	none

B.5.2 Washing and Recovery

Objective

This group of methods involves a variety of techniques to wash or flush and recover the oil from the shoreline substrate.

Description

Typically the oil is moved by the water stream from hand-operated or remote-controlled hoses to a down slope location for containment, recovery and collection for disposal. The oil is washed either:

(1) onto the adjacent water where it can be contained by booms and collected by skimmers or recovered with sorbent materials, or

(2) towards a collection area, such as a lined sump or trench, where it can be removed by a vacuum system or skimmer.

Oil is washed by a variety of methods that can include:

- flooding
- low-pressure or high pressure cold (ambient) or warm temperature washing
- steam cleaning
- sand blasting

Summary of Washing Temperature and Pressure Ranges

Tactic	Pressure Range		Temperature Range (°C)
	psi	bars	
flooding ("*deluge*")	< 20	< 1.5	ambient water
low-pressure, ambient wash	< 50	< 3	ambient water
low-pressure, warm/hot wash	< 50	< 3	30 - 100
high-pressure, ambient wash	50-1000	4 - 70	ambient water
"*pressure washing*"	> 1000	> 70	ambient water
high-pressure, warm/hot wash	50-1000	4 - 70	30 - 100
steam cleaning	50-1000	4 - 70	200
sandblasting	~ 50	~ 4	n/a

The variables that distinguish one particular washing tactic or technique from another are pressure and temperature. The higher water pressures and temperatures provide more physical force necessary to dislodge and flush oil that cannot be removed using lower pressure and/or ambient temperature water. The washing or steam cleaning techniques are sometimes referred to as “spot washing” when applied to small sections of shoreline.

Summary of Efficiency Factors for Washing and Recovery

<table>
<tr><th>Technique</th><th>Resource Requirements</th><th>Relative Cleanup Rate</th><th>Single- or Multiple-Step</th><th>Waste Generation</th></tr>
<tr><td colspan="5">WASHING AND RECOVERY TECHNIQUES</td></tr>
<tr><td>Flooding</td><td rowspan="3">labour intensive</td><td rowspan="3">slow</td><td rowspan="3">multiple</td><td rowspan="2">high</td></tr>
<tr><td>Washing</td></tr>
<tr><td>Spot Washing</td><td>moderate</td></tr>
</table>

Applications

Washing techniques can be practical and effective on most shoreline types. Low-pressure, ambient water washing can be practical and effective on most impermeable shoreline types and on some permeable shores (beaches) or marshes. Effectiveness decreases as the oil viscosity increases and as depth of oil penetration increases on cobble or boulder beaches.

B.5.3 Manual removal

Objective

To remove oil or oiled materials (including oiled sediments) with manual labour and hand tools.

Description

The technique involves cleanup teams to pick up oil, oiled sediments, or oily debris with gloved hands, rakes, forks, trowels, shovels, sorbent materials, or buckets. It may include scraping or wiping with sorbent materials or sieving if the oil has come ashore as tar balls. Collected materials are placed directly in plastic bags, drums, or other containers for transfer.

Applications

This technique can be used practically and effectively in any location or on any shoreline type or oil type. Manual removal is most applicable for:

- small amounts of viscous oil (e.g., asphalt pavement),
- surface or near-surface oil,
- areas inaccessible to vehicles or where vehicles cannot operate.

This technique is labour intensive and slow for large oiled areas. This is a significantly slower method than mechanical removal, but generates less waste and the waste materials (tar balls, oiled sediment, oiled debris, etc.) can be segregated easily during cleanup.

Summary of Efficiency Factors for Manual Removal Techniques

<table>
<tr><th>Technique</th><th>Resource Requirements</th><th>Relative Cleanup Rate</th><th>Single- or Multiple-Step</th><th>Waste Generation</th></tr>
<tr><td colspan="5">MANUAL REMOVAL TECHNIQUES</td></tr>
<tr><td>Shovels, rakes</td><td rowspan="3">labour intensive</td><td rowspan="4">slow</td><td rowspan="4">multiple</td><td>low-moderate</td></tr>
<tr><td>Vacuums</td><td>moderate</td></tr>
<tr><td>Vegetation Cutting</td><td>can be high</td></tr>
<tr><td>Sorbents</td><td>labour intensive if used extensively with large amounts of oil</td><td>can be high if frequent change-outs required</td></tr>
</table>

Manual removal typically requires vehicle or vessel support to transfer collected materials to temporary storage or permanent disposal sites.

B.5.4 Mechanical removal

Objective
To remove oil and oiled materials using mechanical equipment.

Description
Oil or oiled materials are removed from the shore zone for disposal by earth moving equipment such as graders or bulldozers that move material for removal by other machines and by scrapers, excavators, loaders, or back hoes that lift or remove material directly for offsite transfer.

Efficiency and cost may be evaluated in terms of the resource requirements, cleanup rates, the number of times the material is handled, and the volume of waste that is generated. Mechanical removal is more rapid than manual removal but generates larger quantities of waste.

Summary of Efficiency Factors for Mechanical Removal Techniques

Technique	Resource Requirements	Relative Cleanup Rate	Single- or Multiple-Step	Waste Generation
MECHANICAL REMOVAL TECHNIQUES				
Grader	minimal labour support	very rapid	multiple	moderate
Bulldozer		rapid		very high
Scraper		very rapid	single	moderate
Front-end Loader		rapid		high
Backhoe / Excavator		medium		
Dragline/ Clamshell				

Off-site beach cleaning machines that treat or wash oiled materials are included with this technique. These involve a waste management program of transfer, temporary storage, and treatment, even if sediments are replaced on the shore. These off-site cleaners involve a multi-step process as oiled material is removed from a beach and subsequently replaced by one or more types of earth-moving equipment.

Applications

Mechanical removal can be used on all but bedrock or solid man-made shoreline types. The various types of commercially-available earth-moving equipment have different operational requirements and different applications. The most important variable is the bearing capacity, which controls the ability of a piece of equipment to travel on a shore type without becoming immobilized. Traction for wheeled equipment on soft sediments (low bearing capacity) can be improved by reducing tire pressures. Tracked equipment may be able to operate where wheeled vehicles cannot, but is not a preferred option as tracks disturb sediments to a much greater degree than tires.

Each type of equipment has a particular application.

- **Scrapers** and **graders** can operate only on hard and relatively flat surfaces and are capable of moving only a thin cut (~10 cm) of surface material.
- **Loaders, bulldozers,** and **backhoes** can operate in a wider range of conditions and are designed to dig and move large volumes of material.
- **Backhoes, draglines,** and **clamshells** with an extending arm or crane so that they may be operated from a barge or from a backshore area and **can reach to pick up material**.
- **Beach cleaning machines** operate in a number of different ways. Mobile equipment operates on a beach, whereas other equipment operates off-site (adjacent) to treat oiled sediment so that cleaned material may be replaced on the beach.
- **Vacuum trucks** remove pooled oil or oil collected in lined sumps.

B.5.5 In situ sediment mixing or relocation

Objective

To break up or increase the exposure of the surface and/or sub-surface oil to both air and water action in order to accelerate natural weathering and removal processes. Mechanical mixing of oiled sediments can involve agitation either in the absence of water ("dry" mixing) above the water line or underwater ("wet" mixing). In both cases the intent is to mix or turn-over the sediment *in situ*. This differentiates mixing from sediment relocation where sediments are purposely moved from one location to another that has higher levels of physical (wave) energy in order to accelerate natural oil removal processes.

Description

In situ sediment treatment can include dry or wet mixing and sediment relocation and for which there is no removal (transfer and disposal) of oiled sediments. These tactics either physically expose oiled sediments and/or change the location of the oiled sediments with respect to wave exposure in order to promote or increase natural weathering and natural water-born removal process. Oil that is released during a rising tide can be contained and recovered, for example with sorbents materials. In some cases, oil released in the water and which resurfaces can be recovered by sorbents or from within a boomed containment area. Some oil is put into fine particle suspension in the water column and is left to natural dispersion and biodegradation processes.

