THE ARCTIC SCAT MANUAL

A Field Guide to the Documentation of Oiled Shorelines in Arctic Regions

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PREFACE TO THE ARCTIC EDITION

The Shoreline Cleanup Assessment Technique (SCAT) process is now a familiar part of an oil spill response in many countries. SCAT teams play a key role in the assessment of the scale and scope of a shoreline response programme. The SCAT approach and documentation protocols were initially developed in 1989 during the *Nestucca* and *Exxon Valdez* spill response operations. Subsequently, Environment Canada developed generic second-generation SCAT protocols to standardize the documentation and description of oiled shorelines (Owens and Sergy, 1994). Since its inception, the SCAT approach has been used on many spills, in a variety of ways, and has been modified by SCAT teams to meet a range of specific spill conditions. A Second Edition SCAT Manual (Owens and Sergy, 2000) was produced to reflect updates and modifications derived from user experience and interagency adaptations. Neither this nor any other documents, however, fully address the seasonality issues in a SCAT programme, or the characteristics or implications of northern climates dominated by snow and ice conditions. To address these issues, this Arctic Edition of the SCAT Manual was initiated by Environment Canada and the United States Coast Guard; an action supported by NOAA in Alaska, and by private spill response and advisory services. The manual was produced and published under the auspices of the Emergency Prevention, Preparedness, and Response (EPPR) Working Group of the Arctic Council.

This Arctic Edition is completely compatible and consistent with the Second Edition SCAT Manual. The Arctic Edition, however, provides new material on the ***unique shoreline types found in arctic regions, on the character of the various forms of snow and shore-zone or nearshore ice in the Arctic or in other cold climate regions during winter months, on the behaviour of oil, and on the activities of SCAT teams in these environments.*** In addition, a First Responder's guide and short versions of key oiling summary forms are included that can be used by local inhabitants during the initial phase of an assessment.

INTRODUCTION

What is SCAT?

As part of oil spill response, Shoreline Cleanup Assessment Technique (SCAT) teams systematically survey the area affected by the spill to provide rapid accurate geo-referenced documentation of shoreline oiling conditions. This information is used to develop real-time decisions and to expedite shoreline treatment planning and response operations.

A SCAT programme includes field assessment surveys, data management, and data application components as part of the spill management organization. The field survey teams use specific and standard terminology to describe and define shoreline oiling conditions. The SCAT process itself, however, is flexible, and the assessment activities are designed to match the unique spill conditions (see the case studies described in Section 2.3).

The systematic approach provides for consistent data collection. This allows a comparison of data and observations between different sites, between different observers, and between the same sites over time. These data also provide the basis for cleanup evaluation. In most surveys, the SCAT teams complete forms and sketches for each segment in the affected area. A standardized Shoreline Oiling Summary form is used for documentation; this template has been modified in this manual for arctic environments and winter conditions.

SCAT surveys provide a geographic or spatial description and documentation of the shoreline or riverbank oiling conditions. A monitoring programme can use the same procedures, terms, and definitions as the SCAT survey for situations where the same section of coast or river is surveyed repeatedly. This can occur when oiling conditions persist for a lengthy period of time, or when a systematic time-series of oiling conditions is required at one or more locations.

Frequently, SCAT teams are asked to provide recommendations regarding appropriate cleanup methods and to define constraints or limitations on the application of cleanup techniques, so that the treatment operations do not result in additional damage to the shore zone. In developing these recommendations, the teams refer to the relevant shoreline treatment manuals and field guides (e.g., ACS, 1999; Environment Canada, 1996a; EPPR, 1998; NOAA, 2000a).

SCAT Manuals

The first complete manual for SCAT surveys was developed by Environment Canada (1992), followed by production of a more simplified Field Guide (Owens and Sergy, 1994). Other agencies adopted the approach and produced similar field forms and manuals (e.g., European Commission – Jacques *et al.*, 1996: NOAA, 2000b). Revisions reflected in the second edition of the SCAT manual (Owens and Sergy, 2000) were based on actual applications of the SCAT process during spill operations. The revision process was interactive with the U.S. National Oceanographic and Atmospheric Administration (NOAA) so that both Environment Canada and NOAA field forms were directly compatible in format and content. This Arctic SCAT Manual is consistent with the 2000 edition SCAT Manual; however, it is technically expanded to address arctic shoreline types, the character of the various forms of snow and of shore-zone or nearshore ice, and the activities of SCAT teams.

The Arctic SCAT Manual is applicable to both the Arctic and during snow or ice conditions to other cold climate regions.

SCAT survey procedures are flexible. This manual provides guidelines for the design of a survey programme to fit a wide range of spill situations. Parameters that govern the scope and scale of a shoreline assessment survey are as follows: the coastal character and configuration; the type and amount of oil spilled; the size of the affected area; and the needs of the response organization. Guidelines and recommendations presented in this manual reflect experience gained from using the SCAT approach on numerous spills worldwide.

Format of the Arctic SCAT Manual

The first part of the Arctic SCAT manual describes the purpose and activities associated with SCAT surveys, and include a standard Arctic Shoreline Oiling Summary (ASOS) form with appropriate terms and definitions. Part 2 discusses spill management issues. Additional forms—suitable for winter conditions or for arctic environments—are presented in Section 2.2. These forms can be used for tar ball conditions, wetlands, tidal flats, riverbanks, small rivers, creeks and streams, and freshwater lakes. Part 3 contains support materials and includes job aids for identifying and describing oiling conditions, arctic shoreline types, and shoreline snow and ice conditions. Part 4 presents a guide for First Responders that includes short versions of the ASOS form and a winter riverbank oiling summary form.

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PART 1 PROCEDURES AND FORMS

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1.1 PURPOSE AND PRINCIPLES OF SCAT

1.1.1 Objectives and Purpose of SCAT

Over the last decade, the term SCAT has taken on a number of meanings and has grown to embody a range of activities, however the basic purpose still remains one of providing **operational support**. The cornerstone activity is the shoreline assessment survey and its fundamental objective is to

- collect and document real-time data on oil and shoreline conditions in a rapid, accurate and systematic fashion

SCAT surveys conducted by trained SCAT teams provide information to build a spatial or geographic picture of the regional and local oiling conditions — an understanding of the nature and extent of shoreline oiling that is key to the development of an effective response. This information is provided in a format that can be interpreted easily and applied by planners and decision makers.

In addition to its primary objective, SCAT surveys can be used for

- development of treatment or cleanup recommendations
- development of treatment or cleanup standards or criteria
- post-treatment inspection and evaluation
- provision of long-term monitoring
- management of special issues

The information collected during shoreline assessment surveys is used in various ways in the decision process. At a minimum, it is used to

- identify oiled and non-oiled areas
- describe the location, character, and amount of stranded oil
- assess environmental and socio-economic constraints
- evaluate operational and logistical factors

The information may also be used to

- document shoreline types and coastal characteristics
- establish treatment priorities
- establish treatment standards or criteria
- propose treatment or cleanup methods
- determine completion of cleanup activities

Shoreline or riverbank oiling conditions are described using a set of ***standard terms and definitions***, so that the potential for misunderstanding or misinterpretation is minimized. In this manner, the oiling condition terms “heavy” or “light” have a specific definition, rather than reflecting a general descriptive opinion. The use of this defined terminology enables a direct comparison to be made between segments, and it can be used to describe how conditions change through time within the same segment.

1.1.2 Principles of Shoreline Assessment Surveys

Shoreline assessment surveys are based on several fundamental principles. These include

- a systematic assessment of all shorelines in the affected area
- a division of the coastline or riverbank into homogeneous geographic units or “segments”
- the use of a standard set of terms and definitions for documentation
- a survey team that is objective and trained
- the timely provision of data and information for decision making and planning

The survey team should be composed of trained individuals with appropriate skills to complete the survey objectives (see Section 1.2.5). The team may include inter-agency personnel who represent the various interests of land ownership, land use, land management, or governmental responsibility.

1.2 PLANNING A SCAT SURVEY

Some of the ingredients for a successful SCAT programme include

- suitable ***training*** and calibration for observers and the SCAT Coordinator
- ***appropriate segmentation*** of the shoreline or riverbank
- ***flexibility*** to adapt the basic concept for individual spill conditions and oiling characteristics
- procedures that are as ***simple*** as possible, yet provide sufficient information to meet the requirements of the decision makers, planners, and operations crews
- a process that is efficient to ensure that information is processed and communicated in a timely manner
- establishment of a ***data management*** system early in the programme
- ***integration*** of key players who represent the response team

1.2.1 Scope of SCAT Surveys and Programmes

SCAT surveys are flexible and adaptable to the spill conditions. They can be conducted

- on spills of different oil types and with different types of shoreline oiling conditions
- on spills of different sizes, from small to large
- in different environments, including marine, freshwater, and terrestrial
- by different methods, both aerial and ground level
- in various levels of detail, from simple single-discipline surveys to complex programmes with geomorphological, ecological, and cultural resource components

The term "SHORE or SHORELINE" refers to that zone where land and water meet. It is applied to freshwater lakes and rivers as well as marine environments.

Data and observations from the basic shoreline assessment surveys describe

- the shoreline types and the character of the coastline or river channel (see Section 3.1.4)
- real-time location, character, and amount of stranded oil
- real-time environmental, cultural, archaeological, human use, or economic issues or constraints
- factors that might assist or constrain operations activities in an oiled segment or at staging locations

This real-time assessment is different from the information that may be available from pre-existing maps or databases as it is current at the time of the spill response operation and probably more accurate in terms of the level of detail on a segment-by-segment basis.

As noted in Section 1.1, the survey teams also may be directed to provide recommendations for treatment options, cleanup standards, and completion or reactivation of cleanup activities.

The design of a SCAT programme considers

- the size and character of the affected area (see Section 1.2.2)
- the individuals or the representatives who will participate (see Section 1.2.5)
- if the survey team is responsible for the development of treatment or cleanup recommendations (see Section 2.1.3)
- if the survey team is responsible for the development of treatment standards or cleanup criteria (see Section 2.1.4)

1.2.2 Scale and Method of Surveys

Shoreline surveys can be conducted by different methods and at different scales depending on the size of the affected area, the character of the coastal area or river channel, and the level of detail that is required (Table 1.1).

Table 1.1 Survey Methods

Survey Method	Key Objectives
Aerial Reconnaissance	Define overall scale of the problem to develop regional objectives. Mapping or documentation not required.
Aerial Video Survey	Systematically document or map to (i) create segments, (ii) develop regional strategies and plans, and (iii) define locations and lengths of oiled shorelines, including surface oil band width and estimated distribution.
Systematic Ground Survey	Systematically document surface and subsurface shoreline oiling conditions in all segments within the affected area.
Spot Ground Survey	Systematically document surface and subsurface shoreline oiling conditions for selected segments within the affected area.

AERIAL RECONNAISSANCE

The purpose of an aerial reconnaissance is to obtain an observational overview of surface oiling conditions (not to map or document) over relatively large areas in a relatively short time period.

Aerial reconnaissance can provide a general picture of the extent and character of the oiled shorelines (see also Section 1.3.4). This information is critical to develop regional objectives, to define the overall scale of the potential response operation, and to direct the initial deployment of response resources.

AERIAL VIDEO SURVEY

The purpose of an aerial video survey is to prepare maps that show the location, distribution, and character of stranded oil. An aerial video survey systematically documents the shoreline types and surface oiling conditions typically using video mapping techniques (see also Section 1.3.4). It can cover an extensive area to provide a level of detail of sufficient accuracy for mapping purposes. This information is the foundation for the development of regional strategies and plans, for segmentation of the shoreline, and for the definition of lengths of oiled shorelines in terms of shoreline types and the oil character.

A systematic low-level aerial video survey may be the only practical method available to survey some areas with inaccessible shorelines or on coasts where access is limited or difficult.

SYSTEMATIC GROUND SURVEY

The systematic ground survey is used to methodically document shoreline oiling conditions in all segments within the affected area and to complete shoreline oiling summary forms and generate sketch maps for each segment. Photographs or videos are taken to record the oiling conditions.

Systematic ground surveys typically are the primary source of detailed data and information. This systematic documentation of the location, character, and amounts of surface and subsurface oil in all of the segments within the affected area is the foundation for planning and implementing the shoreline treatment or cleanup operations (see also Section 1.3.5).

If more than one survey team is in the field, or if the assessment team(s) does not have sufficient time to complete a field summary or report, a SCAT Coordinator and/or SCAT data manager is assigned to ensure that appropriate information is produced and distributed in a timely manner to the Planning and Operations sections.

SPOT GROUND SURVEY

Spot ground surveys are used to systematically document oiling conditions for selected segments within the affected area, and to complete oiling summary forms and generate sketch maps for those segments. Photographs or videos are taken to record the oiling conditions.

A spot ground survey can focus on specific locations if the aerial survey identifies discontinuous oiling conditions, or if treatment or cleanup is planned only for selected segments within the affected area. In some cases (see, for example, the *Buffalo 292* case study in Section 2.3), a simplified survey approach may involve a spot ground assessment with a verbal report of the oiling conditions. When observations are reported in this manner, the use of standard terms and definitions becomes an essential part of the communications process.

1.2.3 Winter or Arctic Surveys

The same four survey methods described in Section 1.2.2 apply equally to all seasons. The primary differences during winter months or when snow and ice are present in an arctic or sub-arctic environment are the possibilities that

- surface oil can be covered by blowing snow
- oil can penetrate fresh snow
- oil can enter ice cracks and leads
- oil beneath or within ice cannot be detected except by drilling holes through the ice

> ➢ These situations are discussed in Section 2.2.5.
> ➢ Segmentation for winter conditions is discussed in Section 1.3.2.
> ➢ The behaviour of oil in snow and ice is discussed in Sections 3.3.1 and 3.3.2 respectively.

Other points that should be considered for winter or arctic surveys include the following:

- Boat-based ground surveys may be more efficient than land-based surveys when ice is present at the shoreline or in the nearshore zone, as the oil may be seen more easily from the water.
- Daylight hours are typically short during winter months in mid- and northern latitudes. The window of opportunity for surveys during the low-tide may be limited in situations where tidal water-level changes are a factor.
- Similarly, days are long during the arctic or sub-arctic summer. It may be possible to survey during both low-tide windows in areas with semi-diurnal tides.

1.2.4 Number of SCAT Teams

A common question is how to define an appropriate level of effort for a SCAT ground survey field programme. On a small spill, or one that is very restricted in area, if the affected segments can be covered in one day by one team, then usually that is all that is required. As the size of the affected area increases, the requirement for more teams depends on the complexity of the affected area and the required turn-around time for the information. If Planning or Operations sections require data for an area to prepare the assignments for the next day, then the appropriate scale is *"**however many teams it takes to cover that area in time to provide the information.**"*

A small-scale operation, for example, would be used for a spill that affects less than 50 km of coast or for a length of coast that can be surveyed in one to two days with one or two teams. A spill in a larger area or one that would require a longer coastal survey probably would involve more field teams and office-based data management support. In addition, it is important to consider a situation that might involve rapidly changing (day-to-day) oiling conditions that would require multiple teams to resurvey the same segments on a regular basis. Areas where access or alongshore movement is difficult, or where buried or penetrated oil requires the digging of pits and trenches, can take considerably more time to survey than a straight, flat, wide, sand beach segment. De Bettencourt *et al.* (1999) suggest three general scales for a SCAT programme.

- A small spill where the size and complexity require ***one to three*** field teams who provide information in a simple format and communicate this by telephone or radio (see *Nestucca* and St. Petersburg Beach case studies in Section 2.3).
- An intermediate spill where as many as ***five teams*** may be required to cover the affected area, using standard forms; this scale would require a data management component (see Komi pipeline and *New Carissa* case studies in Section 2.3).
- A large or complex spill incident that would require ***many integrated and cross-trained SCAT teams*** (see *Exxon Valdez* case study in Section 2.3).

1.2.5 Participation in SCAT

The management of a spill response operation is a cooperative effort that involves national, regional, and local government agencies, as well as the organization responsible for the spill or a response contractor acting on behalf of that organization. Many government agencies have a legal responsibility for the coastal zone, and non-governmental organizations or local landowners or managers have a direct interest in the condition of the shorelines. The information that is collected by the SCAT teams is of interest to many or all of these agencies or groups and often they wish to be represented on the field surveys.

Practical considerations limit an assessment team to two or three, and occasionally four or five participants. The ideal composition of a team combines

- an individual with ***oil spill experience*** and ***SCAT training*** who can identify and document oil on the shore from the air or on the ground

- an individual familiar with the ***coastal ecology*** of the affected area who can document the impacts of the oil and who can recommend priorities and cleanup end points
- in areas where ***archaeological or cultural resources exist,*** a ***specialist*** who can advise on precautions and constraints to protect those resources
- a representative from the ***operations*** group who can identify feasibility issues, logistical constraints and solutions, and who can evaluate the types of resources and level of effort that might be required for cleanup or treatment of a segment

For the efficiency of a field survey, it is important to include a team member with knowledge of the local coastal region. For example, a government agency biologist familiar with the affected area would be a valuable member of a field team.

Representatives of aboriginal groups or other landowners and managers also can provide a local knowledge and understanding of issues and priorities that contribute to the knowledge base generated by the SCAT team.

If more than one team is in the field, or if the field team is in a remote location and cannot return daily to report their observations, then a SCAT Coordinator provides the link between the field teams and the spill management team.

When it is not possible for agency or other representatives to participate directly in the field surveys, a review team or committee can be established to develop recommendations for priorities based on the information generated by the field teams (e.g., Knorr *et al.*, 1991).

1.3 FIELD ACTIVITIES

1.3.1 Shoreline Segmentation

The essential first step of a SCAT survey is to divide the coastline or river into working units called segments, within which the shoreline character is relatively homogeneous in terms of physical features and sediment type (Table 1.2). Each segment is assigned a unique location identifier. Segment boundaries are established on the basis of prominent geological features (such as a headland), changes in shoreline or substrate type (Figure 1.1), a change in oiling conditions, or establishment of the boundary of an operations area.

Segment lengths are small enough to obtain adequate resolution and detail on the distribution of oil, but not so small that too much data are generated. Most segments in oiled areas would be in the range of 0.2 – 2.0 km in length.

A common mistake on coastlines is to place the boundary in the middle of a stream, or, in the case of rivers, to place it in the middle of a tributary or joining channel. As a “rule of thumb,” where there is a stream, river, or an inlet at the coast, or where two river channels join, it is preferable to make that stream, river, or inlet a separate segment so that it has its own physical and ecological identity. In some cases, it may be appropriate to have two separate segments, one for each side of the channel, so that data users then do not have to decide if the observed oiling conditions refer to one or the other or both sides of the entrance/outlet.