Dry mixing can involve tilling or raking that agitates oiled surface sediments and digging or ploughing actions that physically turn over or displace surface and subsurface sediments. Manual mixing involves rotary garden tillers or rakes. Heavier machinery includes agricultural equipment, such as disc systems, harrows, ploughs, rakes or tines; or earth-moving equipment, such as rippers, (tines), front-end loaders, backhoes, graders, or bulldozers. Agricultural "rippers" or "scarifiers" typically can mix sediments up to a depth of 55 cm whereas backhoes could work to significantly greater depths; on the order of a meter or more.

Wet mixing is used in shallow water (typically <1m) either in the intertidal zone during rising or falling tides or at the water line during the tidal low-water slack. The sediments are agitated *in-situ* to release the oil by physical abrasion. Agricultural equipment, such as disc systems, harrows, ploughs, rakes or tines; or earth-moving equipment, such as rippers (tines), front-end loaders, or backhoes; or high-volume, low-pressure or low-volume high-pressure water jets agitate the underwater sediments within a boomed containment area. Custom-designed machines which combine mechanical mixing with water jets have proved to be very effective.

Sediment relocation differs from mixing as oiled sediments are physically moved from one location to another. The physical movement of oiled sediments causes mixing of those sediments, but the intent is to move the material to areas with higher physical energy levels, for example, from a location above the normal high water level to the upper intertidal zone where sediments can be reworked during each high tide period.

Summary of Efficiency Factors for In Situ Sediment Treatment

Technique	Resource Requirements	Relative Cleanup Rate	Single- or Multiple-Step	Waste Generation
IN SITU SEDIMENT TREATMENT				
Dry Mixing	minimal labour support	very rapid	single	minimal
Wet Mixing				
Sediment Relocation				

Applications

Dry mixing increases the exposure of surface and subsurface oiled sediments to air and water, and/or to break up a surface oil layer to prevent the formation of an asphalt pavement. This technique can be used on sand, mixed sediment, pebble-cobble beaches or sand tidal flats and is particularly useful in promoting the evaporation of light oils or product.

Wet mixing can be used on sand, mixed sediment pebble-cobble beaches or tidal flats for light and medium oils that will float to the water surface when agitated.

Sediment relocation has been proven effective on sand, mixed-sediment and pebble-cobble (coarse-sediment) beaches and is particularly useful:

- where oiled sediments are located above the limit of normal wave action (i.e., if a beach was oiled during a storm surge or a period of higher tide levels), and
- for “polishing” of sand or fine mixed sediments where other cleanup or treatment activities have removed most of the bulk oil or oiled sediment and only light oiling (i.e., stains) remain.

All three in situ sediment treatment techniques are effective:

- in promoting evaporation and physical abrasion,
- where sediment removal is undesirable due to
  - a lack of natural sediment replenishment,
  - waste transfer and/or disposal issues,
  - logistical constraints in remote areas, or
  - inaccessibility to a segment location;
- immediately prior to expected storm events or periods of high wave-energy levels, and
- where a rapid/immediate removal of stranded oil is warranted or required.

Dry mixing and sediment relocation may be used in conjunction with manual removal (to pick up patches of oil that are exposed) or bioremediation. The technique may be appropriate after initial removal of bulk oil by mechanical removal methods.

B.5.6 In situ burning

Objective
To remove or reduce the amount of oil by burning the oil in-situ.

Description
Oil on a shore will not sustain combustion by itself unless it is pooled or has been concentrated in sumps, trenches, or other types of containers. This technique is used primarily where combustible materials, such as logs or debris, have been oiled and can be collected and burned. It can also be used where vegetation, such as that found in a wetland, has been heavily oiled.

Burning efficiency can be improved by using fans to provide wind on burn piles. Torches can burn oil from hard substrates, but this is a labour intensive method that uses large amounts of energy to remove small amounts of oil. In most cases, burned oil residues remain and recovery of these heavy or solid oil residues would involve manual removal.

Portable incinerators based on a number of different technologies can be used to burn oiled sediments or debris.

Summary of Efficiency Factors for In Situ Burning

Technique	Resource Requirements	Relative Cleanup Rate	Single- or Multiple-Step	Waste Generation
IN SITU BURNING				
In Situ Burning	minimal labour support	very rapid	single	minimal

Applications
This technique is applicable primarily for oiled logs and debris or where oil has been collected in sumps or drums and can be ignited with sustained combustion.

Burning has been used effectively for oil spills in salt marshes and on ice or in ice leads.

B.5.7 Bioremediation

Objective
To enhance or increase the rate of biodegradation of oil in the intertidal zone by the addition of oil spill bioremediation agents.

Three classes of oil spill bioremediation tactics have been recognized: Bioenhancement agents contain only non-living materials such as nutrients, (fertilizers containing nitrogen and phosphorous) intended to enhance the natural oil-degrading activity of the indigenous microbial population at a spill site; Bioaugmentation agents contain living microbes (and possibly also chemical agents to enhance oil biodegradation), intended to increase or supplement the natural rate of hydrocarbon biodegradation at a spill site. A third tactic, phytoremediation, involves the use of fungi and plants to accelerate oil degradation.

Historically, bioaugmentation and phytoremediation techniques have had limited use and application to the remediation of oil on shorelines so this description focuses on bioenhancement – the *in situ* addition of nutrients to oiled substrates.

Description
Naturally-occurring micro-organisms (bacteria) use oxygen to convert hydrocarbons into water and carbon dioxide. This process usually occurs at the oil/water interface and primarily is limited by oxygen and nutrient availability and by the exposed surface area of the oil. If these three factors can be increased, then the rate of biodegradation can be accelerated.

Nutrients can be applied in solid or liquid form and typically are applied in situ. Solid fertilizers, such as pellets, can be broadcast on an oiled substrate using seed spreaders that are commonly used on lawns or. On contact with water, the fertilizer slowly dissolves and releases water-soluble nutrients over time. Liquid fertilizers can be sprayed onto a shoreline using a number of commercially available types of equipment, such as paint sprayers or back packs.

Summary of Efficiency Factors for Bioremediation

Technique	Resource Requirements	Relative Cleanup Rate	Single- or Multiple-Step	Waste Generation
BIOREMEDIATION				
Bioremediation	minimal labour support	very rapid	single	minimal

There is no removal of oiled sediments and the only waste generated is from the packing material and from PPE.

Off-site treatment of oiled sediments is similar to land farming technology and could involve bioaugmentation and/or phytoremediation as well as nutrient addition.

Applications

Bioremediation is an *in situ* treatment technique that is applicable where there is light oiling or on residual oil ("polishing") after other techniques have been used to remove mobile or bulk oil from the shoreline. Bioremediation is not a short-term solution (days to weeks) and is not a suitable where short term oil removal is required. Applications may be repeated periodically (weeks or months as appropriate) to continue the supply of nutrients.

Fertilizers may be used alone on a shore to degrade residual surface and/or subsurface oil, but the process is more effective if combined with mixing or other methods of breaking the oil into smaller particles. This significantly increases the surface area available to the micro-organisms.

Appendix B.6   Surface Oil Category

The terminology for degree of oiling (the Surface Oil Category) is based on Owens and Sergy 2002 and MCA 2007.

		Width of Oiled Area			
		Wide >6m	**Medium >3-6m**	**Narrow 0.5 – 3m**	**Very Narrow <0.5m**
Oil Distribution	**Continuous 91-100%**	Heavy	Heavy	Moderate	Light
	Broken 51-90%	Heavy	Heavy	Moderate	Light
	Patchy 11-50%	Moderate	Moderate	Light	Very Light
	Sporadic 1-10%	Light	Light	Very Light	Very Light
	Trace <1%	Very Light	Very Light	Very Light	Very Light

In general terms these categories characterize the oiling conditions as follows:

HEAVY 3 m wide and >50% Distribution

MODERATE 0.5 m to 3m wide and generally 10 to 50% Distribution

LIGHT <3 m wide and generally <10% Distribution

VERY LIGHT <0.5 m wide and generally <10% Distribution

This categorization applies primarily to marine shorelines with tides. Oiled lake shorelines typically have a Narrow or Very Narrow band width.

Appendix C WasteManagement Plans

C.1 *Waste Management for Contingency Planning*

The following is a summary of recommended contents for the waste management section of an oil spill response or contingency plan.

INTRODUCTION
Statement of scope, applicability, and references to supporting documents

SCOPE AND RESPONSIBILITY
Statement of personnel, agencies, and spill management roles assigned to responsibilities in waste management process.