A second “rule of thumb” for segmentation is to divide the coast or river on the basis of practical aspects that can be used by Planning or Operations teams to deploy cleanup crews. On a long uniform coast or river, a segment may be centred on access points with a segment boundary approximately midway between two access points. Alternatively segments can be defined on the basis of distance. For example, segment boundaries could be every 500 m or some other length alongshore or downstream.

Table 1.2 Definition of Shoreline Segmentation

Segments are – distinct alongshore sections of shoreline that can be used as operation units, – relatively homogeneous physical features or sediment type, – identified by a unique location code, and – bounded by prominent geological or operational features, or by changes in shoreline type, substrate, or oiling conditions.
Subsegments are created if – alongshore oiling conditions vary significantly within a pre-designated segment, – alongshore oiling conditions change through time within a segment during a spill incident, or – there is an operational division boundary within a segment.

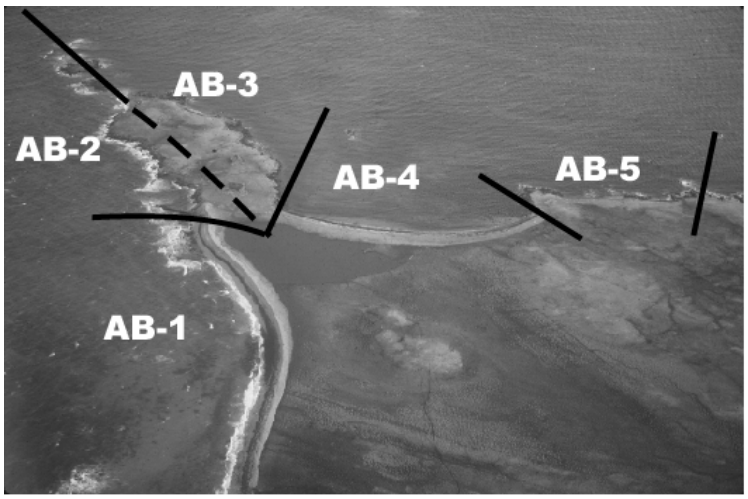

Figure 1.1 Example of Shoreline Segmentation.

Segments are identified by a numbering scheme. In the case of a survey covering an extensive area an alpha-numeric scheme may be appropriate, with an alphabetical prefix (the Segment Group code) keyed to a geographic place name (e.g., LB = Liverpool Bay) followed by a number based on an alongshore sequence (LB-24). Segmentation may already exist as part of a pre-spill planning exercise or sensitivity-mapping database (see Section 2.2.1). If this is the case, the segments should be reviewed for suitability alongshore because the segment boundaries may need to be adapted to existing spill conditions. Pre-designated segments could be subdivided if oiling conditions vary significantly alongshore within the segment. Subdivisions can be identified by a suffix, e.g., LB-24A, LB-24B. For river or stream surveys, segments are numbered in a downstream direction and labelled with “L” or “R” to indicate the appropriate bank when facing downstream (see Section 2.2.2).

Although the numerical designation suffix for a series of segments is generally based on the order in which segments are surveyed, it may be practical to pre-assign a set of numbers if more than one team is surveying a region. For example, one team may be assigned segment numbers LB-1 through LB-50, and another team assigned LB-51 through LB-100.

Variations in across-shore oiling conditions are documented on the Shoreline Oiling Summary forms as ***Zones***. For consistency, zones are numbered from the low water sections up to the higher water or backshore sections (see Photo 3.2 and Section 3.3.1).

1.3.2 Segmentation in Snow and Ice

An oiled shoreline or river that has snow or ice can be considered in exactly the same manner as described in Section 1.3.1. Segments can be defined if there is a change in the snow or ice conditions or if shoreline features are evident. If the shore-zone character is uniform over a long distance, due to the presence of intertidal ice, then a segment may be centred on access points with a boundary midway between two access points. Alternatively segments can be defined on the basis of distance. For example, segment boundaries could be every 500 m or some other length alongshore or downstream. The boundaries should be indicated with flags or similar boundary markers.

If oil is detected below the snow or under the ice, the area limits of the oil should be flagged on the surface or indicated with boundary markers. These areas should be identified in the same manner as linear segments, with a Segment Group prefix and a numbered sequence. The principal of segmentation is to divide an area into working units; the organization or sequence of segment numbers should be designed with a view to operational activity.

1.3.3 Field Equipment Checklist

The following is a checklist of equipment that can be used by the field teams.

<u>Survey Gear</u>

- ❑ Waterproof paper (8½" x 11") for field forms and sketch maps, field notebooks (waterproof)
- ❑ Office supplies - pencils, waterproof markers, rulers, paperclips, clipboard
- ❑ Job aids (see Section 3.5)
- ❑ Segment maps and base sketch maps (if available), topographic or nautical charts of area
- ❑ Compass, liquid-filled, 1-degree graduations, Brunton types are preferable if bearings are recorded
- ❑ Shovels - folding or clam, best with the pick on the backside
- ❑ Global Positioning System (GPS), hand-held, portable
- ❑ Tape measure or range finder (hand-held, ≥0 -500 m)
- ❑ 35-mm or digital camera that can date the photos
- ❑ Film, water-tight film bags, Kodachrome (slide), Kodacolor (print) or equivalent recommended (the use of Ektachrome near water is not appropriate)
- ❑ Video camera and storage media, if required
- ❑ Batteries, charged battery packs (for GPS, cameras, etc.) [note: take extra in winter as battery life is considerably reduced in cold temperatures; keep batteries warm if possible]
- ❑ 10-cm or 25-cm long photo scale with 1-cm increments

- ❑ Day pack (waterproof)
- ❑ Communication equipment (hand-held 2-way radio(s), VHF Marine (5 watt), cellular phones)

Survival Gear

- ❑ First aid kit, water
- ❑ Shotgun, 12-gauge pump, slugs and buckshot, if needed
- ❑ Personal flotation device (PFD)/exposure suit, floater suit/floater coat

For remote areas, EPIRB (Emergency Position Indicating Radio Beacon) and survival equipment (hunter's survival kit or better)

Personal Gear

- ❑ Rain gear, insect repellent, sun glasses, sun screen, hat
- ❑ Rubber boots, non-skid soles
- ❑ Gloves and liners, waterproof, work type, high quality
- ❑ For winter surveys, suitable personal clothing to withstand expected and unexpected cold and wind conditions

1.3.4 Aerial Surveys

The purpose of reconnaissance and of ***aerial reconnaissance*** is to provide an overview of the distribution of the oil. Detailed observations and mapping are not required, in most cases, although as much information should be recorded as is possible within the scope and time frame of the survey.

An aerial reconnaissance survey requires prior experience as this technique relies heavily on the ability of the observer(s) to identify substrate materials and oil and to distinguish oil from the many other materials of similar colour and texture that occur naturally on the shoreline (lichen, mussel beds, heavy mineral deposits, stranded seaweed or sea grasses, peat).

Typical steps for an aerial reconnaissance survey include

- define the low-tide window
- decide on area or segments to be surveyed, the flight line direction, and associated logistics

- collect all necessary equipment and supplies
- review existing information and data
- brief all team members on the survey's objectives, methodology, and safety concerns
- take photos (or record videos if planned)
- fill in flight-line maps, appropriate forms, etc., record GPS waypoints, or take notes to be able to complete forms later
- discuss assessments / major observations prior to return from the survey
- finalize and copy maps, forms, field notes, photo/video logs
- submit copies to the SCAT Coordinator or Data Manager
- file a daily report form with the SCAT Coordinator
- review day's activities, discuss improvements, and prepare for next day, if necessary

The purpose of an ***aerial video survey*** is to systematically document and map the oiling conditions. Experienced observers can distinguish oil while flying at low altitudes (less than 100 m) and low speeds (less than 150 km/hr). Aerial surveys, which typically use video-mapping techniques, can cover an extensive area and generate detailed information for databases and shoreline maps. The commentary and video images can be used to identify shoreline type, coastal character, presence, width, and distribution of surface oil. This information is the foundation for the development of regional strategies and plans, for segmentation of the shoreline, and for the definition of lengths of oiled shoreline in term of shoreline types and the oil character.

Aerial video surveys require prior experience as this technique relies heavily on the ability of the observer to identify substrate materials and oil characteristics continuously and to record this information on the audio channel of the recorder while using the video tape or digital camera to record the section of shoreline that is being described by the commentary. An experienced assistant provides support to change tapes and log locations or to manage the automatic processing of GPS waypoints. Mapping from the videos can provide a level of detail on the order of metres if the flight height and speed are suitable and if the commentary and video imagery are of suitable quality. The data are only as good as the flying conditions permit and as the experience and skill of the camera operator/commentator.

Key elements of a successful aerial video mapping survey include

- flight-path planning with respect to (tidal) water levels, sun angles, and flying altitude
- communication with the pilot regarding flying height and distance from shore to minimize camera work (e.g., use of the zoom lens) and to ensure complete coverage
- a “rule of thumb” that a point on the ground passes through the video image for approximately six seconds
- accurate flight-line data that are linked to the tapes (for example, automatic GPS data logging)
- ground calibration where it is difficult to distinguish shoreline features
- continuous commentary using the video image as the background for the observations that are documented on the audio channel
- open-window or open-door for the camera and a mouth-microphone for the observer (to minimize wind sounds)

The procedures are described in more detail by Owens and Reimer (1991).

1.3.5 Ground Surveys

Generally, ground surveys should be coordinated between the Planning and Operations sections to ensure that the areas are surveyed within the context of the regional priorities and that they provide up-to-date information for upcoming (e.g., following day) operations activities.

The following are general elements of a ground survey.

Pre-Survey Planning

- Divide shoreline into segments, or adapt existing segmentation (see Section 1.3.1).
- Create segment numbering scheme (match to Operations divisions or vice-versa).
- Decide on segments to be surveyed based on survey priorities, logistics, and low-tide window.
- Select alternate areas in case weather conditions prevent access to primary target(s).
- Collect all necessary equipment and supplies.
- Review existing information and data.
- Brief all team members on objectives, methodology, forms, and safety concerns.

On-Site Activities

- Conduct segment overview; gain an overall perspective.
- Complete observations and measurements of the segment.
- Take photos and/or videos.
- Draw sketch maps.
- Fill in required forms, or take appropriate notes to be able to complete forms later.
- Discuss assessments/major observations prior to departure.

Post-Survey Activities

- Finalize and copy all forms, maps, field notes, and photo/video logs.
- Submit copies to the SCAT Coordinator or Data Manager.
- File a daily report form with the SCAT Coordinator.
- Review day’s activities, discuss improvements, and prepare for next day, if necessary.

Segment Overview on Arrival

- If working from vessel or aircraft, conduct a radio check before departing and agree on calls, channels, and ETA's (estimated times of arrival) with the captain or pilot.
- On arrival at the site, traverse the entire segment by skiff or helicopter, or if operating from a vehicle, view the segment from an elevated vantage point in the backshore to:
  - verify if the pre-determined segment boundaries are correct,
  - acquire a good perspective of the extent of stranded oil, and
  - estimate the level of effort required to complete the assessment.

Survey Strategy

- Once on shore, the team spreads out and begins walking from one end of the segment to the other while observing and documenting important oil features. If little or no oil is observed and treatment is not recommended, only a cursory assessment of ecological or cultural resource features is required.
  - On short segments: Walk the entire segment while making general observations and then return to areas that require more detailed documentation.
  - On long segments: It is more efficient to make extensive notes as team members progress along the shore to avoid backtracking.
- Site activities consist of systematic observation, collection, and documentation of the information on field forms, sketches, maps, and by photo and video recording methods.
- Completion of the Oiling Summary Form (Section 1.5) focuses on the physical aspects of the shoreline and the oiling conditions (typically, the mid- and upper-intertidal zones).

- If present, an ecologist would focus on the biological environment and typically would concentrate near the lower intertidal/swash zone (usually the most ecologically productive area).
- If present, an archaeologist would focus on the supratidal and backshore or over-bank regions, as this is where most archaeological or cultural features would be found.
- If operations or agency personnel are present on the assessment team, they can assist in a variety of ways (e.g., photos, measuring, documentation, digging pits) as well as assessing operations features such as access, potential staging areas, safety issues, etc.
- Sketch maps are generated (see Section 1.6) and photos/videos taken.

Prior to Departing the Site

- As a team, review the individual assessments and discuss treatment or cleanup options to ensure nothing has been overlooked, and reach agreement on major points. At a minimum there must be a consensus on oil character and distribution.
- Check that forms and sketch maps are complete and consistent, or ensure that adequate notes and measurements have been taken to complete them later.
- Ensure that all photographs and videos have been accurately logged in the field notes and that all of the documented and unusual features of the segment have been photographed.
- Check that all equipment, survey gear, personal items, and litter are taken when leaving the site.

1.3.6 Monitoring Programmes

As part of the SCAT programme, repetitive surveys can be used to provide a temporal picture of changes in oiling conditions. Monitoring surveys can be conducted for the following reasons:

- To document conditions where oil continues to wash ashore over an extended time period (weeks or longer)
- To assess changes in oiling conditions over time (days to months) that result from treatment and cleanup activities (by man) and/or natural self-cleaning processes
- To evaluate the effectiveness (performance and effects) of treatment decisions and options that were applied
- To investigate environmental processes that affect the fate, behaviour and effects of oil or of treatment methods

A monitoring programme includes these basic steps:

- Identify the extent of the area to be repeatedly surveyed
- Select areas or transects to be monitored and the monitoring time interval
- Place backshore markers that will remain for the duration of the monitoring
- Establish the survey procedures and develop appropriate forms to record the measurements and observations

Time-series monitoring usually involves a set of repetitive observations and measurements that are taken in a systematic manner, at a known point or points, over selected time intervals. Typically, the observation and measurement points are on fixed transects or across-shore profile lines, and beach elevation surveys are measured in conjunction with oil monitoring. Stakes, rebar, or other types of resistant material are used to mark the transects, and may be surveyed relative to each other and to a common datum (vertical reference point).

One option for beach profiles is to use the pole-and-horizon method to obtain elevations (Emery, 1961). A rope or tape can be stretched along the transect and lined up with the two backshore stakes to delineate the transect location. If the horizon is obscured, a hand level can be used to line up the top of the forward rod with the corresponding point on the back rod.

Oil cover estimates can be obtained by observing the surface oil distribution, to the nearest 5%, over a 2.5-m swath on either side of a transect line that runs perpendicular to the shoreline. Estimates require some care, particularly in lightly oiled areas where there is a natural tendency to over-estimate. One approach to offset this tendency is to consider the size of the non-oiled or clean area, rather than the amount of oil. A second concept is to envision herding all of the surface oil into one corner of the square and then to estimate the percent cover. A visual aid for estimating oil distribution is given in Figure 3.1 (pg 74). Where elevation measurements are also being made, a preferred method is to take both elevation and oil/sediment observations along the transect at fixed 2-m intervals. The estimate thus refers to the percent cover observations on the surface within a 10-m square area, positioned by the location on the transect.

If oil distribution maps or summary tables use category limits of 10%, 50% and 90% oil cover then it is important that either (1) category limits be defined specifically, for example as "less than or equal to 50%" or "greater than or equal to 50%," or (2) the exact break point number be avoided and the observer records only to the nearest 5% (e.g., 45 or 55%). The latter is preferred as this provides more accurate information.

As an example of the application of SCAT procedures to a monitoring programme, the design developed for the BIOS experiment involved a series of regular and systematic observations, measurements, and sampling of the oiling conditions and sediments along staked transects. This approach generated data for the comparison of surface oil distribution, oil character, and oil thickness over a ten-year period on an 800-m section of shoreline that was oiled by a nearshore controlled release of Lagomedio crude. The concept of documenting surface oil distribution in terms of percent cover (referred to as "equivalent area") was first developed on this project. Further information can be found in Humphrey *et al.* (1992).

Another example is the *New Carissa* incident in Oregon, where tar balls were washed ashore from the stern section that remained in the nearshore over the winter of 1999-2000. A time series of shoreline oiling conditions was generated by repetitive surveys of tar ball frequency and size that were carried out at regular intervals along two segments that were subdivided by backshore markers placed at half-mile intervals (Owens *et al.*, 2002) (see also the case study in Section 2.3).

1.3.7 Field Documentation

Basic steps in the collection and documentation of on-site field data are summarized in Table 1.3 and Section 1.3.5.

Table 1.3 Basic Steps of On-Site Field Data Collection

– Reconnoitre the site to gain an overview perspective
– Define segment (sub-segment and zones) boundaries
– Describe shoreline type and character within the segment
– Describe surface oiling conditions
– Describe subsurface oiling conditions
– Draw sketch or map
– Take photos or video
– Review forms and discuss major observations with team

SCAT programmes are designed so that the scale of the field activities and the type of information that is collected are appropriate for the spill incident. A modification of the standard SCAT forms or the development of new SCAT forms may be part of the design.

Oversimplification of the forms, however, can result in the deletion of key information items that would allow accurate reconstruction of the oiling conditions. In establishing the field programme and defining data collection procedures, several essential components should be included (Table 1.4).

Table 1.4 Essential Components of a SCAT Data Set

General
- Location, date, time, and segment code
- Names, affiliation, contact information for team members

Surface Oil Conditions
- Location and tidal zones
- Length and width of oiled section or segment described
- Location of oil relative to tidal zones or lake/river levels
- Distribution (percent surface cover to nearest 5 or 10%)
- Oil thickness
- Oil character

Subsurface Oil Conditions
- Location and area (length and width) of penetrated or buried oil
- Pit or trench locations and depths
- Thickness of clean sediment on buried oil
- Thickness of sediment to base of penetrated/buried oil

Field Sketch Map
- Scale, North arrow, GPS coordinates
- Surface oil locations and characteristics (abbreviations)
- Pit and trench locations
- Access, staging, and safety or operational concerns

Photographs and/or Video
- Dated and logged

When more than one SCAT team is fielded or multiple surveys are conducted over the same areas, then repetition, calibration, and consistency in reporting by field observers are important components of data accuracy.

Without the data listed in Table 1.4, it is difficult to provide accurate estimates of the volume and type of oil to be recovered or treated by the operations crews. In addition, attempts to estimate shoreline oil volumes, or budgets, are doomed to inaccuracy if the data are not complete and systematic. For example, if the oil distribution box for a “Patchy” surface oil cover is checked, the actual range may be any number between 11 and 50%. Typically, an individual reading data to calculate oil volumes would have little choice but to assume a mid-point value (which would be 30.5% in this case) and so the calculation could be inaccurate by as much as 20% for the volume of oil for that particular shoreline data set. Simplification in the field description that uses categories, rather than actual observed values or measurements, reduces the quality and accuracy of the information that is collected. In turn, this makes an estimation of the amount of oil to be recovered very difficult for the planning team and greatly reduces the accuracy of any attempts to develop oil budgets or waste management estimates. Some guidelines or “rules of thumb” for the collection and documentation of shoreline oiling conditions are provided in Table 1.5.

Table 1.5 SCAT Documentation “Rules of Thumb”

– The role of the SCAT is to be the “eyes and ears” for the Planning and Operations teams. – Record, on a form or in a field notebook, any and all information required to recreate later the character and location of the oil. – Define practical segments, based on the physical shore-zone character, oiling conditions, or operational units. – Be more, rather than less, detailed and do not categorize (i.e., enter the actual value of 15% for Distribution, not Patchy; enter the value 15 m for Width of Oiled Band, not >3 m). – Always make a sketch (or draw a map or on a map) to indicate important features and the location of the oil. – If there is no standard term or definition that fits an observed feature, then define and describe the feature. – Look around and identify advantages or constraints that might help or hinder the field cleanup crew.

1.4 RESULTS

1.4.1 Data Management

Field activities are of little value to decision makers or planners if the information is not available quickly. Data management activities can be carried out by the SCAT field team for small-scale or single-team surveys, or on incidents where there is sufficient time to organize and present a summary of the observations. But if the scale of the field activities involves several SCAT teams, a data bottleneck most likely will be created without a committed data management system.

Often, and particularly in the early stages of a spill response, the information from the field teams is used to plan cleanup activities for the following day. This information probably would be required by late afternoon or early evening to be of value in the planning process. In these circumstances, field teams may be required to communicate key information by telephone or radio to a person who can collate and process the data. In other circumstances, particularly after the initial response phase, the planning process may be several days ahead of operations.

Typically a précis of each SCAT survey is provided to planning and/or operations and would briefly highlight oiling and treatment recommendations (see Section 2.1.3)

One role of the data manager is to collect and review the incoming field forms, sketches, and other information (films, videos etc.) as they are received and to log or distribute the information. The review should involve a quality check to make sure that all sections of the forms have been completed and that the information appears reasonable and consistent. Any questions regarding missing information or apparent inconsistencies should be discussed with the field teams before the next field assignment. After the quality control is complete, forms are copied and distributed. Key information usually is transferred to tables or computer data files.

Discussions of data management are provided by Lamarche and Owens, (1997); Lamarche and Tarpley, (1997); Lamarche *et al.* (1998); and Williams *et al.* (1997).

1.4.2 Data Outputs

Data generated by SCAT surveys may be combined and used in a variety of ways:

Length, by itself, is mainly useful for initial scoping on a regional-scale and operational planning.

Length x Width of the total oiled area can be used in planning cleanup operations and in monitoring changes through time.

Length x Width x Surface Distribution of the actual surface area that is covered by oil, i.e., the total oiled area x % coverage (also known as "equivalent area" oiled). This value is useful when trying to quantify the degree of oiling or to monitor changes and oil removal rates.

Depth of Burial or ***Penetration*** measurements assist in the selection of cleanup options and predictions of oil persistence.

Depth x Surface Area is the oiled sediment volume that might have to be handled in cleanup.

Oil Volume calculations require the oil concentration data in combination with the knowledge of oiled sediment volume or equivalent area oiled, or oil loading data, together with sediment porosity/retention estimates.

RATING THE DEGREE OF OILING

In the case of a small spill or when information is needed quickly to plan operations, the planners may require a summary of the more detailed field observations. This summary should be simple, but accurately reflect oiling conditions. Figure 3.2 (pg 76) is an example of a ***Surface Oil Cover Category*** matrix that combines the width of the oiled area with the surface oil distribution using standard terms and definitions. This index can be used to provide spill managers with a concise measure of the oiling conditions for each segment and can be summarized verbally from the field.

The use of such indices allows a single-value, site-to-site relative comparison that provides a perspective to describe, summarize, or compare multiple areas or long sections of oiled coast in an easily understandable manner. The rating can be adjusted to the local conditions.

The two indices described in this manual are:

Surface Oil Cover Category = width x surface distribution of the oil (see Figure 3.2)

Surface Oil Category = width x surface distribution x thickness of the oil (see Figure 3.3)

These indices are a rating of the degree of oiling in that segment (Very Light, Light, Moderate, or Heavy). Typically, the rating category is combined with alongshore length (e.g., "Segment AB-1 has 20 m of 'heavy' surface oiling").

As the scale of the affected area and the size of the response operation increases, the information outputs usually become more sophisticated. Entry of the field data into spreadsheets enables a data manger to provide summary data sets and maps that could be used both to support the planning process and the cleanup operations or to track the progress of an operation (Lamarche and Owens, 1997; Lamarche and Tarpley, 1997; Lamarche *et al.*, 1998; Williams *et al.*, 1997).

A wide range of maps and tables can be generated to assist in the understanding of the oiling conditions for use by the management team or the public information team, or simply to document the operational activities or the changes in oiling conditions. Maps that can be produced from the SCAT data to support a response operation include the following:

- shoreline types, coastal or river channel character
- segment limits and operational divisions
- oiling category by segment (including changes over time)
- estimated surface oil volume (including changes over time)
- oil remobilization potential
- estimated oil persistence
- segment treatment or cleanup priority
- recommended cleanup or treatment methods
- SCAT survey or cleanup status

Tables can be created to show

- lengths of oiled shoreline (by oil rating or shoreline type)
- lengths treated (by oil rating and/or treatment method)

Examples of data outputs for tar ball frequencies, concentrations, and oil volumes calculated from a long-term SCAT tar ball monitoring programme are described in Owens *et al*. (2002).

1.5 ARCTIC SHORELINE OILING FORM

The standard Shoreline Oiling Summary (SOS) forms are presented in The SCAT Manual (Owens and Sergy, 2000). As the focus of this manual is on forms that are suitable for arctic shorelines and for winter conditions, the standard SOS template has been adapted to include (a) three additional shore types that are found in the Arctic (Section 3.2.2), and (b) descriptions of snow, shore-zone ice, and nearshore ice conditions.

The standard form is provided at two levels of complexity and detail. The Arctic Standard Oiling Summary (ASOS) form is the adaptation of the standard SOS form and would be the format most commonly used (Section 1.5.1). A "short" ASOS form intended for use by first responders to assess oiling conditions easily and rapidly is presented in Part 4. Terms and definitions are summarized in Section 1.5.2 and detailed in Sections 3.1.1 and 3.1.2. Job aids to assist in the description of oil distribution, sediment size, shoreline types, and ice and snow conditions are provided in Section 3.5.

Additional forms that can be used for tar ball conditions, wetlands, tidal flats, riverbanks, small rivers, creeks and streams, and for freshwater lakes that would be suitable for winter conditions or arctic environments are presented in Section 2.2.

The content and layout of the standard SOS forms and the terms and definitions correspond closely to those recommended by NOAA. For the ASOS form the descriptions for snow and ice conditions were developed for this manual, while the nearshore ice conditions terminology were taken directly from NOAA (2000c).

1.5.1 Arctic Shoreline Oiling Summary (ASOS) Form

PRIMARY USE

On all spills in the Arctic or any other region where snow and ice are present in the shore zone, and where surface or subsurface oiling conditions are variable between or within segments, and where detailed information is appropriate.

INSTRUCTIONS

Boxes 1 – 3

Complete boxes 1, 2 and 3.

Boxes 4 – 5

Box 4A: Select only one primary (P) shoreline type that best describes where the oil is located and any number of other secondary (S) types that apply to the segment.

Box 4B: Describe the shore-zone snow and ice conditions with reference to the tidal zone to which the snow and /or ice descriptions apply.

Box 4C: Estimate the ice concentration, form, and thickness for the nearshore area adjacent to the segment.

Box 4D: Indicate one primary (P) backshore character that best describes the area inland of the segment and any number of other Secondary (S) types that apply to the area.

Box 5: Note any access or staging information that might be useful for the segment.

Box 6

If No Surface Oil Is Present:

- check the NO box in "**Oil Character**"

If Surface Oil Is Present:

STEP 1 Decide if the segment has relatively uniform alongshore and across-shore oiling conditions:

- if YES, then go to STEP 2;
- if NO, then (a) subdivide the segment into as many alongshore ***Sub-Segments*** and/or across-shore ***Zones*** (see Section 1.3.1) as necessary for an accurate description, then (b) go to STEP 2. Use a separate form for each sub-segment.

STEP 2 Define the location (Tidal Zone), Oil Cover, Oil Thickness, Oil Character and primary and any secondary (in parentheses) Substrate Type (Subst. Type) for each zone in the segment or sub-segment in which oil is observed (for terms and definitions see the following pages and Section 3.1).

STEP 3 Draw sketch map(s) (see Section 1.6) to locate sub-segments, zones, and oiled areas. Take photographs or videos.

Box 7

If No Subsurface Oil Is Present:

- check the NO box in ***Subsurface Oil Character*** and go to Box 8

If Subsurface Oil Is Present:

<u>STEP 1</u> Decide if the segment has relatively uniform alongshore and across-shore subsurface oiling conditions:

- if YES, then go to STEP 2
- if NO, then (a) subdivide the segment into as many alongshore ***sub-segments*** and/or across-shore ***zones*** as are necessary for an accurate description, then (b) go to STEP 2. <u>Note: use a separate form for each sub-segment.</u>

<u>STEP 2</u> Define the location (Tidal Zone), Trench/Pit Depth, Oiled Zone Depth, Oil Character, and Substrate Type(s) for each trench or pit (for terms and definitions see following pages and Section 3.1)

Box 8

Add comments on cleanup recommendations, ecological, recreational, cultural, economic issues, and /or constraints and wildlife observations.

Take photographs or videos. Note the roll/frame and/or tape number(s) at the bottom of the form.

Form 1.1 Arctic Shoreline Oiling Summary (ASOS) Form

ARCTIC SHORELINE OILING SUMMARY (ASOS) FORM for ______________________ Spill Page _____of _____

1 GENERAL INFORMATION	Date (dd/mm/yy)	Time (24h): standard/daylight	Tide Height
Segment ID:		hrs to hrs	rising / falling
Operations Division:		Season: Open Water / Freeze-Up Transition / Frozen Period / Breakup-Thaw	
Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________		Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg C.	

2 SURVEY TEAM # _______ *name*	*organization*	*contact phone number*

3 SEGMENT ***Total Segment Length ________m*** ***Segment Length Surveyed ________m***

Start GPS: LATITUDE _____deg. _____min LONGITUDE _____deg. _____min. ***Differential GPS*** Yes / No

End GPS: LATITUDE _____deg. _____min LONGITUDE _____deg. _____min.

4A SHORELINE TYPE ***select only one primary (P) oiled shoreline type and any number of secondary (S) types***

BEDROCK : ____ ***MAN-MADE SOLID :*** ____ ***SEDIMENT BEACH :*** Sand ___ ***SEDIMENT FLATS :*** Mud Flats ___

cliff/vertical ____ sloping ____ platform ____ Pebble-Cobble ___ Boulder ___ Sand Flats ___ Sand-Gravel ___

GLACIER : _____ ***MARSH :*** ___ Mixed Sand-Grave ___ Peb-Cob ___ Boulder ___

Tundra Cliff : ice rich ___ ice poor ____ ***Peat Shoreline*** ___ ***Inundated Low-lying Tundra*** ___

4B SNOW and ICE CONDITIONS ***circle all tidal zone locations as necessary - Lower : Middle : Upper : Supratidal***

snow: cover ________% thickness ______cm fresh Y / N compacted Y / N location L M U S

glacier ice: height of ice front: _____m floating front: Y / N

frozen spray: width ________m thickness____cm

frozen swash: width ________m thickness____cm location L M U S

grounded floes: ave. length ________m ave. thickness______cm location L M U S

ice foot: width ________m thickness ______cm location L M U S

ice push ridge width ________m thickness ______cm location L M U S

4C NEARSHORE ICE CONDITONS ***circle one in each of the three categories***

CONCENTRATION: 0/10
open drift < 1/10
very open drift 1/10 - 3/10
open drift 4/10 - 6/10
close pack 7/10 - 8/10
very close pack 9/10
compact ice 10/10

FORM: (m)
pancake 0.3 -3 small floes 20-100
brash < 2 medium floe 100-500
ice cakes < 20 big floe 500-2000
none Y vast-giant floe > 2000
Fast ice: Y /N
Tidal Cracks: Y / N

AGE and thickness (cm):
new = frazil-grease-slush
nilas or ice rind < 10 age unknown ___
young: grey-white 10-30
first year > 30
second year > 250
multi year > 300

4D COASTAL CHARACTER ***backshore character — select only one primary (P) and any number of secondary (S) types***

CLIFF or HILL _____ : est. height _________ m Beach ____ Delta ___ Tidal inlet ___ Marsh/Wetland ____

slope: gentle (<5º) ___ medium ___ steep (>30º) ___ Barrier beach ____ Dune ___ Channel ___ other _______________

5 OPERATIONAL FEATURES debris Y / N oiled? Y / N debris amount: _______ bags OR ________ trucks

direct backshore access Y / N suitable backshore staging Y / N depth of active layer: _________cm

alongshore access from next segment Y / N access restrictions ____

6 SURFACE OILING CONDITIONS ***begin with "A" in the lowest tidal zone***

OIL ZONE ID	TIDAL ZONE				OIL COVER *Length*	*Width*	*Distrib.*	OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
	LI	MI	UI	SU	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	**NO**	
A																					

7 SUBSURFACE OILING CONDITIONS ***use letter for ZONE location plus Number of pit or trench — e.g., "A1"***

TRENCH or PIT NO.	TIDAL ZONE				MAX. PIT DEPTH	OILED ZONE	SUBSURFACE OIL CHARACTER							WATER or FROST TABLE (cm)	SHEEN COLOUR	CLEAN BELOW	SUBST. TYPE(S)
	LI	MI	UI	SU	cm	cm-cm	SAP	OP	PP	OR	OF	TR	**NO**		B, R, S, N	Yes / No	

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # _____ Frames______) **Video Tape** Yes/No (tape #______) ver. 01/04

1.5.2 Summary of Terms and Definitions

Standard terms and definitions presented in this section provide a summary explanation for completion of the standard ASOS form. Complete definitions and terms are provided in Section 3.1.

SHORELINE CONDITIONS (BOX 4)

- For Box 4A, examples of shoreline types are provided in Section 3.5.3 and illustrations of the three arctic shoreline types (Tundra Cliff; Peat Shoreline; Inundated Low-lying Tundra) are provided in Section 3.5.4.
- For Box 4B, illustrations of snow and ice conditions are provided in Section 3.5.5.
- For Box 4C, refer to the Observers' Guide to Sea Ice (NOAA, 2000c).

TIDAL ZONE (BOX 6 AND 7)

LI ***Lower Intertidal Zone*** — the lower approximate one-third of the intertidal zone.

MI ***Mid Intertidal Zone*** — the middle approximate one-third of the intertidal zone.

UI ***Upper Intertidal Zone*** — the upper approximate one-third of the intertidal zone.

SU ***Supratidal Zone*** — the area above the mean high tide that occasionally experiences wave activity. Also known as the splash zone.

SURFACE OIL COVER (BOX 6)

Length refers to the alongshore distance of oiled shoreline within a segment or zone.

Width refers to the average across-shore distance of the intertidal oil band within a segment or zone. If multiple across-shore bands are grouped, then width represents the sum of their widths.

Surface Distribution represents the actual percent of the surface covered by oil, within a fixed area (see Figure 3.1–

visual aid to estimate oil distribution). In the event of grouped multiple bands, distribution refers to the average oil conditions for the zone.

SURFACE OIL THICKNESS (BOX 6) — Refers to the average or dominant oil thickness within the segment or zone. It is described according to the following categories.

PO ***Pooled or Thick Oil*** — generally consists of fresh oil or mousse accumulations >1 cm thick.

CV ***Cover*** — >0.1 cm and <1 cm thick.

CT ***Coat*** — >0.01 cm and <0.1 cm thick. Can be scratched off with fingernail on coarse sediments or bedrock.

ST ***Stain*** — <0.01 cm thick. Stain cannot be scratched off easily on coarse sediments or bedrock.

FL ***Film*** — transparent or translucent film or sheen.

SURFACE OIL CHARACTER (BOX 6) — Provides a qualitative description of the form of the oil.

FR ***Fresh*** — unweathered, low viscosity oil.

MS ***Mousse*** — emulsified oil (oil and water mixture) existing as patches or accumulations, or within interstitial spaces.

TB ***Tar Balls*** — discrete balls, lumps, or patches on a beach or adhered to the substrate. Tar ball diameters are generally <10 cm.

PT ***Tar Patties*** — discrete lumps or patches >10 cm diameter that are on a beach or adhered to the substrate.

TC ***Tar*** — weathered coat or cover of tarry, almost solid consistency.

SR ***Surface Oil Residue*** — consists of non-cohesive, oiled, surface sediments, either as continuous patches or in coarse-sediment interstices.

AP ***Asphalt Pavement*** — cohesive mixture of oil and sediments.

NO ***No Oil Observed***.

SUBSTRATE, SNOW, OR ICE TYPE (BOX 6 AND BOX 7)

R	***Bedrock outcrops***
B	***Boulder*** *(> 256 mm diameter)*
C	***Cobble*** *(64 – 256 mm diameter)*
P	***Pebble*** *(4 – 64 mm diameter)*
G	***Granule*** *(2 – 4 mm diameter)*
S	***Sand*** *(0.06 – 2 mm diameter)*
M	***Mud/Silt*** *(< 0.06 mm diameter)*
A	***Anthropogenic/Manmade***
FSW	***Frozen swash***
FSP	***Frozen spray***
IFT	***Ice foot***
IPR	***Ice-push ridge***
GFL	***Grounded ice floes***
GLC	***Glacier ice***
SNW	***Snow***

SUBSURFACE OILED ZONE (BOX 7) — Refers to the vertical width or thickness of the oiled sediment (subsurface) layer when viewed in profile by digging a pit or trench. The top and bottom boundaries of the lens are recorded. The bottom boundary is equal to the maximum depth of oil penetration. The top boundary may equal 0 (the beach surface) or a greater number depending on whether clean sediments have been deposited on top of the oiled sediment. See Figure 3.4 (pg 79) and Section 3.1.2 for guidance on surface and subsurface differentiation.