LEGAL REQUIREMENTS
List and describe applicable regulations and laws and how waste management will comply with requirements

POLICY
Statement on company/agency policy for waste management: waste minimization, early planning, recycling, and disposal

DECONTAMINATION
Procedures and responsibilities for equipment and personnel decontamination (or cross-reference where this is developed elsewhere)

WASTES AND CLASSIFICATION
Describe expected or typical wastes generated from spill response, how these are classified (in a country, province, state, or region), tests or procedures to be used to classify and segregate wastes, packaging and labeling (where and if appropriate)

RECOVERED OIL
Describe procedures for handling recovered oily liquids, including those from pumping (from tanks, pipelines, etc.) and skimming.
1. Initial Process
2. Decanting (Oil / Water Separation)
3. Storage
4. Recycling

OILY DEBRIS
Describe procedures for handling recovered oily solids, including sorbents, oiled sediments or substrates, PPE, hoses, etc.

1. Segregation
2. Testing
3. Containers
4. Interim Storage
5. Burning
6. Transportation
7. Record Keeping and Reporting

NON-OILED MATERIAL

Describe procedures for handling solids that are not oiled. These typically wastes generated at facilities, such as containers and refuse from food, water, and services. Most often these follow standard (not oil spill) waste stream procedures

ANIMAL CARCASSES

Describe procedures for handling carcasses (oiled and non-oiled). Generally entails coordination with government agency(ies) and, in cases, detailed logs and chain-of-custody. Typically is coordinated with Wildlife Response Plan and teams.

TRANSPORTATION

Identify licensed transportation companies, contacts, agreements, capabilities and limitations.

DISPOSAL AND RECYCLING FACILITIES

Identify licensed transportation companies, contacts, agreements, capabilities and limitations.

RESOURCES AND LOGISTICS

List or cross-reference equipment available (facility, company, local), capacities, points of contact, and limitations for:

- Temporary waste storage
- Oil-water separators
- Labs and Test Facilities
- Transportation (water, land, air - as appropriate)
- Disposal

MODEL DISPOSAL PLAN

See example in Section C.2 below.

Example Tables

Table 1	Oil Recyclers
Table 2	Testing Laboratories / Chemists--Analytical
Table 3	Transporters
Table 4	Disposal Facilities and Capabilities

C.2 Model Disposal Plan for Oil Spills

The information typically required for an incident-specific waste management plan, which is developed at the time of a spill, is outlined below.

(*Incident Name*)

Responsible Party:

Spilled Material:

Spill Volume (estimate):

Spill Location:

Spill Date/Time:

Prepared by: **Date Prepared:**

Disposal Plan Authorization

This plan is written at the request of the National, Provincial/State, and Local agencies. The responsible party will recover the maximum feasible amount of oil spilled during the above named incident. In addition an unknown quantity of oily waste debris (including plastics, sands, etc.) will be recovered. When disposing of this material, the responsible party will abide by all applicable local, provincial/state and federal laws and regulations. Disposed material will be tracked to provide an accurate means of estimating total oil recovered.

This plan may be amended as necessary to ensure compliance with all applicable laws and regulations. Amendment may occur only upon mutual agreement of the responsible party, the Federal OSC (______), and/or the State/Provincial OSC (__________).

Submitted By: ________________________Date: ______

Approved by State/Provincial OSC: __________________________Date: ______

Reviewed by Federal OSC: ________________________Date: ______

Approved by Responsible Party: ________________________ Date: ______

Approved by other Local Government Representative(s) (Optional):

__________________________Date: ______

SECTION I WASTE HANDLERS

The following licensed transporters and approved treatment and disposal facilities are to be used for waste handling and disposition unless otherwise directed. All waste handlers have read and are working in accordance with this plan.

Name of Company	Disposal Functions	Company Representative Signature

SECTION II DESIGNATION

The spilled material was deemed (non-) dangerous waste based on the following:

>>>> *Insert criteria used to define or classify waste (lab, regulations, etc.)*

SECTION III INTERIM STORAGE, SEGREGATION, and TRACKING

A. INTERIM STORAGE OF SOLID MATERIAL

Interim storage sites will be located at: ________________________________

>>>> *for large spills, consider adding map(s) to show locations*

Authorization of Oversight Agency

>>>> *insert authorizing statement by appropriate agency*

B. SEGREGATION

Material recovered must be segregated in the following manner unless otherwise directed by the Provincial/State or Federal OSC:

1. Oil collected from decontamination of vessel hulls (ship and skimmers) will bagged (sorbents) and pumped (liquids, if applicable) to vacuum trucks.
2. Oil and oil/water mixtures recovered: skimmer tanks to be gauged prior to pumping off to vacuum truck. Vacuum truck volumes to be registered by truck driver.
3. Oiled organic debris: wood, aquatic vegetation to be bagged and placed on/in lined interim storage area.

4. Oiled sorbent material: oil snares, pads, and booms to be placed on/in lined interim storage area or truck for transport. Truck drivers to maintain register of material transported/hauled to disposal.
5. PPE and other typically non-sorbent materials to be decontaminated as appropriate. Items for disposal will bagged separately and placed on/in lined interim storage area or truck for transport.

C. TRACKING

Consignment Reference Number	Date and Time Collected	Work Site or Collection Point	Transporter (Company)	Type Waste	Quantity (m^3)	Destination

D. DECANTING

Decanting is to be used to reduce oily liquids when available storage is or becomes limited. Decanting will be performed after oily liquids have passed through an oil-water separator or have been allowed sufficient time (and conditions) to naturally separate.

Decanted water is to be pumped into containment (tanks or boomed areas) and visually monitored for oil discharge. Visible oily discharges require decanting operations to cease.

The following vessels/locations are identified as decanting points:
>>>> *list vessels or sites for decanting*

Decanting authorization form (if approved) should be attached.

SECTION IV DECONTAMINATION

Describe the areas designated for decontamination including location, set up, and pollution prevention measures.

SECTION V ANIMAL CARCASSES

Should animal carcasses be discovered, they will be collected and placed by itself in bag and labeled (DAY, TIME, Person Collecting Carcass; Oiled or Non-Oiled). Any carcass bags will be provided to _________ (*generally need to insert name of agency responsible for wildlife*). No oiled carcasses shall be disposed of until authorized by the appropriate agency.

Incineration of oiled carcasses will take place at _____________ (*a permitted facility*) following approval of local Air and Health authorities and the wildlife agency.

SECTION VI WASTE DISPOSITION and FINAL DISPOSAL

Waste streams should be documented on status boards at the Command Post or EOC. Typically, the ICS 209 Incident Summary Form is used for this purpose.

ICS Form 209 Final Waste Status Summary

TYPE	Recovered	Stored	Disposed of
Oil (m^3)			
Oily Liquids (m^3)			
Oily Solids (m^3)			
Solids (m^3)			

Include copies of waste tracking forms for final disposal if used. Also, include copies of receipts from disposal facilities.

A. RECOVERABLE OIL

Oil recovered will be transported by to ______________________________by ____.

Company name and contacts: ____
____
____.

B. BURNABLE MATERIAL:

Burnable material includes oily wood, debris, PPE, sorbents, oil snares and other suitable organic material collected during cleanup operations. The debris will be transported from the interim storage site by _______________ to _________________.

Consignment Reference Number	Date and Time Collected	Work Site or Collection Point	Transporter (Company)	Type Waste	Quantity (m^3)	Incineration Facility

On-site burning is requested to minimize material requiring transport and handling. Burns are to be conducted with fire monitor supervisor on site and under approved conditions. Burning may consist of:

>>> *describe methods*

- Open pit burn
- Portable incinerator

C. OTHER MATERIAL:

This material may consist of sand and tar balls and other assorted material that has been collected from the cleanup effort and has been stored at interim storage sites. All of this material will be transported to a licensed facility.

Transporter(s)	Facility

C.3 Waste Plan References

AMSA - Management and disposal of oil spill debris: The National Plan to Combat Pollution of the Sea by Oil and other Noxious and Hazardous Substances. This Australian Maritime Safety Authority document presents guidelines for "Developing a contingency plan for oil spill debris disposal, including selection of a site (or alternative sites) before the need arises":

- http://www.amsa.gov.au/Marine_Environment_Protection/National_Plan/Supporting_Documents/Management_and_disposal_of_oil_spill_debris.asp

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal:

- Convention description: http://www.basel.int/text/documents.html
- Forms: http://www.basel.int/techmatters/forms-notif-mov/vCOP8.pdf

BTC - Example contents for a general spill waste management plan for the Baku-Tblisi-Ceyhan Pipeline:

- http://www.bp.com/liveassets/bp_internet/bp_caspian/bp_caspian_en/STAGING/local_assets/downloads_pdfs/xyz/BTC_English_General_OSRP_Content_APPENDIX_C.PDF

California Office of Spill Prevention and Response for a spill-specific plan:

- http://www.dfg.ca.gov/ospr/response/acp/marine/2005RCP/Appendices/Appx_XXVII_samplewastemngmtplan.pdf

Northwest Area Contingency Plan, 2006. Chapter 9620, Washington State Disposal Guidance, 11 pp.

- www.rrt10nwac.com/files/nwacp/9620.pdf

C.4 Tools and Forms

C.4.1 Waste Branch Director (or Group Supervisor)

Role and Responsibilities Checklist

Initial Response
☐ After consultation with the Operations Section Chief, Environmental Unit Leader and the Field Team Leader coordinate with the Procurement Unit Leader and Logistics Section Chief for manpower, equipment, and services necessary to execute waste disposal/storage plan.
☐ Develop temporary waste holding, transportation, and waste disposal plan.
☐ Arrange waste disposal sites with local authorities for recovered oil and oiled debris, and determine procedures and conditions to be followed.
☐ Work with the On-Land and On-Water Recovery Supervisors to identify shoreside or on-water (barge) staging areas for recovered oil and debris storage.
☐ Utilize, as much as possible, predetermined disposal sites, both temporary and permanent.
☐ Supervise activities of waste disposal contractors.
☐ Coordinate with the Transportation Unit Leader and Procurement Unit Leader to obtain all transportation, not supplied by the OSR contractor, which is required for the hauling of waste material.
☐ Identify and obtain equipment for recovered oil storage.
Daily / On-going
☐ Prepare for and attend the Operations Supervisors daily meeting.
☐ Ensure oily and non-oily wastes are segregated.
☐ Monitor effectiveness of disposal operations.
☐ Coordinate with the On-Land and On-Water Recovery Supervisors to ensure response operations are done in a way to minimize waste generation.
☐ Re-assign equipment to areas where it will have greater effectiveness.
☐ Conduct safety inspections.
☐ Document all activities.
☐ Approve contractor time sheets and receipts for equipment used.
☐ Stand down equipment/manpower.
☐ Provide the Documentation Unit, before leaving site, with a copy of any notes or observations made during the operation for use at the post-incident stewardship meeting.
☐ Maintain logs to document: quantity and types of materials stored, storage locations for recovered materials and disposal sites used for recovered materials.

C.4.2 Example Waste Manifest Form

Hazardous Waste Manifest **(Information of hazardous waste for disposal)**	
1. Occupier's Name & Mailing Address: (including Phone No.)	2. Occupier's Registration No. 3. Manifest Document No.

4. Transporter's Name & Address: (including Phone No.)	5. Type of Vehicle: Truck Tanker Special Vehicle	.6. Transporter's Registration No. 7. Vehicle Registration No.

8. Designated Facility Name &Site Address:	9. Facility's Registration No.	
	10. Facility's Phone	
11. Waste Description:	12. Total Quantity of Waste	
	m^3	t
	13. Consistency Solid Oily Semi-Solid Tarry Sludge Slurry	

14. Transport Description of Waste	15. Containers		16. Total Quantity	17. Unit Wt/Vol.	18. Waste Category
	No.	Type			No.

18. Special Handling Instructions & Additional Information		
20. OCCUPIER'S CERTIFICATE: I hereby declare that the contents of the consignment are fully and accurately described above by proper shipping name and are categorized, packed, marked, and labeled, and arc in all respects in proper condition for transport by road according to applicable national government regulations.		
Typed Name & Stamp Signature Month Day Year	Month/Day/Year	
2 1. Transporter Acknowledgement of Receipt of Materials		
Typed Name & Stamp Signature Month Day Year		
22. Discrepancy Note Space		
23. Facility Owner or Operator's Certification of Receipt of Hazardous Waste		
Typed Name & Stamp Signature Month Day Year	Signature	Month/Day/Year

Appendix D   Legislation Summary for Arctic Canada

Canadian Federal, Territorial and Aboriginal Group,
Regulations, Guidelines and Procedures Regarding Oily Waste
Management, Transport, and Disposal
in the Yukon, Northwest Territories and Nunavut

TABLE OF CONTENTS

GLOSSARY

CEPA	Canadian Environmental Protection Act
DIAND	Department of Indian Affairs and Northern Development
E2	Environmental Emergency
EISC	Environmental Impact Screening Committee
ENR	Environment and Natural Resources
EPA	Environmental Protection Division
IRC	Inuvialuit Regional Corporation
IFA	Inuvialuit Final Agreement
ILA	Inuvialuit Land Administration
IPG	Institutions of Public Government
ISR	Inuvialuit Settlement Region
JS	Joint Secretariat
MV EIRB	Mackenzie Valley Environmental Impact Review Board
MV RMA	Mackenzie Valley Resource Management Act
NWT	Northwest Territories
PAH	Polycyclic Aromatic Hydrocarbons
PSL	Priority Substances List
TDGR	Transportation of Dangerous Goods Regulations
YESAB	Yukon Environmental and Socio-economic Assessment Board

Purpose and Summary

This document provides a brief summary description of Federal, Territorial and Inuvialuit laws and regulations regarding oily waste management, transport, and disposal in the Yukon, Northwest Territories (NWT) and Nunavut.

These laws and regulations are summarized in Table 1 and Internet sources to obtain copies in the reference source document are provided in Section 6. This document only provides a brief summary of the cited legislation. It is not a legal opinion as to which specific laws and regulations may or may not apply to a particular incident or situation. Legal counsel should be consulted and official copies of the laws and regulations themselves should be referred to for all relevant details.

1.0 Inuvialuit Regional Corporation / Inuvialuit Settlement Region / Joint Secretariat

The Inuvialuit Regional Corporation (IRC) is a corporate entity created under the Inuvialuit Final Agreement (IFA) in the far northwest of Canada. The IRC administers Inuvialuit owned lands in the Inuvialuit Settlement Region (ISR; Regulatory Roadmaps Project, 2001) via its Lands Administration (ILA). The ISR includes areas in both the Yukon and Northwest Territories bordering on the Beaufort Sea portion of the Arctic Ocean. The Joint Secretariat (JS) in Inuvik, NWT, was created in 1986 to provide technical and administrative support for the Inuvialuit Game Council, the Environmental Impact Screening Committee (EISC), the Environmental Review Board, the Wildlife Management Advisory Council (NWT) and the Fisheries Joint Management Committee.

1.1 Inuvialuit Final Agreement

The IFA between the Inuvialuit and the federal Canadian Government was signed in 1984 (IRC, 1987; Regulatory Roadmaps Project, 2001). It represents the settlement of the western Arctic land claim. The IFA document, ‘The Western Arctic Claim; Inuvialuit Final Agreement (As amended; 1987)’, specifies the relationship between the Inuvialuit and the federal Canadian Government, and the Yukon and Northwest Territories in regard to the application of laws and regulations on Inuvialuit-owned territorial and Crown Land. This includes the administration and management of natural resources and the environmental screening and review of development and other projects.

1.2 Regulations for the NWT portion of the Inuvialuit Settlement Region

The Environmental Impact Screening Committee (EISC) within the Joint Secretariat (JS) has developed a process for that portion of the ISR in the Northwest Territories (EISC, 2004). The EISC process, 'Operating Guidelines and Procedures (November 2004)', specifies how the EISC operates and how proposed development projects will be screened for environmental impacts. The EISC can recommend terms and conditions for permits which, if accepted by the permit issuing regulatory agency, may be attached to that permit.