SUBSURFACE OIL CHARACTER (BOX 7) — Provides a qualitative description of the character and/or quantity of the oil.

SAP ***Subsurface Asphalt Pavement*** — cohesive mixture of weathered oil and sediment situated completely below a surface sediment layer (record thickness).

OP ***Oil-Filled Pores*** — pore spaces in the sediment matrix are completely filled with oil. Often characterized by oil flowing out of the sediments when disturbed.

PP ***Partially Filled Pores*** — pore spaces filled with oil, but generally does not flow out when exposed or disturbed.

OR ***Oil Residue as a cover*** (> 0.1 – 1 cm) or **coat** (0.01 – 0.1 cm) of oil on sediments and/or some pore spaces partially filled with oil. It can be scratched off easily with fingernail on coarse sediments or bedrock.

OF ***Film or Stain*** (< 0.01 cm) of oil residue on the sediment surfaces. Non-cohesive. It cannot be scratched off easily on coarse sediments or bedrock.

TR ***Trace*** — discontinuous film or spots of oil on sediments, or an odour or tackiness with no visible evidence of oil.

NO ***No Oil*** — no visible or apparent evidence of oil.

SHEEN COLOUR

S ***Silver***
R ***Rainbow***
B ***Brown***
N ***None***

1.6 Sketch Maps

A sketch map (Figure 1.2) is drawn for each segment to identify the physical layout of the shoreline and the location of the oil, samples, pits, and photographs. (Note: Within a segment it is also valuable to locate areas of buried oil by flags or stakes so that operation crews can easily locate this oil). Aerial photographs or small-scale maps can be traced to create a base map for the sketches in order to enhance their accuracy and scale. If only a portion of the segment is sketched or several sketch maps are drawn for a site, include a sketch location map to indicate how the sketches match or overlap. Some guidelines for sketch maps are given below.

- Include north arrow, segment number, approximate scale, segment and sub-segment boundaries, HWL/LWL (high water or high-tide level: low water or low-tide level), major features, and landmarks.
- Oil conditions should be shown as shaded areas (designation corresponds to SOS forms).
- An alphabetic designation is given to each oiled area on the sketch that corresponds to a letter designation for the ZONE on the field form or field notes. Indicate the dimensions for each oiled area, as well as the percent oil cover estimates, oil character, and substrate.
- Indicate pits by a triangle, and give them a numerical designation that corresponds to the one on the SOS form. The triangle is filled in to represent oil found in the pit; an open triangle is used if no oil is found.
- Include notes about biota within oiled areas - nesting locations, etc.
- Show photograph locations by a dot with a connecting arrow indicating the direction in which the photo was taken, with frame number/roll number on sketch.
- Indicate location(s) where a video was recorded.

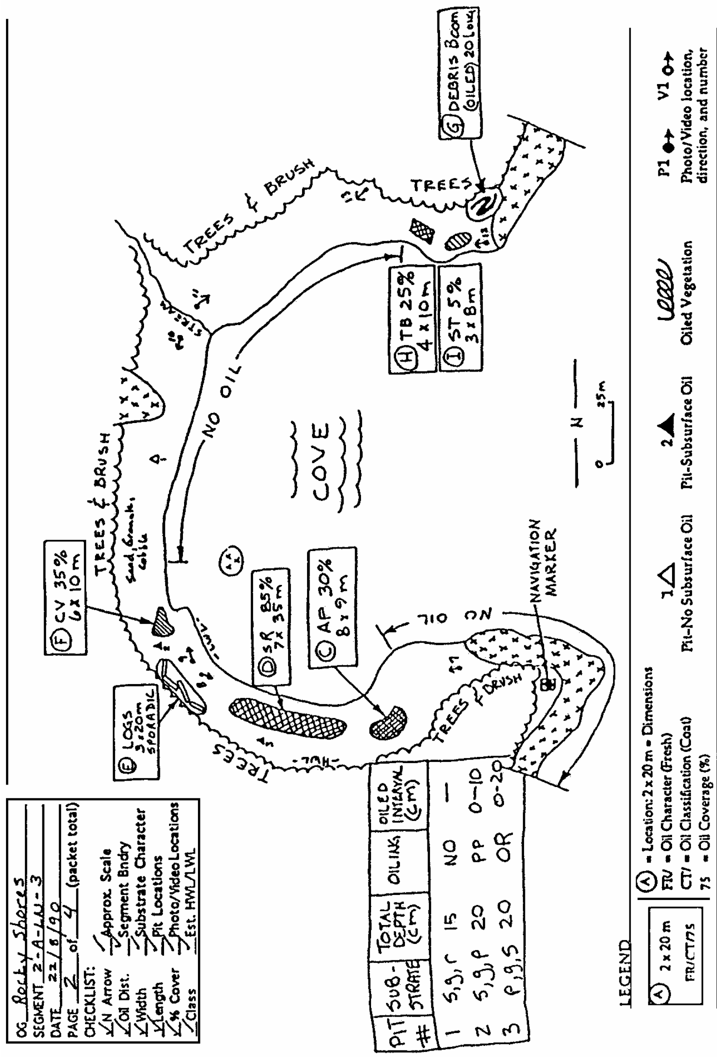

Figure 1.2 A Typical Sketch Map.

PART 2 APPLICATIONS

2.1	**SPILL MANAGEMENT APPLICATIONS**
2.1.1	SCAT and the Spill Management Organization
2.1.2	Who Uses SCAT Data?
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2.1 SPILL MANAGEMENT APPLICATIONS

2.1.1 SCAT and the Spill Management Organization

SCAT activities are part of the Planning Section in the Incident Command System (ICS) that has been adopted for many response operations (Figure 2.1). If more than one field team is deployed, a SCAT coordinator usually is required to communicate with other units in the Planning Section and with the Shoreline Operations Supervisor in the Operations Section. This link with Operations is important in the development of practical, effective, and efficient treatment or cleanup options. Often, the coordinator provides direct input for field cleanup activities that are carried out on the following day (Lamarche *et al.*, 1998: Lamarche and Tarpley, 1997: Martin *et al.*, 1997). Field reports and data summaries are provided to the Situation Unit, where they are available to other interested users, and to the Documentation Unit for archiving.

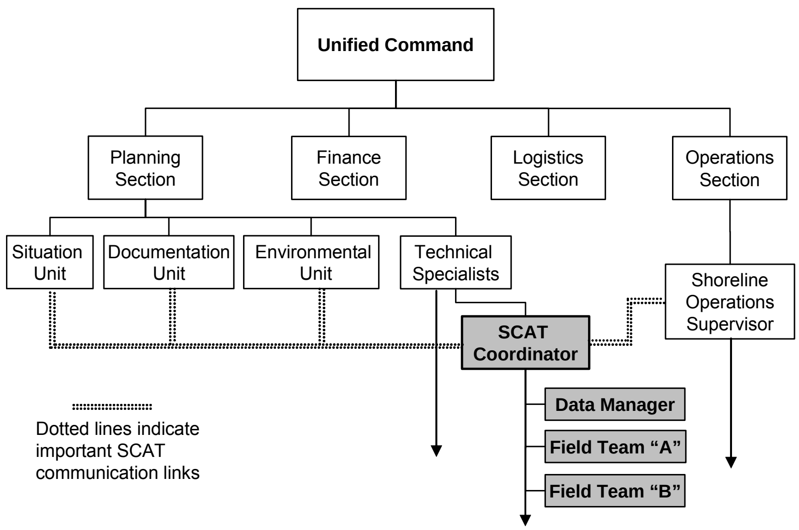

Figure 2.1 Typical ICS — SCAT Organization Diagram.

The shoreline oiling information provided by the SCAT surveys is used in various specific ways by decision makers and planners within the spill management organization (see Section 2.1.2). The generalized flow of this information through the decision process is presented graphically in Figure 2.2. This idealized cycle depicts how the SCAT process provides input to aspects of a response operation by:

- initially helping to define the regional scale and scope of the problem
- providing planning information for the response operation
- setting site-specific guidelines for cleanup crews to follow in the field
- completing the decision cycle for shoreline treatment

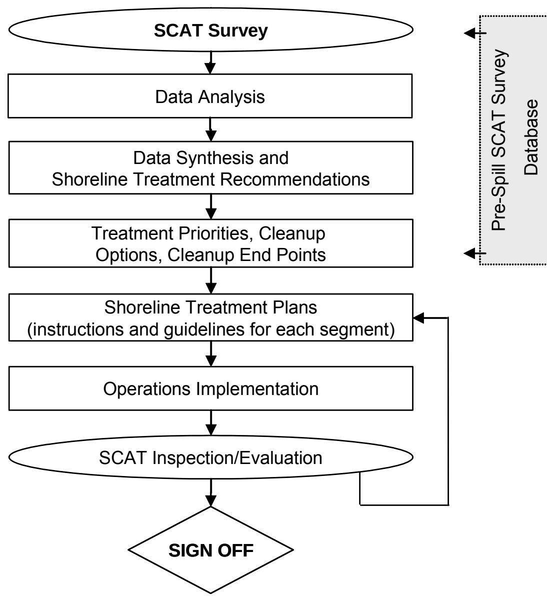

Figure 2.2 SCAT Within The Spill Management Cycle.

On some spills, a shoreline assessment survey may be carried out at the same time as shoreline surveys for the purpose of environmental/resource damage assessment (e.g. NRDA in the US). These types of surveys usually are, and should be, a separate activity (NOAA, 1998), although the SCAT data and information may be used as part of the damage assessment.

2.1.2 Who Uses SCAT Data?

The groups that typically use the information and data generated by the SCAT programme include the following:

- Unified Command, to evaluate the scale of the problem and the scope of the response.
- Planning, to:
  - define regional and segment treatment objectives
  - define regional shoreline treatment priorities
  - select cleanup or treatment methods
  - identify the required level of effort for shoreline operations
  - define and apply cleanup or treatment end-point criteria
  - monitor cleanup and treatment progress, and
  - update the Status Boards (Situation Unit)
- Logistics, to estimate the resources required to complete the job on a site-by-site or segment-by-segment basis.
- Operations, to locate the work sites and the oil and to implement the cleanup task.
- Waste team, to determine the type and quantity of waste generated at each site.
- Environmental teams, to identify potential liabilities and to assess effects and recovery.
- Safety Officer(s), to identify shore-zone hazards and other safety issues at each work site.
- Public Information team, to provide accurate data to the media and others on the scale of the oiling and on the progress of the cleanup operation.

- Documentation team, to record what happens.
- Agencies and stakeholders, to evaluate the proposed activities and to monitor progress. (Many regions in North America now expect to see a SCAT team in action very early in a spill response, and regional agencies and stakeholders' representatives expect to participate in the field surveys).

2.1.3 Treatment and Cleanup Recommendations

The information generated by the SCAT survey(s) is a basic component of the decision process for setting regional response priorities, cleanup objectives, and standards for acceptable levels of treatment.

The decision process involves a number of steps beginning with the initial collection of information on the shoreline oiling conditions (Figure 2.3). Field manuals that provide guidance for this decision process have been developed by Environment Canada for the arctic regions (Environment Canada, 1996a) and by API (2001). See also Section 3.4.4.

Recommendations for treatment or cleanup techniques can be made by the SCAT team in the field or by discussions following the field survey that might involve representatives from the Operations Section, government agencies, and local organizations.

A short one page summary of oiling condition, treatment recommendations and constraints can be used to transmit the essence of the treatment plan to operations and can be included in the Incident Action Plan. An example of a completed SCAT Recommendations Transmittal Sheet is provided in Table 2.1. The "Approvals" block would provide for sign-off agreement by necessary agencies/parties, for example, in the USA this could include approval initials for FOSC – SOSC – LOSC - RP reps + SHIPO (for the Cultural Resources Program).

Gather & Assess Information And Data	Define regional distribution of oiled shorelines (e.g., aerial video survey) Segment Shorelines and assess local (segment) oiling conditions-ground SCAT survey
Define Objectives	Identify acceptable treatment levels Establish segment (local) treatment objectives, priorities, and treatment levels
Develop Strategy	Establish segment (local) treatment strategy(ies) to meet the segment treatment objectives
Select Response Options	Define acceptable and available procedures and techniques that can achieve the treatment objectives and strategies
Evaluate Response Feasibility	Identify environmental (physical), ecological, and logistical constraints that might affect the proposed operations Evaluate the Net Environmental Benefit of the proposed actions Evaluate the practicality and ability of the proposed operations and procedures to achieve the segment (local) treatment objectives and strategies Evaluate the need to redefine an objective or strategy if the original proposed actions cannot be conducted in a safe of effective manner
Prepare Shoreline Treatment Plans	Develop a long-range regional shoreline treatment/cleanup plan **Prepare individual segment (or group-of-segments) treatment or cleanup plans**

Figure 2.3 Shoreline Treatment Decision Process.

Table 2.1 SCAT Recommendations Transmittal Sheet.
(Example of completed text in italics)

Site Location: *Shadow Bay, Eagle Sound*
Segment #: *SB-2* **Length**: *900m* **Survey Date**: *01/04/04*
Shoreline Type: *Sand Beach* **Coastal Character**: *Dunes*
Staging:
No backshore access. No backshore staging.
Some Supratidal staging available (15m wide with logs)
Oiled Areas for Treatment:
1. 600m x 3m wide : 35% distribution : 1 cm thick : UITZ
2. tar balls along swash line: ~2 per m x 800 m
3. sporadic cover on logs in Supratidal zone
☑ **Oiled Debris**: *Oiled kelp on drift line.*
Treatment Recommendations:
Manual: Remove oiled sand with rakes and flathead shovels. Remove oiled kelp and tar balls >2 cm diameter
Sorbents: Wipe fresh oil off logs
Treatment Constraints:
Minimize activity near eagle nest – just north segment boundry.
Do not remove logs from Supratidal zone.
Temporary Waste Disposal Considerations
High spring tides may flood supratidal zone end of week.
☑ Night Operations ☑ Lighting Required
Safety Issues:
Bears sighted in area. Slippery logs.
Approved:
[Insert Signature blocks for sign-off by necessary agencies]
Attached: ☑Sketch Map ☑SOS Form ☑Fact Sheets ☐ Other____
Prepared by: *Gary Sergy* Date: *01/04/2004*

2.1.4 Treatment Standards and Cleanup End Points

Treatment standards, or cleanup end points, are based on an accurate knowledge of the initial oiling conditions and the character of the stranded oil that is provided by the SCAT survey. The decision to end the treatment or cleanup of an oiled segment should be based upon goals, standards, or levels of effort that are established before the operation begins. The primary intent of the development of end-point standards is as follows:

- Assist the spill management team in the selection of the treatment objectives and treatment techniques for a specified area before the response operation begins.
- Provide operations with a clear objective or target so that they can tailor their activities towards a known point of completion.
- Provide an inspection team with treatment criteria and standards upon which to evaluate the results of the treatment activities and to reach closure.

The secondary benefits of end-point standards are to

- Facilitate a recognition and assessment of all of the various environmental, social, and economic factors that are important and that should be considered in the shoreline treatment or cleanup decision process and in the selection of response options that are appropriate and practical.
- Facilitate recognition of concerns within, and attempt to create a consensus between, various responsible parties and stakeholders.

Typically the establishment of the cleanup criteria is a joint decision by the spill management team and is agreed upon by the responsible party. There may be range of criteria that vary depending upon the following:

- the shoreline type (e.g. bedrock, sea walls, sand beaches, marshes)
- the environmental character and habitat value of the segment
- the use of the segment (e.g. wildlife refuge, residential area, park, remote area)
- operational factors (e.g. access, staging, techniques)
- the degree of oiling
- the anticipated rate of natural cleaning

Treatment standards or cleanup end points may vary from one area or segment to another and may be based on (Owens and Sergy, 2003b):

- qualitative field observations
- quantitative field measurements (such as SCAT survey data)
- analytical measurements (e.g. chemical, toxicological)
- interpretative assessments (such as a Net Environmental Benefit Analysis)

Often a step or phased approach is developed that involves an initial inspection, which typically will involve members of the SCAT team(s), to establish that the treatment criteria or cleanup standards have been met. This may be followed by a later inspection to ensure that the segment remains in an acceptable condition. These post-cleanup inspections often rely on the SCAT data to provide a picture of the oiling conditions through time (Figure 2.4).

Shoreline Treatment and/or Cleanup Operations	Segments are treated or cleaned following the guidelines, and possibly constraints, provided in the Shoreline Treatment Plan
Post-Treatment Survey or Inspection	Inspection team (may involve SCAT personnel) establish that "end point" criteria or treatment standards for the segment have been met
Possible Second-Phase Survey or Inspection	Inspection team (may involve SCAT personnel) ensures that shoreline conditions in the segment remain acceptable
"Sign Off"	Spill management team (e.g., Unified Command) approves that no further shoreline treatment or cleanup activities are required within the segment

Figure 2.4 Key Phases Of A SCAT Programme.

2.1.5 The Selection of Treatment Standards

The decision begins before the shoreline or riverbank treatment operation plans are developed, as the level of operational effort cannot be calculated without knowledge of the completion standards (Owens and Sergy, 2003b).

STEP 1. Divide the impacted shoreline or river into segments based on information on the physical and ecological character of the area and on the oiling conditions.

STEP 2. Define the issues and objectives that drive the selection of treatment criteria and treatment end-point standards for each segment.

STEP 3. Select the treatment standards for each segment.

STEP 4. Ensure that Operations understand the issue(s), the treatment objectives, and the end-point standard for each segment.

STEP 5. Ensure that Operations agree that the criteria or standard are appropriate and practical and that they can be achieved.

STEP 6. Consider that more than one set of standards or end points may be appropriate within one segment based on the use of a number of sequential treatment actions or methods.

STEP 7. Consider a phased completion approach with a first inspection and a later revisit to ensure that the required or expected conditions are achieved and/or maintained.

END-POINT GUIDELINES

- Assume that different criteria and standards apply to different shoreline or river segments.
- There may be more than one set of treatment criteria and standards within one shoreline segment.