All development proposals on Crown land go through a two-part screening and review process. In the ISR, the Canadian federal Department of Indian Affairs and Northern Development (DIAND) issues land permits and the NWT Water Board issues water permits. The Inuvialuit Land Administration (ILA) issues permits on private land. The ILA has its own rules and procedures for development and other matters, such as oily waste storage and disposal (Joint Secretariat, 2006). Some development proposals may straddle Crown and private lands. These proposals would go through the EISC screening procedure.

South of the ISR, various land and water boards in the Mackenzie River valley have the authority to issue land and water permits. These boards would screen development projects for the Mackenzie Valley Environmental Impact Review Board (MV EIRB) under the Mackenzie Valley Resource Management Act (1998) (MV RMA; MV EIRB, 2005).

1.3 Laws and regulations for the Yukon portion of the Inuvialuit Settlement Region

The Yukon Environmental and Socio-economic Assessment Board (YESAB) administers environmental assessments conducted under the IFA in the Yukon portion of the ISR (YESAB, 2006). The process by which these assessments are conducted is specified in the 'Yukon Environmental and Socioeconomic Assessment Act (May 13, 2003)' (Department of Justice Canada, 2003). The environmental assessment process is regulated by the 'Assessable Activities, Exceptions and Executive Committee Projects Regulations (November 28, 2005)' (Department of Justice Canada, 2005). East of the Babbage River, the EISC would conduct environmental screening and review, but not socio-economic screening, as this would be covered by the YESAB. There is some overlap, but the Government of the Yukon and the Inuvialuit have developed a process that avoids duplication. The western half of the Yukon portion of the ISR consists of Ivvavik National Park. Any development permits in the national park would be issued by Parks Canada.

Table 1

Canadian Federal, Territorial and Aboriginal Group, Regulations, Guidelines and Procedures Regarding Oily Waste Management, Transport and Disposal in the Yukon, Northwest Territories and Nunavut

Subject Area	Government or Legal Entity	Government or Legal Entity Department/Agency	Applicable Laws	Applicable Regulations, Guidelines and Procedures	Contact Persons	Comments
Oily waste management, disposal and transport	Inuvialuit Regional Corporation, Inuvialuit Settlement Area	Inuvialuit Joint Secretariat, Environmental Impact Screening Committee	The Western Arctic Claim; Inuvialuit Final Agreement (as amended; 2005)	Environmental Impact Screening Committee Operating Guidelines and Procedures (November 2004)	Dr. Norm Snow 867-777-2828	NWT portion of Inuvialuit Settlement Area
Oily waste management, disposal and transport	Inuvialuit Regional Corporation, Inuvialuit Settlement Area	Yukon Environmental and Socioeconomic Assessment Board	Yukon Environmental and Socioeconomic Assessment Act (May 13, 2003) Statutes of Canada Chapter 7	Assessable Activities, Exceptions and Executive Committee Projects Regulations (November 28, 2005)		Yukon North Slope portion of Inuvialuit Settlement Area
Oily waste management, disposal and transport	Government of Canada	Environment Canada, Environmental Protection Operations	Canadian Environmental Protection Act (CEPA) 1999, Statutes of Canada Chapter 33	Environmental Emergency Regulations (August 2003) (Under Part 8 of CEPA, 1999) [see 'Implementation guidelines for Part 8 of the CEPA, 1999 – Environmental Emergency Plans']	Nathalie Lowry 867-667-3405 David Tilden 867-669-4728	See also: 'A guide to understanding the Canadian Environmental Protection Act, 1999 (October 27, 2004)
Oily waste transport	Government of Canada	Transport Canada	Transportation of Dangerous Goods Act 1992	Transportation of Dangerous Goods Regulations (Canada) SOR/2001-286		
Oily waste transport	Government of Canada	Environment Canada	Canadian Environmental Protection Act (CEPA) 1999, Statutes of Canada Chapter 33	Interprovincial Movement of Hazardous Waste Regulations (SOR/2002-301) Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149) (both issued under Section 191, Part 7 Division 8 of CEPA, 1999]		
Disposal at sea	Government of Canada	Environment Canada, Environmental Protection Operations	Canadian Environmental Protection Act (CEPA) 1999, Statutes of Canada Chapter 33	Disposal at Sea Regulations SOR/2001-275 (August 2001) (Under Part 7, Division 3 of CEPA) [Only substances listed in Schedule 5 of CEPA] Regulations Respecting Applications for Permits for Disposal at Sea (August, 2001) Ocean Dumping Permit Fee Regulations (March, 1999)	Lisa Perry 867-669-4748	

Subject Area	Government or Legal Entity	Government or Legal Entity Department/Agency	Applicable Laws	Applicable Regulations, Guidelines and Procedures	Contact Persons	Comments
Oily waste management	Government of the Northwest Territories	Department of Environment and Natural Resources, Environmental Protection Division	Environmental Protection Act (1988), Revised Statutes of the Northwest Territories	Used Oil and Waste Fuel Management Regulations (November 2003) [issued under Section 34 of the NWT EPA, 1988] Guideline for the general management of hazardous waste (February 1998)' [issued under Section 2.2 of the NWT EPA, 1988}	Harvey Gaukel Don Helfrick	
Oily waste transport	Government of the Northwest Territories	Department of Transportation	Transportation of Dangerous Goods Act 1990 [NWT]	Transportation of Dangerous Goods Regulations (August 15, 2002) [issued under Sections 63 and 64 of the NWT TDGA, 1990]	Michael Brown	
Oily waste management	Government of Yukon	Department of Environment	Environment Act (2002) Revised Statutes of the Yukon, 2002 Chapter 76	Special Waste Regulations (1995) [issued under Part 7 of the Yukon Environment Act] Spills Regulations (1997)[issued under Part 11 of the EA]		See also: 'Guide to Yukon Special Waste Regulations'
Oily waste transport	Government of Yukon	Department of Highways and Public Works, Transportation Division	Dangerous Goods Transportation Act, Revised Statutes of the Yukon 2002 Chapter 50	Dangerous Goods Transportation Regulations (OIC 1986/118)[issued under Section 28 of the DGTA] Special Waste Regulations Special Waste Transportation Permit		New special waste transportation permit issued early 2006 – required [See press release and fact sheet]
Oily waste management	Government of Nunavut	Department of Environment, Environmental Protection Service	Environmental Protection Act (Nunavut) (1988; Revised Statutes of the NWT; Ch. E-7)	Spill contingency planning and reporting regulations (R-068-93; July 22, 1993) See also: 'Guideline for the General Management of Hazardous Waste in Nunavut' (January 2002)	Robert Eno 867-975-7748	The Government of Nunavut uses many laws and regulations of the NWT as the basis for its laws and regulations
Oily waste transport	Government of Nunavut	Department of Economic Development and Transportation	Transportation of Dangerous Goods Act, 1990 (Revised Statutes of the NWT; Ch. 81 (Suppl.)	Transportation of Dangerous Goods Regulations, 1991 (R-095-91; Revised Regulations of the NWT):		

Contacts

Robert Eno
Manager, Pollution Control
Environmental Protection Service
Department of Environment
Iqaluit, NU X0A 0H0
Tel: 867-975-7748
E-mail: reno@gov.nu.ca

Harvey Gaukel
Hazardous Substance Specialist
Environmental Protection Division
Environment and Natural Resources
Government of the Northwest Territories
Yellowknife, NT X1A 3S8
Tel: 867-873-7654
Fax: 867-873-0221
E-mail: harvey_gaukel@gov.nt.ca

Nathalie Lowry, B.Sc., M.G.I.S.
Coordinator, Emergency Prevention, Planning and Liaison
Environment Canada, Emergencies Program, Yukon Section
91782 Alaska Highway, Whitehorse, YT Y1A 5B7
Tel: 867-667-3405
Cell: 867-333-9917
Fax: 867-667-7962
E-mail: Nathalie.Lowry@ec.gc.ca

2.0 Government of Canada

2.1 Canadian Environmental Protection Act (1999) and regulations

The Canadian Environmental Protection Act (CEPA 1999; Statutes of Canada 1999 Chapter 33) is the basic environmental law in Canada that governs pollution prevention, ecological risk assessment, toxic substances, biotechnology products, disposal at sea, air emissions from vehicles, engines and machines, hazardous waste, environmental emergencies (including oil spills), and citizen input (Environment Canada, 2000; 2004a). The CEPA (in Section 64) defines substances as 'toxic' if they enter or may enter the environment in quantities or concentrations that:

- "Have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
- Constitute or may constitute a danger to the environment on which life depends; or
- Constitute or may constitute a danger in Canada to human life or health."

Substances that are declared 'toxic' under CEPA are added to the List of Toxic Substances in Schedule 1 of the CEPA. Certain polycyclic aromatic hydrocarbons (PAHs) and BETX compounds (benzene, ethylbenzene, toluene and xylenes), that are components of many petroleum products are considered 'toxic' and are listed in Schedule 1 of the CEPA 1999 (Environment Canada, 2004b). In addition, Schedule 1 lists fuels that contain 'toxic' substances considered 'dangerous goods' under the Transportation of Dangerous Goods Laws and Regulations that are not considered additives or are present in unusual quantities.

In addition to the substances on Schedule 1, the Ministers of the Environment and Health are required to establish a Priority Substances List (PSL) of substances that are to be evaluated to see if they fall under the definition of 'toxic' above (Environment Canada, 2004b). Waste crankcase oil was added to the PSL1 list, but it was found that there was insufficient data to conclude whether it was 'toxic'.

2.1.1 Environmental Emergency (E2) Regulations

The Environmental Emergency Regulations (August 2003) or E2 regulations were issued under Part 8 of the CEPA 1999 (Environment Canada, 2006a).

The E2 regulations:

> "…aim at enhancing the protection of the environment and human health in environmental emergency situations by promoting prevention and ensuring preparedness, response and recovery."

In addition, the E2 regulations require those:

> "…who own or manage specified toxic and hazardous substances at or above the specified thresholds to provide required information on the substance(s), their quantities and to prepare and implement environmental emergency plans."

These substances and their concentrations and quantities are listed in Schedule 1 of the E2 regulations. The list of substances includes gasoline and many hydrocarbons (alkanes, etc.), PAHs, and BETX compounds that are found in petroleum products.

The E2 regulations also require notification to Environment Canada and the preparation of Environmental Emergency Plans if hazardous substances in quantities covered by the regulations are held at 'places' in Canada as defined in the E2 regulations (Environment Canada, 2005). 'Places' as defined in the E2 regulations also include hazardous substances held at temporary locations for greater than 72 hours. The required form and contents of Environmental Emergency Plans are specified in the E2 regulations and also in the 'Implementation Guidelines for Part 8 of the Canadian Environmental Protection Act, 1999 – Environmental Emergency Plans' (Environment Canada, 2004c).

2.1.2 Hazardous waste regulations

The Interprovincial Movement of Hazardous Waste Regulations (SOR/2002-301; August 8, 2002) were issued under Section 191 of Part 7 Division 8 in the CEPA 1999 (Environment Canada, 2006b). The goal of the regulations is:

> "…to ensure that the Canadian manifest tracking and hazards classification conditions for waste, formerly set out in the Transportation of Dangerous Goods Regulations, are maintained for the interprovincial movements of hazardous wastes."

The Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations (SOR/2005-149; May 17, 2005) were also issued under Section 191 of Part 7 Division 8 in the CEPA 1999 (Environment Canada, 2006c). The purpose of the regulations is:

> "…to protect Canada's environment and the health of Canadians from the risks posed by the transboundary movement of hazardous wastes and hazardous recyclable materials through exports from and imports into Canada and to implement Canada's international obligations."

2.2 Transportation of Dangerous Goods Laws and Regulations

The Transportation of Dangerous Goods Act 1992 (Statutes of Canada Chapter 34; TDGA) and Transportation of Dangerous Goods Regulations (SOR/2001-286; TDGR) apply to substances that fall under the definition of 'dangerous goods' in the regulations (Transport Canada, 2006). Substances relevant to oily waste fall under the following classes:

- Class 3: "Flammable and combustible liquids",
- Class 4: "Flammable solids; substances liable to spontaneous combustion; substances that on contact with water emit flammable gases",
- Class 6: "Poisonous (toxic) and infectious substances", and
- Class 9: "Miscellaneous products, substances or organisms considered by the Governor in Council to be dangerous to life, health, property or the environment when handled, offered for transport or transported and prescribed to be included in this class".

Schedule 1 of the Transportation of Dangerous Goods Regulations lists specific substances and quantities contained in the above classes.

2.3 Disposal at Sea Regulations

Disposal at Sea Regulations (SOR/2001-275; August 2001) were issued under Part 7, Division 3 of the CEPA (Environment Canada, 2002). These regulations apply only to substances listed in Schedule 5 of CEPA, which consist of:

- Dredged material
- Fish waste
- Ships, aircraft, platforms or other structures from which floating debris and pollutants have been removed
- Inert, inorganic geological matter
- Uncontaminated organic matter of natural origin
- Bulky substances primarily composed of iron, steel, concrete or other similar matter

Regulations Respecting Applications for Permits for Disposal at Sea (August, 2001) and the Ocean Dumping Permit Fee Regulations (March 1999) also apply to disposal at sea (Environment Canada, 2002).

3.0 Government of the Northwest Territories

3.1 Environmental Protection Act laws, regulations and guidelines

The Department of Environment and Natural Resources (ENR) of the Government of the Northwest Territories (NWT) administers the Environmental Protection Act (1988; Revised Statutes of the NWT; NWT EPA) for the NWT (NWT ENR Environmental Protection Division, 2006a). A number of regulations and guidelines were issued under the NWT EPA.

3.1.1 Used Oil and Waste Fuel Management

The Used Oil and Waste Fuel Management Regulations (November 2003) for the NWT were issued under Section 34 of the NWT EPA (NWT ENR Environmental Protection Division, 2003). Among other provisions, these regulations apply to the generation, management, handling, storage, disposal and incineration of used oil and waste fuel. Used oil includes:

- crankcase oil
- hydraulic fluid
- automatic transmission fluid, and
- gear oil

that is unsuitable for its intended purpose.

Waste fuel includes:

- gasoline
- diesel fuel
- furnace fuel
- aviation fuel
- kerosene, and
- naptha

that is unsuitable for its intended purpose.

The document 'Plain language guide to the used oil and waste fuel management regulations' (NWT ENR Environmental Protection Division, 2006b) provides a general guide to these regulations.

3.1.2 Management of Hazardous Waste

The 'Guideline for the General Management of Hazardous Waste in the NWT (February 1998)' was also issued under Section 2.2 of the NWT EPA (NWT ENR Environmental Protection Division, 1998). This guideline was developed by the

Environmental Protection Service (EPS) of the NWT Department of Resources, Wildlife and Economic Development (now the Department of Environment and Natural Resources (ENR)). The intent of the guideline is to:

- "…provide information for the proper management of hazardous waste in the Northwest Territories
- increase awareness of hazardous waste in the Northwest Territories, and
- establish a 'cradle to grave' monitoring system for hazardous waste from generation to final disposal."

The guideline defines 'hazardous waste' as a contaminant which is a 'dangerous good' (under the TDGR, Canada), "… that is no longer used for its original purpose and is intended for recycling, treatment, disposal or storage."

3.1.3 Spill Contingency Regulations

The 'Spill Contingency Planning and Reporting Regulations (R-068-93; July 22, 1993)' (NWT Department of Justice, 2006a) were issued under the NWT Environmental Protection Act (NWT ENR Environmental Protection Division, 1998). The regulations apply to spills of specified amounts of listed substances including flammable liquids, flammable solids, and miscellaneous products or substances as defined under the federal Canadian TDGR. Persons who store contaminants in greater amounts than specified in the regulations are required to file a spill contingency plan. The document: 'A guide to the spill contingency planning and reporting regulations' (June 2002; NWT ENR Environmental Protection Division, 2006c) provides a general guide to these regulations.

3.2 Transportation of Dangerous Goods Act laws and regulations

The 'Transportation of Dangerous Goods Act (1990)'and the 'Transportation of Dangerous Goods Regulations (August 15, 2002)' govern the transport of dangerous goods in the Northwest Territories (NWT Department of Justice, 2003b and 2003c). The 'Transportation of Dangerous Goods Regulations (August 15, 2002)' were issued under Sections 63 and 64 of the 'Transportation of Dangerous Goods Act (1990)'. The NWT regulations basically adopt the entire Canadian federal 'Transportation of Dangerous Goods Regulations (SOR/2001-286; Transport Canada, 2006)', with some definitions and other provisions changed as per the text of the NWT regulations. See Section 2.2 for a discussion of the Canadian federal TDGR.