- Individual standards and end points, even the same ones, can be applied to different environmental components, e.g., to water, vegetation, sediments, surface and subsurface sediments, intertidal and subtidal zones.
- There is no uniform or standard approach that can be applied universally. Treatment criteria or standards typically vary from one spill to another, depending on the unique features of the incident, and typically also vary within a single response operation as impacts and risks often are not uniform within the affected area.
- One intermediate end point may be the trigger for further treatment in one segment and the standard for completion in another.
- Even with a clearly defined standard, a judgment call may be required from the spill management team.

2.2 OTHER APPLICATIONS OF SCAT

2.2.1 Pre-Spill SCAT Surveys

Pre-spill mapping projects can be coupled to the SCAT process by creating shoreline segments and acquiring basic physical shoreline data on shoreline types and coastal character so that key elements of the SCAT database are in place at the time of an incident (Figure 2.5). This data can be integrated with a GIS digitized shoreline layer so that maps with the segment boundaries and other shoreline features can be generated to support field surveys (Lamarche *et al*., 2003). Refer to Case Studies (Section 2.3) for examples of where the SCAT approach has provided direct input for regional-scale spill response planning and shoreline sensitivity mapping.

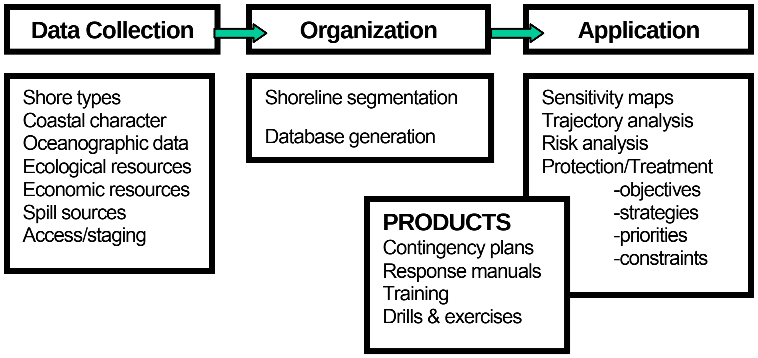

Figure 2.5 Components Of Pre-Spill Mapping And Planning.

2.2.2 SOS Forms for Different Environments

The Arctic Shoreline Oiling Summary (ASOS) Form is presented in Section 1.5. It is generic in nature and applicable for the description of oiling conditions on many shoreline types and habitats in the Arctic or during winter months in cold climates. Some oil spill environments, however, have specific characteristics that do require modifications to the basic form. The following material highlights adaptations to the ASOS Form that may be applied to tar ball oiling conditions and several specific environments.

The format of the Tar Ball Shoreline Oiling Form (see winter version Form 2.1) was developed during the *New Carissa* response SCAT survey in 1999 (see Section 2.3). The standard SOS descriptions of oiling conditions were not sensitive to the very light oiling conditions that typify small amounts of widely scattered tar balls. The oiling conditions recorded in Box 6 on this form treat the shore zone in terms of areas rather than across-shore zones.

The Winter Wetland and the Winter Tidal Flat Oiling Summary Forms (Form 2.2 and 2.3) are identical to the standard Wetland and Tidal Flat forms (Owens and Sergy, 2000) with the addition of boxes to describe Snow and Ice Conditions.

The Winter Riverbank Oiling Summary Form (Form 2.4) and the Winter Stream Bank Oiling Summary Form (Form 2.5) are identical to the Rivers, Streams, and Creeks forms as described in Section 2.2.2 of Owens and Sergy (2000) with the addition of Boxes 4B and 4C to document Snow and Ice Conditions. A "Short" Riverbank Oiling Summary Form for first responders is provided in Part 4.

A primary aspect of surveys of a river or stream is the requirement to distinguish between the two banks. For ***large rivers***, a team surveys only one bank at a time and the observations are recorded on the Winter Riverbank Oiling Summary Form. Typically segments, or reaches, would be generated and described in a downstream direction, as this is the same as the direction of oil movement. The segment numbers might have an "L-" or "R-" prefix to indicate that the segment is on the left or right bank (facing downstream). For ***small rivers, streams, or creeks,*** where both channels of a segment (or reach) are surveyed by a single team, it is appropriate to record information for each stream bank side-by-side on the same form (a Winter Stream Bank Oiling Shoreline Form). Complete Boxes 1 through 5 and then describe the Left Bank Surface Oiling Conditions (Box 6-L) followed by the Right Bank (Box 6-R).

Terminology that is specific to the Riverbank and the Small Rivers, Streams, and Creeks Oiling Summary Forms is as follows:

BOX 4A: RIVERBANK TYPE or STREAM BANK TYPE

- **Vegetated** — equivalent to Great Lakes shore type definition (see Environment Canada, 1996b).

BOX 4D: RIVER or STREAM VALLEY CHARACTER

- **Braided Channel** — the channel splits into many smaller interlaced channels with multiple bars and shoals
- **Anastomosed Channel** (or *anabranched channel*) — a channel that has split into two or more well-defined channels that re-converge downstream.

BOX 4E: RIVER or STREAM CHANNEL CHARACTER

- **Est. Width** and **Est. Water Depth** both relate to the water in the channel.

BOXES 6 AND 7

The River Stream Bank Zone definitions are:

MS ***Mid-Stream*** — shoal(s) or bar(s) exposed in the channel and separated from the riverbank (a ***Point Bar*** is attached to the riverbank)

LB ***Lower Bank*** — exposed only during low flow conditions

UB ***Upper Bank*** — under water only during full river stage

OB ***Overbank*** — floodplain – inundated only during flood conditions

The Winter Lake Shoreline Oiling Summary Form (Form 2.6) is identical to the Large Freshwater Lakes Form as described in Section 2.2.2 of Owens and Sergy (2000) with the addition of Boxes 4B and 4C to document Snow and Ice Conditions. The following across-shore definitions are used for lakes:

LSZ ***Lower Swash Zone*** — the area between the mean annual water level and the lowest annual water level, the lower approximate one half of the zone of wave activity.

USZ ***Upper Swash Zone*** — the area between the highest annual water level and the mean annual water level, the upper approximate one half of the zone of wave activity.

SSZ ***Supra-Swash Zone*** — the area above the highest annual water level that only occasionally experiences wave activity, as during a storm event.

Form 2.1 Winter Tar Ball Summary (WTB) Form

WINTER TAR BALL SUMMARY (WTBS) FORM for ____________________ Spill Page _____ of _____

1 GENERAL INFORMATION Segment ID: Operations Division:	Date (dd/mm/yy)	Time (24h): standard/daylight hrs to hrs	Tide Height rising / falling
Survey by: Foot / ATV / Boat / Helicopter / Overlook / __	Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg C.		

2 SURVEY TEAM # ____ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment Length*** _______________ ***Segment Length Surveyed*** _______________ ***m***

Start GPS: LATITUDE ______ deg. ______ min. LONGITUDE ______ deg. ______ min.

End GPS: LATITUDE ______ deg. ______ min. LONGITUDE ______ deg. ______ min.

Differential GPS Yes / No

4A SHORELINE TYPE ***select only one primary (P) oiled shoreline type and any number of secondary (S) types***

BEDROCK : ____ ***MAN-MADE SOLID :*** ____	***SEDIMENT BEACH :*** Sand ___	***SEDIMENT FLAT:*** Mud Flats ___	
cliff/vertical ___ sloping ___ platform ___	Pebble-Cobble ___ Boulder ___	Sand Flats ___ Sand-Gravel ___	
	Mixed Sd-Gravel ___ ***MARSH*** ___	Peb-Cob ___ Boulder ___	

4B SNOW/ICE CONDITIONS ***circle all tidal zone locations as necessary - Lower : Middle : Upper : Supratidal***

snow: cover ________%	**frozen spray:** width ________m	**ice foot:** width ________m
thickness _______cm	thickness _______cm	thickness _______cm
fresh Y / N		location L M U S
compacted Y / N		**ice push ridge:** width _______m
location L M U S	**frozen swash:** width ________m	thickness ______cm
	thickness _______cm	location L M U S
	location L M U S	**grounded floes:** ave. length _______m
		ave. thickness ______cm
		location L M U S

4C NEARSHORE ICE CONDITONS

CONCENTRATION:	0/10	***FORM: (m)*** pancake	0.3 -3	***AGE:***	*thickness (cm)*
open	< 1/10	brash	< 2	new = frazil-grease-slush	
very open drift	1/10 - 3/10	ice cakes	< 20	nilas or ice rind	< 10
open drift	4/10 - 6/10	small floes	20-100	young: grey-white	10-30
close pack	7/10 - 8/10	medium floe	100-500	first year	> 30
very close pack	9/10	big floe	500-2000	second year	> 250
compact ice	10/10	vast-giant floe	> 2000	multi year	> 300
		fast ice	Y / N	unknown	Y
TIDAL CRACKS:	Y / N				

4D COASTAL CHARACTER ***backshore character - select one primary (P) and any number of secondary (S) types***

Cliff or Hill: ____ : est. height _______ m	Beach ___ Dune ___ Delta _____ Tidal inlet ____ Marsh/Wetland _____
slope: gentle (<5 deg)___ medium __ steep (>30	Barrier beach _____ Channel ____ other ________

5 OPERATIONAL FEATURES		
		debris Y / N oiled? Y debris amount: _____ bags OR _____ trucks
direct backshore access	Y / N	suitable backshore staging Y / N
alongshore access from next segment	Y / N	access restrictions ______________________

6 TAR BALL CONDITIONS	***AREA 1***	***AREA 2***	***AREA 3***
Tar Balls Observed ? **Oiled Debris Observed ?**	YES ? NO ? YES ? NO ?	YES ? NO ? YES ? NO ?	YES ? NO ? YES ? NO ?
Tidal Zone (LI - MI - UI - SU)			
Length (m) Approximate alongshore length of of shore in segment in which tarballs/oiled debris are observed			
Width (m) Across-shore width of the band on the shore in which tarballs/oiled debris are observed			
Average Number of Tar Balls Within Area (e.g. 2 per sq.m. within band; 3 per 100 m alongshore; 6 total within area, etc..) Be Specific			
Average Size of Tar Balls (cm)			
Size of Largest Tar Ball (cm)			
Type of Tar Balls	Weathered ? Sticky ?	Weathered ? Sticky ?	Weathered ? Sticky ?
Tar Balls Collected ?	YES ? NO ?	YES ? NO ?	YES ? NO ?

7 COMMENTS ***cleanup recommendations - ecological/recreational/cultural/economic issues & constraints - wildlife observations***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # ____ Frames______) **Video Tape** Yes/No (tape #_____) ver. 01/04

Form 2.2 Winter Wetland Oiling Summary (WWOS) Form

WINTER WETLAND OILING SUMMARY (WWOS) FORM for ______________ Spill Page _____of _____

1 GENERAL INFORMATION	Date (dd/mm/yy)	Time (24h): standard/daylight	Tide Height
Segment ID:			
Operations Division:		hrs to hrs	rising / falling

Survey by: Foot / ATV / Boat / Helicopter / Overlook / ____ Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg C.

2 SURVEY TEAM # ___ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment Length*** ______________ ***m*** ***Segment Length Surveyed*** ______________ ***m***

Start GPS: LATITUDE ___________deg. ___________min. LONGITUDE ___________deg. ___________min.

End GPS: LATITUDE ___________deg. ___________min. LONGITUDE ___________deg. ___________min.

Differential GPS Yes / No

4A WETLAND TYPE ***select only one primary (P) oiled wetland type and any number of secondary (S) types***

Saltwater Marsh	______	Forest or Woodland	______	Low-Lying Tundra	___________
Brackish Marsh	______	Freshwater Swamp	______		
Freshwater Marsh	______	Other	__________________________		

4B VEGETATION CHARACTER

Dominant Vegetation Type(s):

4C SNOW/ICE CONDITIONS ***circle all tidal zone locations as necessary - Lower : Middle : Upper : Supratidal***

snow:	cover	_______%	**frozen spray:**	width	_______m	**ice foot:**	width	_______m
	thickness	_______cm		thickness	______cm		thickness	_______cm
	fresh	Y / N					location	L M U S
	compacted	Y / N				**ice push ridge:**	width	______m
	location	L M U S	**frozen swash:**	width	_______m		thickness	______cm
				thickness	______cm		location	L M U S
				location	L M U S	**grounded floes:**	ave. length	______m
							ave. thickness	_____cm
							location	L M U S

4D NEARSHORE ICE CONDITONS

CONCENTRATION:	0/10	***FORM: (m)*** pancake	0.3 -3	***AGE:***	*thickness (cm)*
open	< 1/10	brash	< 2	new = frazil-grease-slush	
very open drift	1/10 - 3/10	ice cakes	< 20	nilas or ice rind	< 10
open drift	4/10 - 6/10	small floes	20-100	young: grey-white	10-30
close pack	7/10 - 8/10	medium floe	100-500	first year	> 30
very close pack	9/10	big floe	500-2000	second year	> 250
compact ice	10/10	vast-giant floe	> 2000	multi year	> 300
		fast ice	Y / N	age unknown	Y
TIDAL CRACKS:	Y / N				

5 OPERATIONAL FEATURES

		suitable backshore or alongshore staging	Y/N
direct backshore access	Y / N	access restrictions	Y/N
alongshore access from next segment	Y / N	(note access constraints below in COMMENTS)	

surface bearing capacity suitable for: personnel / marsh vehicles / other : ____________________ (circle only those applicable)

6 SURFACE OILING CONDITIONS

Enter oil on Substrate versus Vegetation on different lines, using (S) or (V) after the Zone ID (e.g., "A S" for sediment, "A V" for Vegetation). Indicate the position of each ZONE on the cross-section below.

OIL ZONE ID	TIDAL ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								OILED PLANT PARTS
					Length	*Width*	*Distrib.*														
	LI	MI	UI	SU	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	TP	TC	SR	AP	**NO**	All B T S L F *

7 SUBSURFACE OILING CONDITIONS Is Subsurface Oil Present ? **Y / N**

If "Y", describe in Comments Section (Box 8) and indicate location on cross-section

* Base, Trunk, Stem Leaf, Flower

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

Approx. TOTAL OILED Area

_______________hectares

CROSS-SECTION SKETCH

show: high tide level (HT)
low tide level (LT)
surface oil
subsurface oil
key vegetation zones
scale

supratidal zone | intertidal zone

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # ______ Frames_______) **Video Tape** Yes/No (tape #_____) ver.01/04

Form 2.3 Winter Tidal Flat Oiling Summary (WTFOS) Form

WINTER TIDAL FLAT OILING SUMMARY (WTFOS) FORM — for ____________ Spill Page _____ of _____

1 GENERAL INFORMATION | Date (dd/mm/yy) | Time (24h): standard/daylight ___ hrs to ___ hrs | Tide Height rising / falling

Segment ID:

Operations Division:

Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________ | Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg

2 SURVEY TEAM # ______ | ***name*** | ***organization*** | ***contact phone number***

3 SEGMENT ***Total Segment Length*** __________________ ***m*** ***Segment Length Surveyed*** ___________________ ***m***

Start GPS: LATITUDE _____________ deg. _____________ min. LONGITUDE ___________ deg. _____________ min.

End GPS: LATITUDE _____________ deg. _____________ min. LONGITUDE ___________ deg. _____________ min.

Differential GPS Yes / No

4A TIDAL FLAT TYPE ***select only one primary (P) oiled tidal flat type and any number of secondary (S) types***

Mud _______ Pebble-Cobble _______ Sand Waves Y / N

Sand _______ Boulder _______ Incised Channels Y / N

Sand-Gravel _______ Boulder Barricade Y / N

4B SNOW/ICE CONDITIONS ***circle all tidal zone locations as necessary - Lower : Middle : Upper : Supratidal***

snow: cover _______% thickness _______cm fresh Y / N compacted Y / N location L M U S

frozen spray: width ________m thickness _______cm

frozen swash: width ________m thickness _______cm location L M U S

ice foot: width ________m thickness _______cm location L M U S

ice push ridge: width _______m thickness ______cm location L M U S

grounded floes: ave. length _______m ave. thickness ______cm location L M U S

4C NEARSHORE ICE CONDITONS

CONCENTRATION: 0/10
open < 1/10
very open drift 1/10 - 3/10
open drift 4/10 - 6/10
close pack 7/10 - 8/10
very close pack 9/10
compact ice 10/10

TIDAL CRACKS: Y / N

FORM: (m) pancake 0.3 -3
brash < 2
ice cakes < 20
small floes 20-100
medium floe 100-500
big floe 500-2000
vast-giant floe > 2000
fast ice Y / N

AGE: *thickness (cm)*
new = frazil-grease-slush
nilas or ice rind < 10
young: grey-white 10-30
first year > 30
second year > 250
multi year > 300
age unknown Y

4D COASTAL CHARACTER ***backshore character - select only one primary (P) and any number of secondary (S) type***

Cliff or Hill: ____ : est. height _______ m
slope: gentle (<5 deg)__ medium__ steep (>30 deg)___

Beach ___ Delta___ Tidal inlet ___ Marsh/Wetland ___
Barrier beach ___ Dune___ Channel ___ other _____________

5 OPERATIONAL FEATURES

direct backshore access Y / N
alongshore access from next segment Y / N
suitable backshore or alongshore staging Y/N
access restrictions Y/N
(note access constraints below in COMMENTS)
surface bearing capacity suitable for: personnel / vehicles / other___________________________ (circle only those applicable)

6 SURFACE OILING CONDITIONS ***begin with "A" in the lowest tidal zone***

OIL ZONE ID	**TIDAL ZONE**				**OIL COVER**			**OIL THICKNESS**					**OIL CHARACTER**								**SEDS.**	
					Length	*Width*	*Distrib.*														WET	DRY
	LI	MI	UI	SU	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	TP	TC	SR	AP	**NO**		

7 SUBSURFACE OILING CONDITIONS IS SUBSURFACEOIL PRESENT ? **Y / N**

If "Y", describe in Comments Section (Box 8) and indicate location on cross-section

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

Approx. TOTAL OILED Area

_______________hectares

CROSS-SECTION SKETCH

show: high tide level (HT)
low tide level (LT)
surface oil
subsurface oil
key zones
scale

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # ________ Frames_______) **Video Tape** Yes/No (tape #_____) ver. 01/04

Form 2.4 Winter Riverbank Oiling Summary (WRBOS) Form

WINTER RIVER BANK OILING SUMMARY (WRBOS) FORM for ______________________ Spill Page _____of _____

1 GENERAL INFORMATION | Date (dd/mm/yy) | Time (24h): standard/daylight | **Water Level**

Segment/Reach ID: **L or R** | | | low - mean - bankfull - overbank

Operations Division: | | hrs to hrs | falling- steday-rising

Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________ | Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg C.

2 SURVEY TEAM # ______ *name* *organization* *contact phone number*

name	organization	contact phone number

3 SEGMENT ***Total Segment/Reach Length _______________ m*** ***Segment/Reach Length Surveyed ______________ m***

Start GPS: LATITUDE __________ deg. __________ min. LONGITUDE __________ deg. __________ min.

End GPS: LATITUDE __________ deg. __________ min. LONGITUDE __________ deg. __________ min.

Differential GPS Yes / No

4A RIVER BANK TYPE ***select only one primary (P) oiled river bank type and any number of secondary (S) types***

BEDROCK : ____ ***MAN-MADE SOLID :*** ____ ***UNCONSOLIDATED :*** Clay ___ Mud ___ Sand ___

cliff/vertical ____ sloping ____ platform ____ Mixed Sand-Gravel ___ Pebble-Cobble ___ Boulder ___ Rubble ___

Marsh/Swamp ___ Peat ___ Vegetated ___ Shell Hash ___

4B RIVER BANK SNOW and ICE CONDITIONS ***circle all bank zone locations as necessary - Lower : Upper : Overbank***

snow: cover ________% thickness ______cm fresh Y / N compacted Y / N location L U O

frozen spray: width ________m thickness____cm

frozen swash: width ________m thickness____cm location L U O

ice foot: width ________m thickness ______cm location L U O

grounded floes: ave. length _______cm ave. thickness _____cm location L U O

4C RIVER ICE CONDITIONS ***circle one in each of the three categories***

CONCENTRATION: 0/10
open drift < 1/10
very open drift 1/10 - 3/10
open drift 4/10 - 6/10
close pack 7/10 - 8/10
very close pack 9/10
compact ice 10/10

FORM: (m)
pancake 0.3 -3
brash < 2
ice cakes < 20
small floes 20-100
medium floe 100-500
big floe 500-2000
vast-giant floe > 2000
fast ice at bank Y / N

AGE and thickness (cm):
new = frazil-grease-slush
nilas or ice rind < 10
young: grey-white 10 - 30
thick 30 - 100
very thick > 100
age unknown ___

4D RIVER VALLEY CHARACTER ***select as appropriate***

CLIFF or BLUFF : ____ : est. height _______ m canyon ____ confined or leveed channel ____ flood plain valley ____

slope: gentle (<5º)___ medium ___ steep (>30º) ___ straight ____ meander ____ anastamosed ____ braided ____

4E RIVER CHANNEL CHARACTER ***circle or select as appropriate***

est. width : < 1m 1–10 m 10–100 m >1000m ______m **est. water depth :** <1 m 1-3 m 3-10 m >10 m ____ m

shoal(s) present Y / N **point bar present** Y / N **bar-shoal substrate :** silt / sand / gravel / cobble / boulder / bedrock / debris

seasonal water level: low / mean / bank full / overbank flow **est. change over next 7 days :** falling — same — rising

5 OPERATIONAL FEATURES debris Y / N oiled? Y / N debris amount: _______ bags OR ________ trucks

direct backshore access Y / N suitable backshore staging Y / N oiled trees/shrubs Y / N

alongshore access from next segment Y / N access restrictions _________________ river current strong Y / N

6 SURFACE OILING CONDITIONS ***begin with "A" in the lowest river bank zone***

OIL ZONE ID	RIVER BANK ZONE				OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
					Length	*Width*	*Distrib.*														
	MS	LB	UB	OB	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	**NO**	
A																					

7 SUBSURFACE OILING CONDITIONS ***use letter for ZONE location plus Number of pit or trench — e.g., "A1"***

TRENCH or PIT NO.	RIVER BANK ZONE				MAX. PIT DEPTH	OILED ZONE	SUBSURFACE OIL CHARACTER							WATER or FROST TABLE (cm)	SHEEN COLOUR	CLEAN BELOW	SUBST. TYPE(S)
	MS	LB	UB	OB	cm	cm-cm	SAP	OP	PP	OR	OF	TR	**NO**		B, R, S, N	Yes / No	

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # _________ Frames_______) **Video Tape** Yes/No (tape #____) ver. 01/04

Form 2.5 Winter Stream Bank Oiling Summary (WSBOS) Form

WINTER STREAM BANK OILING SUMMARY (WSBOS) FORM for ____________________ Spill Page ____of ____

1 GENERAL INFORMATION | Date (dd/mm/yy) | Time (24h): standard/daylight ____ hrs to ____ hrs | **Water Level** low — mean — bankfull — overbank; falling — steady — rising

Segment or Reach ID:

Operations Division:

Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________ | Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ____ deg C.

2 SURVEY TEAM # ______ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment/Reach Length*** ______________ ***Segment/Reach Length Surveyed*** ________________ ***m***

Start GPS: LATITUDE ___________deg. ____________min. LONGITUDE ___________deg. ___________min.

End GPS: LATITUDE ___________deg. ____________min. LONGITUDE ___________deg. ___________min.

Differential GPS Yes / No

4A STREAM BANK TYPE ***select only one primary (P) oiled stream bank type and any number of secondary (S) types if banks are different, then indicate by P-L and P-R, then S-R and S-L etc.***

BEDROCK : ____ ***MAN-MADE SOLID :*** ____ ***UNCONSOLIDATED :*** Clay ___ Mud ___ Sand ___

cliff/vertical ____ sloping ____ platform ____ Mixed Sand-Gravel ___ Pebble-Cobble ___ Boulder ___ Rubble ___

Marsh/Swamp ___ Peat ___ Vegetated ___ Shell Hash ___

4B STREAM BANK SNOW/ICE CONDITIONS ***circle all stream bank zone locations as necessary - Lower : Upper : Overbank***

snow: cover _______% ; thickness _______cm ; fresh Y / N ; compacted Y / N ; location L U O

frozen spray: width ________m ; thickness _______cm

frozen swash: width ________m ; thickness _______cm ; location L U O

ice foot: width ________m ; thickness _______cm ; location L U O

grounded floes: ave. length _______m ; ave. thickness ______cm ; location L U O

4C STREAM ICE CONDITIONS

CONCENTRATION: 0/10

- open drift < 1/10
- very open drift 1/10 - 3/10
- open drift 4/10 - 6/10
- close pack 7/10 - 8/10
- very close pack 9/10
- compact ice 10/10

FORM: (m)

- pancake 0.3 -3
- brash < 2
- ice cakes < 20
- small floes 20-100
- medium floe 100-500
- big floe 500-2000
- vast-giant floe > 2000
- **fast ice** Y / N

AGE and thickness (cm):

- new = frazil-grease-slush
- nilas or ice rind < 10
- young: grey-white 10 - 30
- thick 30 - 100
- very thick > 100
- age unknown ___

4D STREAM VALLEY CHARACTER ***select as appropriate — indicate Left (L) or Right (R) bank if appropriate***

CLIFF or BLUFF : ____ : est. height _______ m ; slope: gentle (<5 deg)___ medium___ steep (>30 deg

canyon ___ confined or leveed channel ___ flood plain valley ___

straight ___ meander ___ anastamosed ___ braided ___

4E STREAM CHANNEL CHARACTER ***circle or select as appropriate***

est. width : <1 m 1–10 m >10m _______ m **est. water depth :** <1 m 1–3 m >3m ____ m

shoal(s) present Y / N **point bar present** Y / N **bar-shoal substrate :** silt / sand / gravel / cobble / boulder / bedrock / debris

channel form: cascade ___ rapids ___ pool ___ riffle ___ glide ___ jam ___ other ____________________

5 OPERATIONAL FEATURES debris Y / N oiled? Y / N debris amount: _______ bags OR ________ trucks

direct backshore access Y / N ; suitable backshore staging Y / N ; oiled trees/shrubs Y / N

down- or up-stream access from next segmen Y / N ; access restrictions _____________ ; rapid current Y / N

6-L LEFT BANK SURFACE OILING CONDITIONS ***begin with "L-A" in the lowest left stream bank zone***

OIL ZONE ID	**STREAM BANK ZONE**				**OIL COVER**			**OIL THICKNESS**					**OIL CHARACTER**								**SUBST. TYPE(S)**
					Length	*Width*	*Distrib.*														
	MS	LB	UB	OB	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	**NO**	
L - A																					

6-R RIGHT BANK SURFACE OILING CONDITIONS ***begin with "R-A" in the lowest right stream bank zone***

OIL ZONE ID	**STREAM BANK ZONE**				**OIL COVER**			**OIL THICKNESS**					**OIL CHARACTER**								**SUBST. TYPE(S)**
					Length	*Width*	*Distrib.*														
	MS	LB	UB	OB	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	**NO**	
R - A																					

7 SUBSURFACE OILING CONDITIONS ***use letter for ZONE location plus Number of pit or trench — e.g., "L - A1"***

TRENCH or PIT NO.	**STREAM BANK ZONE**				**MAX. PIT DEPTH**	**OILED ZONE**	**SUBSURFACE OIL CHARACTER**							**WATER TABLE**	**SHEEN COLOUR**	**CLEAN BELOW**	**SUBST. TYPE(S)**
	MS	LB	UB	OB	cm	cm-cm	SAP	OP	PP	OR	OF	TR	**NO**	cm	B, R, S, N	Yes / No	

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

Sketch Yes/No **Photos** Yes/No (Roll # ________ Frames_______) **Video Tape** Yes/No (tape #_____) ver. 01/04

Form 2.6 Winter Lake Shoreline Oiling Summary (WLSOS) Form

WINTER LAKE SHORELINE OILING SUMMARY (WLSOS) for ____________________ Spill Page _____of _____

1 GENERAL INFORMATION | Date (dd/mm/yy) | Time (24h): standard/daylight | Water Level

Segment ID: | above/below ?

Operations Division: | hrs to hr | ***the monthly mean***

Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________ | Sun / Clouds / Fog / Rain / Snow / Windy / Calm | rising / falling

2 SURVEY TEAM # ______ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment Length _________m*** ***Segment Length Surveyed __________m***

Start GPS: LATITUDE _______deg. _______min. LONGITUDE _______deg. _______min.

End GPS: LATITUDE _______deg. _______min. LONGITUDE _______deg. _______min. ***Differential GPS Yes / No***

4A SHORELINE TYPE (USZ) ***select only one primary (P) oiled shoreline type and any number of secondary (S) types***

BEDROCK : Cliff ______ Shelving ______ | Sand Beach ____ | Cobble ____ | Sand/Barrier Lagoon ____

Exposed Sediment Bluff : ______ | Pebble Beach _____ | Boulder _____ | Delta mud Flat _____

Manmade : Impermeable _______ | Pebble-Cobble _____ | Fringe Wetland _____ | Manmade Permeable _____

Tundra : ______ | Mixed Sand-Gravel _____ | Broad Wetland _____ | Low Vegetated Bank _____

4B SNOW and ICE CONDITIONS ***circle all swash zone locations as necessary — Lower : Middle : Upper : Supraswash***

snow: cover ________% ; thickness _______cm ; fresh Y / N ; compacted Y / N ; location L M U S

frozen spray : width ______________m ; thickness __________cm

frozen swash : width ______________m ; thickness __________cm ; location L M U S

grounded floes : ave. length __________m ; ave. thickness ______cm ; location L M U S

ice foot : width ___________m ; thickness ______cm ; location L M U S

ice push ridge : width ___________m ; thickness ______cm ; location L M U S

4C NEARSHORE ICE CONDITONS ***circle one in each of the three categories***

CONCENTRATION: 0/10
- open drift < 1/10
- very open drift 1/10 – 3/10
- open drift 4/10 – 6/10
- close pack 7/10 – 8/10
- very close pack 9/10
- compact ice 10/10

FORM: (m)
- pancake 0.3 -3
- brash < 2
- ice cakes < 20
- none Y
- small floes 20–100
- medium floe 100–500
- big floe 500–2000
- vast-giant floe > 2000
- **Fast ice: Y /N**
- **Shore Zone Cracks: Y / N**

AGE and thickness (cm):
- new = frazil-grease-slush
- nilas or ice rind < 10
- young: grey-white 10–30
- first year > 30
- second year > 250
- multi year > 300
- age unknown ___

4D COASTAL CHARACTER ***backshore character — select only one primary (P) and any number of secondary (S) types***

Cliff or Bluff : < 1m 1–5m > 5m | Beach ____ | Delta ____ | Inlet ____ | Wetland ____

slope: gentle (<5º) ____ medium ____ steep (>30º) ____ | Barrier beach ____ | Dune ____ | Channel ____ | Other _______________

5 OPERATIONAL FEATURES | debris? Y / N | oiled? Y / N | debris amount: _________ bags OR _________ trucks

direct backshore access Y / N | suitable backshore staging Y / N | Depth of Active Layer: _________cm

alongshore access from next segment Y / N | access restrictions ____

6 SURFACE OILING CONDITIONS ***begin with "A" in the lowest swash zone***

OIL ZONE ID	SWASH ZONE			OIL COVER			OIL THICKNESS					OIL CHARACTER								SUBST. TYPE(S)
				Length	*Width*	*Distrib.*														
	SSZ	USZ	LSZ	m	m	%	PO	CV	CT	ST	FL	FR	MS	TB	PT	TC	SR	AP	NO	
A																				

7 SUBSURFACE OILING CONDITIONS ***use letter for ZONE location plus Number of pit or trench — e.g., "A1"***

TRENCH or PIT NO.	SWASH ZONE			MAX. PIT DEPTH	OILED ZONE	SUBSURFACE OIL CHARACTER						WATER TABLE (cm)	SHEEN COLOUR	CLEAN BELOW	SUBST. TYPE(S)
	SSZ	USZ	LSZ	cm	cm-cm	OP	PP	OR	OF	TR	NO		B, R, S, N	Yes / No	

8 COMMENTS ***cleanup recommendations — ecological/recreational/cultural/economic issues & constraints — wildlife obs.***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes / No **Photos** Yes / No (Roll # _______ Frames_______) **Video Tape** Yes / No (tape #_______) ver. 01/04

2.2.3 Other SCAT Shoreline Forms

The Environment Canada SCAT Manual (1992) and the first edition of this Field Guide (Owens and Sergy, 1994) included a series of forms used to document shoreline ecology (SES), human use (HUS), and cultural resources (CRE) (e.g., Mobley *et al*., 1990). In practice, these forms have not been used on spills since the *Exxon Valdez* SCAT survey programme and are not included in this Second Edition. These forms were developed initially because of the requirement to document these types of information on a specific spill response. It is advisable to include the information defined in Boxes 1 and 2 of the SOS forms if similar types of forms are appropriate and developed to support an assessment survey,

A variety of standard forms can be developed to assist in the organization and documentation of the SCAT activities including

- daily team report forms
- daily segment treatment recommendations
- document tracking forms
- photograph logs
- video logs

2.2.4 SCAT Surveys for Nearshore Submerged Oil

A SCAT team may be requested to provide recommendations for locating or tracking oil that has submerged or sunk in nearshore shallow waters, thus posing a threat to the adjacent shorelines. Oil that is denser than the nearshore water can sink and collect in low areas, such as the troughs that are a common feature of nearshore bar systems on open coasts (Michel *et al.*, 1995).

Survey methods for sunken oil include (Castle *et al*., 1995)

- visual inspection from aircraft or boats
- visual observations by divers along predefined transects
- sampling by dropping sorbents attached to a weighted line

More sophisticated techniques, primarily for deeper waters, could involve the use of remote-operated vehicles with video cameras.

The purpose of this type of nearshore survey is the same as for an onshore survey and would involve the following:

- identification of oiled and non-oiled areas
- description of the location, character, and amount of submerged or sunken oil
- evaluation of the operational options and logistical factors
- establishment of recovery or treatment priorities
- establishment of recovery or treatment standards or criteria
- recommendation of recovery or treatment methods

2.2.5 SCAT Surveys for Oil in Snow or Under Ice

If oil is known or thought to be present within snow or ice, the only detection methods are digging (snow) or drilling (ice). Low-altitude aerial surveys may locate the oil if it is near the surface, but ground surveys are required to delineate the exact geographic extent and the depth and thickness of the oil. Attempts to develop other more technologically advanced systems have not been successful (Dickins, 2002).

Oil under ice cannot be detected except by drilling, for example with a 5-cm ice auger or by direct diver observations. Underwater lights can be used through drilled holes to provide a light source that may enable detection of oil within or under the ice (ACS, 1999).

A typical search pattern would begin at a known location with oil and follow a straight line in one direction until no further oil is encountered. The line could then next be extended in the opposite direction followed by a perpendicular line to define the lateral extent of the oiling. The layout of additional lines would depend on the shape of the oil body, but a coarse grid followed by a finer grid pattern may be the most efficient approach.

2.2.6 Computer Technology Applications

The traditional field methods for a SCAT survey involve the use of paper forms and notebooks. Technology applications that have been developed to support these field activities include:

- electronic SCAT forms (Simecek-Beatty and Lehr, 1996; Owens and Sergy, 2003a)
- wireless links (radios and cellular phones) (Rubec *et al*., 1996 and 1998)
- laptop, Personal Digital Assistant, or hand-held field computers with GPS positioning and/or satellite communications links
- laser range-finders to quickly measure accurate distances
- hand-held (non-differential) Global Positioning Systems (GPS) integrated with field computers to provide location information for segment boundaries or specific features
- video cameras or digital cameras that provide a method of immediate capture and replay (video systems can replay directly onto a lap-top or large computer without the requirement for a television monitor)

Data management and information displays can benefit from many off-the-shelf computer applications as well as custom-designed spill management tools (e.g., Lamarche *et al*., 1998: Williams *et al*., 1997). The most important computer applications involve

- entry of data into electronic files or a database
- data summary generators
- report generators
- GIS maps

2.3 CASE STUDIES

Case studies provide a means of describing the application of SCAT principles to a range of different spill situations. Additional examples to those briefly described below can be found referenced in Owens, 1999.