4.0 Government of Yukon

4.1 Environment Act laws and regulations

Under the ‘Environment Act (2002; Revised Statutes of the Yukon Chapter 76)’, a number of regulations were issued relevant to oily waste, including the ‘Special Waste Regulations (1995)’ and the ‘Spills Regulation’ (Yukon Environment Department, 2006a; Government of Yukon, 2004a).

4.1.1 Special Waste Regulations

The ‘Special Waste Regulations (1995)’ were issued under Part 7 of the ‘Environment Act’ (Yukon Environment Department, 2006b). As defined by the regulations, ‘special waste’ includes:

- Waste oil including used motor oil
- Used anti-freeze
- Dead batteries
- Leftover cleaners, solvents, paints, pesticides, industrial chemicals and petroleum products; and
- Biomedical waste

The ‘Special Waste Regulations’ require a special waste permit if:

- More than 20 litres of used oil is generated per month
- Used oil is burned
- Used oil is disposed of or stored
- Used oil is mixed with other substances, including water
- Used oil is collected from other generators

See also the document: ‘Guide to Yukon Special Waste Regulations’ (Yukon Environment Department, 2006c) for a basic guide to the regulations.

4.1.2 Special Waste Transportation Permit

In January 2006, the Environment Department announced that a new ‘Special Waste Transportation Permit’ would be required under the ‘Special Water Regulations’ (Government of Yukon, 2006). This permit is for

> “…all transportation companies or individuals operating in Yukon which transport dangerous goods no longer used for their original purpose. These goods include waste oil, used batteries, used antifreeze, leftover solvents, cleaners, paints and pesticides.”

This permit applies to the following minimum threshold amounts of special waste (Yukon Environment Department, 2006d):

- 5 kg or more of a solid special waste, or a combination of more than one solid special wastes;
- 5 litres or more of a liquid special waste other than waste oil;
- 5 kg or 5 litres or more of a mixture of a solid special waste and a liquid special waste other than waste oil; or
- 20 litres or more of waste oil.

Other requirements for the permit include proof of insurance and vehicle ownership, a list or special wastes carried and an approved spill response plan.

4.1.3 Spills Regulations

The ‘Spills Regulations (1997)’ were issued under Part 11 of the ‘Environment Act’ (Yukon Environment Department, 2006e). The ‘Spills Regulations’ apply to spills of specified amounts of listed substances including flammable liquids, flammable solids, and miscellaneous products or substances as defined under the federal Canadian TDGR, and special waste as defined under the ‘Yukon Special Wastes Regulations’.

4.2 Dangerous Goods Transportation Act laws and regulations

The ‘Dangerous Goods Transportation Regulations (O.I.C. 1986/118)’ for Yukon were issued under Section 28 of the ‘Dangerous Goods Transportation Act’ (2002; Revised Statutes of the Yukon Chapter 50; Government of Yukon, 2004b; Yukon Highways and Public Works Department, 2002). These regulations essentially adopt the entire Canadian federal ‘Transportation of Dangerous Goods Regulations’ (SOR/2001-286; Transport Canada, 2006), with the exception of Parts 10, 11, and 13 and other portions as per the regulations text. See Section 2.2 for a discussion of the Canadian federal TDGR.

5.0 Government of Nunavut

Nunavut Territory came into existence on April 1, 1999 out of the prior larger extent of the Northwest Territories (NWT; Government of Nunavut, 2006). As part of the ‘Nunavut Act’ creating the territory, the laws and regulations of the NWT as they stood at that time were adopted as the laws and regulations of Nunavut. Amendments and changes to these laws and regulations have been made by the Nunavut Legislative Assembly since April 1, 1999 (Department of Justice Canada, 2006a).

5.1 Environmental Protection Act laws and regulations

Several regulations relevant to oily waste in Nunavut were issued under the 'Environmental Protection Act (Nunavut)' (1988; Revised Statutes of the NWT; Ch. E-7) (Nunavut Department of Justice, 2005a). These regulations include the 'Guideline for the General Management of Hazardous Waste in Nunavut (January 2002)' (Nunavut Department of Environment, 2004) and the 'Spill contingency planning and reporting regulations (R-068-93; July 22, 1993)' (Nunavut Department of Justice, 2005b). There are also independent review boards or Institutions of Public Government (IPGs) in Nunavut created under the Nunavut Land Claims Agreement Act (Department of Justice Canada, 2006b) as co-management entities that are responsible for land use planning, water use and assessment of development project impacts (Nunavut Planner, 2006).

5.1.1 Management of Hazardous Waste

The 'Guideline for the General Management of Hazardous Waste in Nunavut (January 2002)' (Nunavut Department of Environment, 2004) is essentially the same as the 'Guideline for the General Management of Hazardous Waste in the NWT (February 1998)' (NWT ENR Environmental Protection Division, 1998). The intent of the guideline is to:

- "…provide information for the proper management of hazardous waste in Nunavut
- increase awareness of hazardous waste in Nunavut, and
- establish a 'cradle to grave' monitoring system for hazardous waste from generation to final disposal."

The guideline defines 'hazardous waste' as a contaminant which is a 'dangerous good' (under the TDGR, Canada), "… that is no longer used for its original purpose and is intended for recycling, treatment, disposal or storage."

5.1.2 Spill Contingency Regulations

The 'Spill Contingency Planning and Reporting Regulations (R-068-93; July 22, 1993)' (Nunavut Department of Justice, 2005b) were issued under the 'Environmental Protection Act (Nunavut)' (1988; Revised Statutes of the NWT; Ch. E-7) (Nunavut Department of Justice, 2005a). The regulations apply to spills of specified amounts of listed substances including flammable liquids, flammable solids, and miscellaneous products or substances as defined under the federal Canadian TDGR. Persons who store contaminants in greater amounts than specified in the regulations are required to file a spill contingency plan.

5.2 Transportation of Dangerous Goods Act laws and regulations

The ‘Transportation of Dangerous Goods Act, 1990 (Revised Statutes of the NWT; Ch. 81 (Suppl.)’ and ‘Transportation of Dangerous Goods Regulations, 1991 (R-095-91; Revised Regulations of the NWT)’ for Nunavut are adoptions of the equivalent act and regulations issued for the NWT (Nunavut Department of Justice, 2005c and 2005d). This law and regulation are discussed in Section 3.2 above. The regulations basically adopt the entire Canadian federal ‘Transportation of Dangerous Goods Regulations’ (SOR/2001-286; Transport Canada, 2006), with some definitions and other provisions changed as per the text of the Nunavut regulations. See Section 2.2 for a discussion of the Canadian federal TDGR.

6.0 References

Department of Justice Canada. 2003. Yukon environmental and socioeconomic assessment act. Department of Justice Canada. Ottawa, Ontario. May 13, 2003. Obtained from Internet site URL: http://laws.justice.gc.ca/en/Y-2.2/index.html.

Department of Justice Canada. 2005. Assessable activities, exceptions and executive committee projects regulations. Department of Justice Canada. Ottawa, Ontario. November 28, 2005. Obtained from Internet site URL: http://laws.justice.gc.ca/en/Y-2.2/SOR-2005-379/index.html.

Department of Justice Canada. 2006a. Nunavut Act. Department of Justice Canada. Accessed June 2006. Obtained from Internet site URL: http://laws.justice.gc.ca/en/N-28.6/index.html.

Department of Justice Canada. 2006a. Nunavut Land Claims Agreement Act. Department of Justice Canada. Accessed June 2006. Obtained from Internet site URL: http://laws.justice.gc.ca/en/N-28.7/index.html.

Environment Canada. 2000. Canadian environmental protection act (CEPA 1999). Environment Canada. March 31, 2000. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/the_act.

Environment Canada. 2002. Disposal at sea program; Regulations. Environment Canada. January 27, 2002. Obtained from Internet site URL: http://ec.gc.ca/seadisposal/regs/index_e.htm.