Table 2.2 Case Studies

Nestucca British Columbia 1989	Two teams with representatives from government agencies and a First Nations tribal council assessed 500 km of affected coasts by helicopter with spot ground inspections; the same teams conducted the post-treatment inspections
Exxon Valdez Alaska 1989-1993	Initial aerial video mapping survey that covered 8000 km of affected coasts, systematic ground surveys (1989), spot ground surveys (1990-1993), and a long-term monitoring programme
Arrow Nova Scotia 1992	Post spill systematic ground survey to define locations and amounts of oil remaining 22 years after the incident
St. Petersburg Florida 1993	A systematic survey of 20 km of sand beaches that involved the delineation of buried oil layers, the assessment of cleanup options, and the development of cleanup recommendations
Komi Pipeline Russia 1995-1996	Adaptation of the SCAT concept for rivers and streams
Buffalo 292 Texas 1996	Two-phase SCAT survey: initial systematic ground survey followed by tar ball survey in remote areas
New Carissa Oregon 1999-2000	Two-phase SCAT survey: initial systematic ground survey followed by tar ball monitoring over a 12-month period
OSSA 2 Pipeline Bolivia 2000	Two-phase aerial video surveys: initially to locate and map surface oil for cleanup in a river flood-plain region, followed by post-cleanup documentation surveys
Pre-Spill Mapping	SCAT and coastal mapping surveys conducted prior to spill events and organized in GIS systems (spill preparedness)

The *Nestucca* Spill Response — British Columbia, 1989

Oil became stranded over a 3-week period along 500 km of the coast of western Vancouver Island. Initial information on the distribution and degree of shoreline oiling in this remote and largely inaccessible region was often incomplete and sketchy. An interagency shoreline evaluation team (SET) that involved a representative from the government, the responsible party, and the local First Nation tribal council was created to locate oil, evaluate the degree of oiling, and recommend appropriate cleanup methods. Standard reporting forms and oil cover definitions were introduced to provide a consistent information base from which response decisions could be developed (Owens, 1990). This 3-week survey involved two 3-person helicopter-supported field teams, and the same SET teams conducted the post-treatment inspections.

The *Exxon Valdez* Spill Shoreline Assessments — Alaska, 1989–1993

Following the spill from the *Exxon Valdez*, the initial spring 1989 SCAT survey covered approximately 1500 km of coast in Prince William Sound and over 4000 km of coastline in the Gulf of Alaska (Owens and Teal, 1990). The affected areas were divided into 549 and 600 segments respectively. The difference in average segment length (2.7 km versus 6.5 km) reflects the different oiling conditions and the subsequent change in scale between the two regions. An initial low-altitude, video mapping survey provided information on the shoreline locations where oil had washed ashore. As the oil moved farther away from the initial spill site, this aerial assessment became a key element and provided a focus for the ground survey teams that followed. The aerial mapping teams surveyed over 8,000 km of coast. The 1989 systematic ground survey used teams comprised of a geologist, an ecologist, and an archaeologist. The subsequent 1990, 1991, and 1992 surveys visited segments in which oil remained after the 1989 cleanup programme and after the natural cleaning by winter wave action. SCAT teams on these surveys included agency, operations, and land manager representatives in addition to a geologist and ecologist (Neff *et al.*, 1995). The information base was shared and used by (i) all decision-makers to develop a regional strategy, (ii) the planning team to develop the response strategy, (iii) the logistics team to develop support plans, and (vi) operations to implement the shoreline treatment programme.

A site-monitoring programme was initiated early in the response and data were collected from a wide range of shoreline types with different degrees of oiling to provide a detailed picture of the changing shoreline conditions. Geologists and ecologists monitored a total of 28 multi-transect sites throughout the area on a regular basis from the spring of 1989 to the fall of 1990. The methodology and results have been described by Owens (1991).

The *Arrow* Post-Spill Survey — Nova Scotia, 1992

The tanker *Arrow* grounded in Chedabucto Bay, Nova Scotia in February 1970 and spilled nearly 72,000 bbl of Bunker C. A survey was carried out in the summer of 1992 to assess the presence and character of any residual oil from the spill (Owens *et al.*, 1993). The 305 km of originally oiled coastline was subdivided into 505 segments, of which 419 segments (248 km) were surveyed by foot. The standard SOS form was used, and the only data collected related to the physical shoreline character and, where present, the observed oiling conditions. The lengths of the segments varied between 75 m and 4.4 km, but 70% of the segments were in the range >300 m and <1000 m.

The total length of shoreline on which oil or oiled sediments were observed was 13,300 m, or 5.37% of the total surveyed shoreline. Of this total, 868 m (6.5% of the total oiled shoreline length) had a HEAVY cover (based on width and distribution parameters) and 77% was described as having either a LIGHT or VERY LIGHT cover. The difference between the total length of oiled shoreline and the length of shoreline with heavy versus light degrees of oiling illustrates the point that the total length of oiled shoreline alone is a poor measure of the actual oiling conditions.

The St. Petersburg Beach Spill Response — Florida, 1993

A spill from a barge/freighter collision at the entrance to Tampa Bay resulted in the oiling of approximately 20 km of ocean shore in the St. Petersburg Beach area. Shortly after the oil was stranded on the beach berm, it was buried by the deposition of a layer of clean sand during a high tide. The assessment process to document the location and amount of surface and subsurface oil was relatively simple. Surface observations were made and pits dug to locate and describe subsurface oil on 92 across-shore transects, spaced 0.1 mile apart, along three sand beaches, which were separated by tidal inlets. Areas of buried oil were marked by surveyor's flagging to assist cleanup crews in the removal of this subsurface oil (similar segmentation and flagging techniques were used on the *Buffalo 292* spill response described below).

The results showed that no surface oil remained on the Madeira Beach section but that subsurface oil was present on 19 of the 24 transects (Owens *et al.*, 1995). The average width of the buried subsurface oil layer was 2.9 m, the average depth 23 cm, and the average thickness of the buried oil layer was 1.3 cm. At four of the transects the oiling was observed to be in the high concentration OP category (see Section 3.1.2). By contrast, on the St. Petersburg Beach section, OP was observed on 10 of the 25 transects but the average depth of the oil was less (12 cm). This data set was used to assess the treatment options and to calculate (1) the resources that would be required, (2) the time to completion, and (3) the volume of material to be removed from each of the three beaches, and disposed of if manual or mechanical cleanup (graders and front-end loaders) methods were used.

This survey, although brief in time and limited in scale and scope, involved the two fundamental elements of the shoreline assessment process: the use of standard terms and definitions and the systematic approach to data collection. This information was a key element in the decision-making process that eventually recommended the mechanical removal of the buried oil layer.

The Komi Pipeline Spills — Russia, 1995–1996

During the autumn of 1994, a combined total of more than one million barrels of crude oil was spilled from the Vosey-Usinsk pipeline in the Russian sub-Arctic Komi Republic. As part of the cleanup operations, the SCAT approach was applied to over 50 km of stream and riverbanks (Sienkiewicz and Owens, 1996). Operational units on the order of 2 to 4 km in length were relatively uniform in physical character and subdivided into segments that were marked by stakes at intervals of approximately 200 m. The segment boundaries were located on 1-inch to 25-m scale maps developed from satellite imagery captured in May 1995. Local scientists were trained in the methodology; standard terminology was developed and translated; and the English and Russian versions of the form were identical in layout so that they could be completed in either language. Pre-treatment and post-treatment surveys were carried out and the information was entered into a database to produce computer maps and graphic displays of both cleanup progress and post-treatment oiling conditions.

The *Buffalo* 292 Spill Response — Texas, 1996

The spill of approximately 3,000 bbl of intermediate fuel oil (IFO 380) from the barge *Buffalo 292* in March 1996 oiled the Galveston Island and Bolivar Peninsula coasts of Texas. The SCAT surveys carried out during this response operation demonstrate the flexibility of the process and also the value of an available pool of pre-trained field personnel (Martin *et al.*, 1997).

The initial shoreline assessment phase, which lasted for the first twelve days after the incident, involved systematic surveys in which segments were revisited every second day as oil continued to wash ashore. Surveyor's flags marked buried oil so that these could be easily found and removed by the cleanup crews.

As the oil began to move along the coast, the scale of operations extended to more than 250 km from the original release point. On these distant shorelines the oil stranded as tar balls and the oiling conditions typically were "trace" (less than 1%) to "sporadic" (1-10%), and were in a band 0.3-m to 3.0-m wide at irregular intervals along the coast. The systematic surveys were no longer appropriate and a second-phase approach was developed in which the segments were redefined at one-mile intervals and the oil condition information was transmitted from the field teams by cellular phone so that they did not have to return to base each day after the survey.

The *New Carissa* Spill Response — Oregon, 1999-2000

The woodchip carrier *M/V New Carissa* ran aground near Coos Bay, Oregon in February 1999 spilling ~1,700 bbl of IFO 280 and marine diesel oil. The initial field methods used for shoreline assessment after the spill followed standard SCAT reporting procedures. Within a few days, the amount of oil on the shoreline diminished significantly and the standard method proved to be too insensitive, so a Beach Assessment Reporting form was developed to provide an appropriate method for recording the frequency and character of stranded tar balls. This form is the basis for the Winter Tar Ball Oiling Summary Form in this Field Guide (Form 2.1).

Shoreline surveys were continued for more than 12 months and the results presented as weekly oil distribution maps for the duration of the cleanup operations (March to September) and as tables and histograms of the daily (1) frequency (number of tar balls/m^2), (2) volume (gallons), and (3) "normalized tar ball concentration per unit area" (gm/m^2) of tar balls (Owens *et al.*, 2000). Large oiling or re-oiling events often masked smaller changes in oil conditions on the shoreline; this problem was resolved by plotting the daily values on semi-logarithmic scale histograms.

The OSSA 2 Pipeline Spill — Bolivia, 2000

Oil was spilled into the Rio Desaguadero during the high flood waters of the rainy season and spread over a distance of 250 km downstream (Owens and Henshaw, 2002). Aerial surveys were conducted for two purposes. First, low-altitude videotaping along closely spaced flight lines, with an integrated Global Positioning System, was used to locate, accurately position, and map surface oil deposits for cleanup in an extensive floodplain region that covered several hundred hectares (Owens and Reimer, 2001).

Secondly, after cleanup operations had been completed, low-altitude video surveys of the entire affected area provided documentation that the cleanup standards had been achieved.

Pre-Spill Mapping

Coastal mapping of Atlantic Canada is based on the division of approximately 34,000 km of coastline into more than 12,500 individual segments. The physical shore-zone characteristics, human-use activities, and coastal resources are part of a database that has been integrated with the Canadian National Sensitivity Mapping Programme to produce a digital environmental resource sensitivity mapping system base on GIS technology as well as hardcopy maps (Percy *et al.*, 1997). The mapping procedure also includes the definition of segment protection and cleanup objectives and strategies. Similarly, 29,000 km of the coast of British Columbia has been divided into 65,500 segments as part of a coastal mapping programme to support oil spill planning and response activities.

The SCAT approach also is the basis for the Alyeska Pipeline (SERVS) pre-spill mapping programme for the Prince William Sound in Alaska. The initial shore-zone segmentation and mapping is based on low-altitude video surveys, and the database is the foundation for the shoreline layers of the Graphical Resource Database that has been designed to support oil spill response planning and response operations (Owens *et al*., 2003a). Similar surveys, based on low-altitude videotaping, have been carried out to provide both reconnaissance- and detailed-scale shoreline mapping for Sakhalin Island, Russia, and in the Arabian Gulf (Bahrain and Qatar). A SCAT training programme in Oa'hu, Hawaii led to an interagency segmentation and mapping ground survey project conducted by representatives of local government agencies, the federal government, and industry operators in that region to provide input for area response plans (Owens, 1999).

PART 3 SUPPORT MATERIALS

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3.1 STANDARD TERMS AND DEFINITIONS

The standard terms and definitions in this section provide an explanation for completion of the SOS forms and the basis for a systematic description of the shoreline and oiling conditions. Some modification may be appropriate based on local or regional geographic conditions or the specific character of the stranded oil.

3.1.1 Surface Oiling Conditions

Surface oiling conditions are described in terms of length, width, distribution, thickness, and character of the oil within a specific tidal zone, lake shore, or riverbank. This information is recorded for each segment, sub-segment, or zone within the survey area (see Section 1.3.1 for information on segmentation). These data may be further combined to rate the degree of oiling (see Section 1.4.2 and Figures 3.2 and 3.3).

Oil on the surface could penetrate ice and snow by a number of different processes. When this occurs, the definition of Surface Oil is “oil that is visible on the surface and that is up to 5 cm below the surface.” Oil that is not visible on the surface but that is present below the surface or oil that has penetrated more than 5 cm below the surface would be considered Subsurface Oil (Section 3.1.2).

LENGTH refers to alongshore (parallel to the shoreline) distance of the oiled area within a segment, sub-segment, or zone.

WIDTH refers to the average across-shore (perpendicular to shore) distance of the intertidal oil band within a segment, sub-segment, or zone. If multiple across-shore bands are grouped, then width represents the sum of their widths. The actual oiling width can also be categorized by the following terms, which can be modified according to the regional shore-zone character within the area affected by a spill.

Wide	> 6 m
Medium	> 3 m to 6 m
Narrow	> 0.5 m to 3 m
Very Narrow	< 0.5 m

SURFACE DISTRIBUTION represents the actual percent of the surface that is covered by oil within a fixed area. A visual aid to surface distribution is provided in Figure 3.1. In the event of grouped multiple bands, distribution refers to the average oil conditions for the zone. The actual oil distribution measurements can also be categorized or grouped.

Trace (TR)	<1%
Sporadic (SP)	1–10%
Patchy (PT)	11–50%
Broken (BR)	51–90%
Continuous (CN)	91–100%

SURFACE OIL THICKNESS refers to the average or dominant oil thickness within the segment or zone. It is described according to the following categories.

PO ***Pooled or Thick Oil*** — generally consists of fresh oil or mousse accumulations >1 cm thick.

CV ***Cover*** — >0.1 cm and <1 cm thick.

CT ***Coat*** — >0.01 cm and <0.1 cm thick. It can be scratched off with fingernail on coarse sediments or bedrock.

ST ***Stain*** — <0.01 cm thick. It cannot be scratched off easily on coarse sediments or bedrock.

FL ***Film*** — transparent or translucent film or sheen.

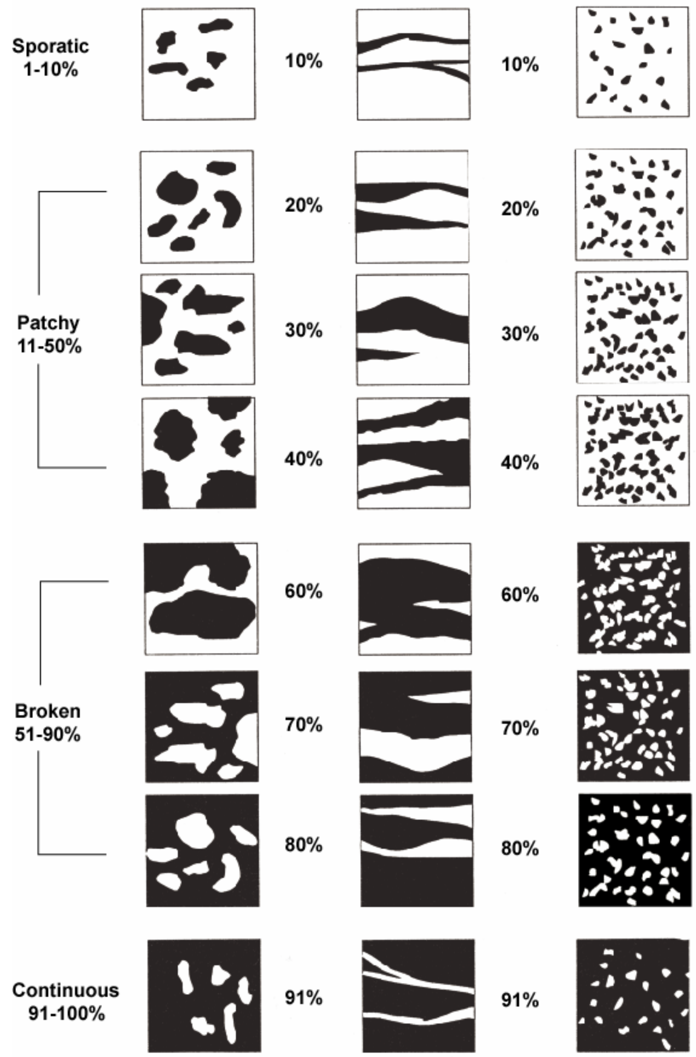

Figure 3.1 Visual Aid For Estimating Oil Distribution.

SURFACE OIL CHARACTER provides a qualitative description of the form of the oil.

- **FR** ***Fresh*** — unweathered, low viscosity oil.
- **MS** ***Mousse*** — emulsified oil (oil and water mixture) existing as patches or accumulations, or within interstitial spaces.
- **TB** ***Tar Balls*** — discrete balls, lumps, or patches on a beach or adhered to the substrate. Tar ball diameters are generally <10 cm.
- **PT** ***Tar Patties*** — discrete lumps or patches >10 cm diameter that are on a beach or adhered to the substrate.
- **TC** ***Tar*** — weathered coat or cover of tarry, almost solid consistency.
- **SR** ***Surface Oil Residue*** — consists of non-cohesive, oiled, surface sediments, either as continuous patches or in coarse-sediment interstices.
- **AP** ***Asphalt Pavement*** — cohesive mixture of oil and sediments.
- **NO** ***No Oil Observed***.

Oiled Debris can consist of logs, rubbish, and flotsam stranded on the shoreline; dead animals or vegetation; and spill response items such as sorbents, booms, snares, etc.

SUMMARIZING THE DEGREE OF OILING

Several of the above data can be combined to create indices to rate the degree or relative severity of oiling in a particular segment. Potential indices are depicted in Figures 3.2 and 3.3.

		Width of Oiled Area			
		Wide	**Medium**	**Narrow**	**Very Narrow**
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

Figure 3.2 Surface Oil Cover Category.
(width x surface distribution data)

		Initial Categorization of Surface Oil			
		Heavy	**Moderate**	**Light**	**Very Light**
Average Thickness	**Thick or Pooled > 1 cm**	Heavy	Heavy	Moderate	Light
	Cover 0.1 – 1.0 cm	Heavy	Heavy	Moderate	Light
	Coat 0.01 – 0.1 cm	Moderate	Moderate	Light	Very Light
	Stain/Film < 0.01 cm	Light	Light	Very Light	Very Light

Figure 3.3 Surface Oil Category.
(surface oil cover category x thickness data)

3.1.2 Subsurface Oiling Conditions

Subsurface oil is usually described in terms of depth of penetration or thickness of the buried oil lens and a qualitative description of the character or concentration of oil. As noted above, oil would be considered Subsurface Oil if the oil is (i) not visible, but is present below the surface due to the accumulation of snow and/or ice on top of the oil or due to the migration of oil in ice, or (ii) visible on the surface and has penetrated more than 5 cm below the surface.