Environment Canada. 2004a. A guide to understanding the Canadian environmental protection act, 1999. Environment Canada. October 27, 2004. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/the_act/guide04/toc.cfm.

Environment Canada. 2004b. CEPA environmental registry. Substances list. Environment Canada. 5-10-2004. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/subs_list

Environment Canada. 2004c. Implementation guidelines for Part 8 of the Canadian Environmental Protection Act, 1999 – Environmental emergency plans. Environment Canada. March 2, 2004. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/guidelines/impl_guid/toc.cfm.

Environment Canada. 2005. Regulations / guidelines. Environmental Emergencies. Environment Canada. August 9, 2005. Obtained from Internet site URL: http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=E3A506F8-1.

Environment Canada. 2006a. Environmental emergency regulations (SOR/2003-307). Environment Canada. February 15, 2006. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/regulations/detailReg.cfm?intReg=70.

Environment Canada. 2006b. Interprovincial movement of hazardous waste regulations (SOR/2002-301). Environment Canada. February 15, 2006. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/regulations/detailReg.cfm?intReg=68.

Environment Canada. 2006c. Export and import of hazardous waste and hazardous recyclable material regulations (SOR/2005-149). Environment Canada. February 15, 2006. Obtained from Internet site URL: http://www.ec.gc.ca/CEPARegistry/regulations/detailReg.cfm?intReg=84

Environmental Impact Screening Committee (EISC). 2004. Operating guidelines and procedures. EISC. Inuvik, NWT. Obtained from Internet site URL: http://www.jointsecretariat.ca/EISC/aboutus.htm.

Government of Nunavut. 2006. The road to Nunavut: a chronological history. Accessed at Internet site URL: http://www.gov.nu.ca/Nunavut/English/about/road.shtml.

Government of Yukon. 2004a. Environment Act (2002; Revised Statutes of the Yukon Chapter 76). Government of Yukon. Obtained from Internet site URL: http://www.gov.yk.ca/legislation.

Government of Yukon. 2004b. Dangerous goods transportation act (2002; Revised Statutes of the Yukon Chapter 50). Government of Yukon. Obtained from Internet site URL: http://www.gov.yk.ca/legislation.

Government of Yukon. 2006. New transportation permit needed by special waste carriers. Press release dated January 31, 2006. Government of Yukon. Accessed at Internet site URL: http://www.gov.yk.ca/.

Inuvialuit Regional Corporation (IRC). 1987. The western Arctic claim; Inuvialuit final agreement (As amended). IRC. Inuvik, NWT. January 15, 1987. Obtained from Internet site URL: http://jointsecretariat.ca/JS/history.htm.

Joint Secretariat. 2006. Documents. Accessed June 2006 at Internet site URL: http://www.jointsecretariat.ca/JS/doc.htm.

Mackenzie Valley Environmental Impact Review Board (MV EIRB). 2005. Mackenzie Valley Resource Management Act (1998). MV EIRB. Obtained from Internet site URL: http://www.mveirb.nt.ca/reference_lib/legislation.php

Northwest Territories (NWT) Department of Environment and Natural Resources (ENR) Environmental Protection Division. 1998. Guideline for the general management of hazardous waste in the NWT (February 1998). NWT ENR Environmental Protection Division. Obtained from Internet site URL: http://www.enr.gov.nt.ca/eps/leg.htm.

Northwest Territories (NWT) Department of Environment and Natural Resources (ENR) Environmental Protection Division. 2003. Used oil and waste fuel management regulations (November 2003). NWT ENR Environmental Protection Division. Obtained from Internet site URL: http://www.enr.gov.nt.ca/eps/leg.htm.

Northwest Territories (NWT) Department of Environment and Natural Resources (ENR) Environmental Protection Division. 2006a. Acts, regulations and guidelines. NWT ENR Environmental Protection Division. Accessed April 5, 2006 from Internet site URL: http://www.enr.gov.nt.ca/eps/leg.htm.

Northwest Territories (NWT) Department of Environment and Natural Resources (ENR) Environmental Protection Division. 2006b. Plain language guide to the used oil and waste fuel management regulations. NWT ENR Environmental Protection Division. Accessed June 13, 2006 from Internet site URL: http://www.enr.gov.nt.ca/eps/leg.htm.

Northwest Territories (NWT) Department of Environment and Natural Resources (ENR) Environmental Protection Division. 2006c. A guide to the spill contingency planning and reporting regulations. NWT ENR Environmental Protection Division. Accessed June 13, 2006 from Internet site URL: http://www.enr.gov.nt.ca/library/publications.htm.

Northwest Territories (NWT) Department of Justice. 2003a. Spill contingency planning and reporting regulations (R-068-93; July 22, 1993). Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nt.ca/Legislation/SearchLeg&Reg.htm

Northwest Territories (NWT) Department of Justice. 2003b. Transportation of dangerous goods act (1990). NWT Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nt.ca/Legislation/SearchLeg&Reg.htm

Northwest Territories (NWT) Department of Justice. 2003c. Transportation of dangerous goods regulations (August 15, 2002). NWT Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nt.ca/Legislation/SearchLeg&Reg.htm

Nunavut Department of Environment. 2004. Guideline for the general management of hazardous waste in Nunavut (January 2002). Nunavut Department of Environment. Obtained from Internet site URL: http://www.gov.nu.ca/Nunavut/environment/home/Environmental.htm.

Nunavut Department of Justice. 2005a. Environmental protection act (Nunavut)(1988; Revised Statutes of the NWT; Chapter E-7). Legislation Division. Nunavut Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nu.ca/english/leg/statreg.html.

Nunavut Department of Justice. 2005b. Spill contingency planning and reporting regulations (R-068-93; July 22, 1993). Legislation Division. Nunavut Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nu.ca/english/leg/statreg.html.

Nunavut Department of Justice. 2005c. Transportation of dangerous goods act (1990; Revised Statutes of the NWT; Ch. 81 (Suppl.)).). Legislation Division. Nunavut Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nu.ca/english/leg/statreg.html.

Nunavut Department of Justice. 2005d. Transportation of dangerous goods regulations (1991; R-095-91; Revised Regulations of the NWT). Legislation Division. Nunavut Department of Justice. Obtained from Internet site URL: http://www.justice.gov.nu.ca/english/leg/statreg.html.

Nunavut Planner. 2006. A description of the PLANNER project. Nunavut Planner. Accessed June 2006 at Internet site URL: http://planner.nunavut.ca/description.html

Regulatory roadmaps project. 2001. 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. Sloan and Associates. Calgary, Alberta. Obtained from Internet site URL: http://www.oilandgasguides.com.

Transport Canada. 2006. Transportation of dangerous goods regulations (SOR/2001-286). Transport Canada. March 8, 2006. Obtained from Internet site URL: http://www.tc.gc.ca/acts-regulations/GENERAL/T/tdg/menu.htm.

Yukon Environment Department. 2006a. Environment act and regulations. Yukon Environment Department. January 30, 2006. Accessed from Internet site URL: http://www.environmentyukon.gov.yk.ca/epa/enactreg.html.

Yukon Environment Department. 2006b. Special waste regulations (1995). Yukon Environment Department. January 30, 2006. Obtained from Internet site URL: http://www.environmentyukon.gov.yk.ca/epa/enactreg.html.

Yukon Environment Department. 2006c. Guide to Yukon special waste regulations. January 30, 2006. Obtained from Internet site URL: http://www.environmentyukon.gov.yk.ca/epa/enactreg.html.

Yukon Environment Department. 2006d. Special waste transportation permits. Yukon Environment Department. January 30, 2006. Obtained from Internet site URL: http://www.environmentyukon.gov.yk.ca/epa/enactreg.html.

Yukon Environment Department. 2006e. Spills regulations. Yukon Environment Department. January 30, 2006. Accessed from Internet site URL: http://www.environmentyukon.gov.yk.ca/epa/enactreg.html.

Yukon Environmental and Socio-economic Assessment Board (YESAB). 2006. YESAB web site accessed at URL: http://www.yesab.ca/.

Yukon Highways and Public Works Department. 2002. Dangerous goods transportation regulations (O.I.C. 1986/118). Yukon Highways and Public Works Department. November 26, 2002. Obtained from Internet site URL: http://www.gov.yk.ca/depts/hpw/trans/regulations/.