SUBSURFACE OIL CHARACTER provides a qualitative description of the character and/or quantity of the oil.

- **SAP Subsurface Asphalt Pavement** — cohesive mixture of weathered oil and sediment situated completely below a surface sediment layer (record thickness).
- **OP Oil-Filled Pores** — pore spaces in the sediment matrix are completely filled with oil; often characterized by oil flowing out of the sediments when disturbed.
- **PP Partially Filled Pores** — pore spaces filled with oil, but generally does not flow out when exposed or disturbed.
- **OR Oil Residue as a Cover** (> 0.1 – 1 cm) or **Coat** (0.01 – 0.1 cm) of oil on sediments and/or some pore spaces partially filled with oil. It can be scratched off easily with fingernail on coarse sediments or bedrock.
- **OF Film or Stain** (< 0.01 cm) of oil residue on the sediment surfaces. Non-cohesive. It cannot be scratched off easily on coarse sediments or bedrock.
- **TR Trace** — discontinuous film or spots of oil on sediments, or an odour or tackiness with no visible evidence of oil.
- **NO No Oil** — no visible or apparent evidence of oil.

SHEEN COLOUR

S	**Silver**	**B**	**Brown**
R	**Rainbow**	**N**	**None**

Sheen colour may be roughly indicative of the oil layer thickness and quantity.

Silver	<0.0001 mm thick	<100 L oil/km^3/km^2 (<0.1 m3/km^2)
Rainbow	0.0001-0.001 mm thick	100-1000 L oil/km^3/km^2 (0.1-1.0 m3/km^2)
Brown	>0.001 mm thick	>1000 L oil/km^3/km^2 (0.1-1.0 m3/km^2)

OILED ZONE (SUBSURFACE) refers to the vertical width or thickness of the oiled sediment, snow, or ice (subsurface) layer when viewed in profile by digging a pit or trench. The top and bottom boundaries of the lens are recorded. The bottom boundary is equal to the maximum depth of oil penetration. The top boundary may equal 0 (the beach surface) or a greater number depending on whether clean sediments have been deposited on top of the oiled sediment.

Due to problems associated with defining the beach surface when differentiating between what is considered surface and subsurface, the following guides have been developed and are further illustrated in Figure 3.4.

- Fine sediments (pebble/granule/sand/mud) and/or fine mixed sediments. The subsurface begins at 5 cm below the beach surface. For the purpose of measurement, the beach surface is the 0 cm reference level.
- Coarse Sediments (pebble/cobble/boulder) and armoured beaches. The subsurface begins at the bottom of the first layer of surface material (i.e., disregard the surface layer). For the purpose of measurement, the beach surface reference point (0 cm) begins at the bottom of the first layer.
- Asphalt Pavement. Where AP exists on the surface, the subsurface begins at the underside of the pavement. For the purpose of measurement, the beach surface reference point (0 cm) begins at the top surface of the pavement.

For oil within snow or ice, the subsurface begins at 5 cm below the surface of the snow or ice, as illustrated in the top diagram in Figure 3.4. If there is a continuous layer of oil within the snow or ice then the top 5 cm is considered Surface Oil and that below 5 cm is considered Subsurface Oil. If the oil is not visible then the top of the oil layer is measured from the surface of the snow or ice.

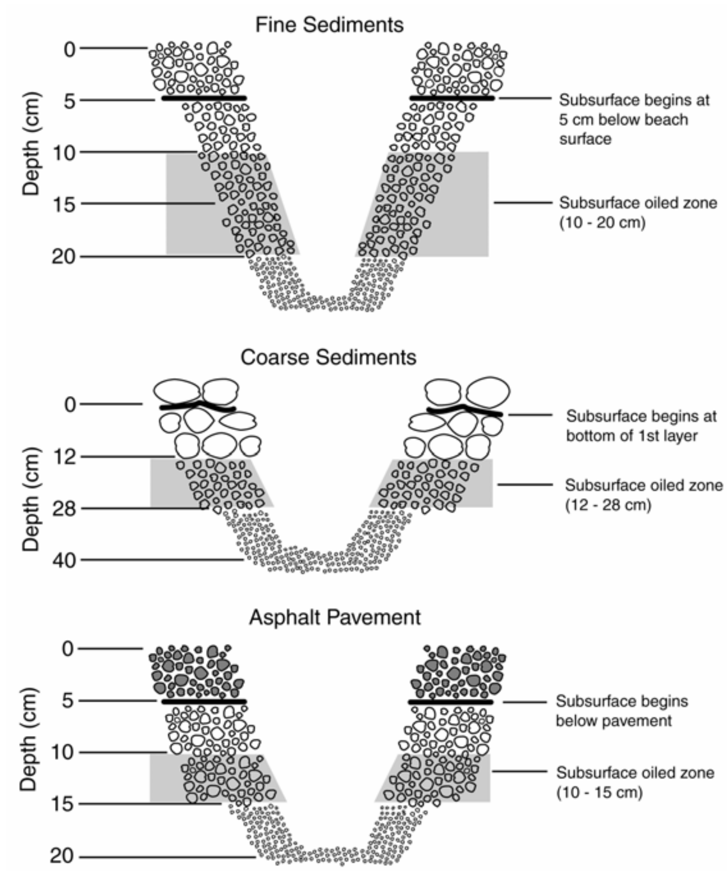

Figure 3.4 Subsurface Definitions.

3.1.3 Other Terms

INTERTIDAL ZONE

LI ***Lower Intertidal Zone*** -- the lower approximate one-third of the intertidal zone

MI ***Mid Intertidal Zone*** -- the middle approximate one-third of the intertidal zone

UI ***Upper Intertidal Zone*** -- the upper approximate one-third of the intertidal zone

SU ***Supratidal Zone*** -- the area above the mean high tide that occasionally experiences wave activity; also known as the splash zone

WATER LEVELS

High Water Mark — the higher limit of the tidal water level

Mean High Water Mark — the higher limit averaged over a time period

Spring High Water Mark — the higher limit of spring tides

Neap High Water Mark — the higher limit of neap tides

NON-TIDAL LAKE SHORELINE ZONE

LSZ ***Lower Swash Zone*** -- the area between the mean annual water level and the lowest annual water level, the lower approximate one-half of the zone of wave activity

USZ ***Upper Swash Zone*** -- the area between the highest annual water level and the mean annual water level, the upper approximate one-half of the zone of wave activity

SSZ ***Supra-Swash Zone*** -- the area above the highest annual water level that only occasionally experiences wave activity, as during a storm event

RIVERINE TERMS

MS ***Mid-stream*** -- shoal(s) or bar(s) exposed in the channel and separated from the riverbank (a Point Bar is attached to the riverbank)

LB ***Lower Bank*** -- exposed only during low flow conditions

UB ***Upper Bank*** -- under water only during bank-full river stage

OB ***Overbank = flood plain*** -- inundated only by over-bank flow during flood conditions

SNOW AND ICE TERMS

(See also photographic examples in Section 3.5.5)

FSW ***Frozen swash***
FSP ***Frozen spray that is above the intertidal zone***
IFT ***Ice foot***
IPR ***Ice-push ridge***
GFL ***Grounded ice floes***
GLC ***Glacier ice***
SNW ***Snow***

3.1.4 Standard Shoreline Types & Coastal Character

The term "shore" or "shoreline" refers to that zone where land and water meet. It applies to freshwater lakes and rivers as well as marine environments. The character of the shore zone; the behaviour, fate and persistence of stranded oil; and the types of cleanup or treatment methods that are appropriate are primarily a function of the substrate materials. In describing a segment, it is important to distinguish between the shoreline type (Section 4A on the SOS Form) and the coastal character (Section 4B on the SOS Form).

SHORELINE TYPE refers to the character of the upper intertidal zone of marine environments (also known as foreshore), or the upper swash zone on lakes, or the upper bank on rivers and streams. This is the area where oil usually becomes stranded and where treatment or cleanup activities take place.

COASTAL CHARACTER refers to the form of the shore zone as a whole and includes the area inland and seaward of the marine intertidal zone or the river valley character as a whole. This is the area where operations activities to implement the treatment or cleanup take place. It defines access constraints to the foreshore (intertidal) or riverbank and to the backshore (supratidal) or floodplain zones as well as the potential for staging areas adjacent to the segment that is to be cleaned.

The basic parameter that defines the shoreline is the MATERIAL that is present in the intertidal zone. The presence or absence of sediments is a key factor, as this will determine whether oil is stranded on the surface of a substrate or can penetrate and/or be buried.

SOLID SHORELINES (or RIVERBANKS) are stable and impermeable, such as bedrock outcrops or man-made sea walls.

UNCONSOLIDATED SHORELINES (or RIVERBANKS) are mobile and permeable, such as beaches, point bars, and deltas.

Within these two fundamental shoreline types, further subdivision is based on the character of the substrate materials. The twelve Environment Canada Marine Shoreline Types are listed in Table 3.1, along with the equivalent Marine Shoreline Habitats that are used by NOAA and API. Three additional marine shoreline types (tundra cliffs, inundated low-lying tundra, and peat shorelines) are common in arctic regions (Environment Canada, 1996a; Owens and Michel, 2003) (Section 3.5.4). The shoreline types for rivers and streams also are based on the character of the substrate materials and are the same as described for marine coasts. A “River Character” qualifier is added to indicate the general features of the segment or reach and describes the morphology of the river or stream (see Box 4B in Section 2.2.2).

Table 3.1 Marine Shoreline Types

Environment Canada Marine Shoreline Types	API* – NOAA* Marine Shoreline Habitats
NON-PERMEABLE	
Bedrock	Exposed or Sheltered Rocky Cliffs, Wave-Cut Platform, or Reef Flats
Man-Made Solid Structures: Ice	Exposed or Sheltered Sea Walls or Piers
PERMEABLE	
Sand Beaches	Fine-Grained, Fine- to Medium-Grained, or Coarse-Grained Sand Beaches
Mixed Sediment (Sand-Gravel) Beaches	Mixed Sand and Gravel Beaches
Pebble-Cobble Beaches	Gravel Beaches
Boulder Beaches	Gravel Beaches: Riprap
Mud Tidal Flats	Exposed or Sheltered Tidal Flats
Sand Tidal Flats	Exposed or Sheltered Tidal Flats
Salt Marshes	Marshes
—	Mangroves
ARCTIC	
Peat Shorelines	Eroding Peat Scarps
Inundated Low-Lying Tundra Shorelines	Inundated Low-Lying Tundra
Tundra Cliffs	Sand

*API American Petroleum Institute (API, 2001)

*NOAA National Oceanographic and Atmospheric Administration (NOAA, 2000b)

3.2 PHYSICAL SHORE-ZONE CHARACTER AND COASTAL PROCESSES OF ARCTIC CANADA AND ALASKA

This section provides a brief summary of the coastal processes that are characteristic of the Arctic and the key features of three shoreline types that are unique to the arctic regions.

3.2.1 Arctic Coastal Processes

WAVES

Sea ice restricts wave action to the open-water season, and intertidal or nearshore ice protects shores from wave attack. The presence of sea ice during the open-water season (a) limits the fetch area over which winds can generate waves, or (b) dampens existing waves that may be heading towards the coast. Nevertheless, storm-wave action can be an important process in areas with short open-water seasons and short fetches (McCann, 1972).

TIDES

Tidal range in the Arctic varies from less than 0.5 m on the Alaska and Canadian Beaufort Sea coasts to over 16 m in Hudson Strait (Ungava Bay) and southeast Baffin Island.

In micro-tidal environments (range <2 m), the open-water season meteorological tides ("storm surges") frequently are greater than the astronomical tides. Along the Beaufort Sea coasts, where the astronomical tidal range is <0.5 m, the wind tides often may exceed 2 m (Harper *et al*., 1988; Owens *et al*., 2003b). Storm surges In low-lying areas can result in backshore inundation as far as several hundreds of metres inland, and driftwood lines indicate the highest water levels that can be generated by the meteorological tides.

Astronomical tides are a year-round process. In the macrotidal environments (range >4 m) the effect of the large water-level changes is to break up the ice and produce ice rafting or a zone of large floes at the junction between the land-fast ice and the sea ice.

SNOW

Snow is common in all Arctic and cold-climate regions. Fresh wind-blown snow can be transported long distances and accumulate in hollows or in wind shadows. Except after a new snowfall in early winter, snow is rarely uniform in depth. Fresh snow is a loose aggregate of crystals with a specific gravity of 0.1 to 0.2. The weight of the snow causes compaction to take place and fresh snow changes to granular snow over a period of days or, at most, weeks. This granular snow has a specific gravity of 0.3. With the continued effect of compaction, the granular snow changes to hard-packed snow which has a specific gravity of approximately 0.5.

In addition, ice lenses form within snow by the freeze-thaw process. The exposed surface of snow is subjected to changing air temperatures. When the air temperature is above the freezing point, the snow crystals at the exposed surface melt and change to water. This water percolates into the snow below thereby exposing the next layer of crystals and, in addition, melts snow crystals with which it comes into contact. If air temperatures drop below freezing, the water and the wet snow would change into ice. The typical freeze-thaw cycle involves melting and possible rainfall during daylight hours with freezing temperatures and snow during the night.

When there are a series of consecutive days over which this freeze-thaw oscillation is repeated, ice builds up either at the surface of the snow or within the snow column. When there are periods with freeze-thaw oscillations separated by a period or periods when the air temperature stays below freezing and there is accompanying snow fall, the potential effect is to create layers of alternating snow and ice. These freeze-thaw cycles are common during the fall/early winter and spring/early summer transition periods.

ICE

Ice in the coastal zone can take a wide range of forms that include

- seasonal shore zone or nearshore ice

- seasonal nearshore sea ice or seasonal frozen wave spray or swash in the shore zone
- individual ice floes
- grounded ice floes or broken pack ice piles and pressure or ice-push ridges
- glaciers or ice shelves
- the presence of a seasonal frost table or permafrost within beach sediments,
- terrestrial ground ice (permafrost) that is exposed in the eroding faces of ice-rich tundra cliffs

Photographs of the ice related shore-zone features described below are provided in Section 3.5.5.

Typical Seasonal Shore Zone and Nearshore Ice Cycle

Freeze-up Transition: On all marine or lake shorelines or riverbanks in the Arctic, ice begins to form in the intertidal or swash zone with the onset of sub-zero daily maximum air temperatures as wave spray or swash run-up freezes (Short and Wiseman, 1974; Owens, 1976). Initially ice accumulates in the upper intertidal zone by the deposition and consolidation of (i) new frazil or slush ice, (ii) stranded brash ice, cakes, or floes, (iii) frozen swash and spray, and (iv) snow. The onshore movement of sea ice can form ice push or pressure ridges or ice piles on the shore (Hume and Schalk, 1964; Owens and McCann, 1970; Taylor, 1978). The net effect is the horizontal and vertical development of an ice foot that is an immobile, solid, ice mass that is attached to the intertidal zone (Evenson and Cohn, 1979; Owens, 1976, 1982; Wiseman *et al*., 1981). There is a wide variety in the types of ice foot that may form, but the primary factors that control the width of the ice foot are the tidal range and the slope of the shore zone (McCann and Carlisle, 1972) whereas the height is a function of wave energy levels during freeze-up.

Winter or Frozen Conditions: The shore zone essentially is inactive, in terms of coastal processes, in the winter as the intertidal sediments are encased by the solid ice foot. Nevertheless, it is not always a static zone. The ice foot can move due to the rise and fall of the tides and to the effects of winds and currents on the adjacent nearshore ice. Typically, there is a zone of tidal cracks where the attached ice foot is hinged to tidal nearshore ice (Owens, 1976). Leads may open and close at any time throughout the winter and rivers may over flood the static nearshore ice at the start of the spring thaw before the sea ice begins to break up (Walker, 1998).

Breakup Transition: The character of the shore zone during this transition period depends on whether the nearshore sea ice is present before or after the ice in the shore zone melts (Owens, 1976; Short and Wiseman, 1975). In warmer regions of the Arctic, the sea ice usually breaks up and nearshore open water exists while the ice foot remains and ablates. In some parts of the Canadian high Arctic, the ice foot may not completely melt during the summer period, typically if the ice is mantled by a protective layer of sediment (Taylor and McCann, 1976). Ice rafting is common during breakup in areas with a large tidal range (Dale *et at*., 2002). Occasionally, in ice-locked regions with thick multi-year ice, the thinner layer of ice in the shore zone may melt before there is nearshore open water.

Open-Water Period: This period begins when the intertidal and nearshore zones are free of seasonal ice. Ice can still play a role in coastal processes during this season as it is exposed in ice-rich tundra cliffs, is usually present within the beach sediments (the ‘frost table’), and ice floes may be blown and stranded if ice remains in the offshore.

Ice Floes, Ice Push, and Pressure Ridges

Ice floes that ground under the influence of currents and wind action can create an ice-push ridge where they plough into beach sediment or pressure ridges as the ice piles up at the shoreline (Forbes and Taylor, 1994; Harper and Owens, 1981; Hume and Schalk, 1964; Owens and McCann, 1970; Taylor, 1978; Taylor and McCann, 1976). These processes can occur during the open-water season or the freeze-up or breakup transition periods.

Tidewater glaciers and ice shelves

Where the glaciers enter the sea the ice typically floats. The ice at the glacier front can be actively calving, which can produce ice floes or bergs, or it may be retreating or eroding by thermal ablation without producing ice fragments. Ice shelves are found only on the northern shore of Ellesmere Island. The ice fronts are generally unstable and routinely calve, sometimes creating ice islands that can be tens of kilometres square (Jeffries, 1987).

Frost Table

Water in beach sediments freezes during periods of sub-zero temperatures to produce ground ice. The formation of this ice within the sediments fills in the spaces between individual particles and effectively bonds the sediments together. On arctic beaches, the depth to which the beach sediments are ice free, often referred to as the depth to the frost table or the thickness of the active layer, can vary from less than 10 to 25 cm during the freeze period to greater than 100 m during the thaw period (Harper *et al*., 1978; Owens and Harper, 1977; McCann and Hannell, 1971; Taylor and McCann, 1976; Taylor, 1980). Not only does the presence of interstitial ice inhibit sediment redistribution, but it can also act as a barrier to the penetration of oil within beach sediments.

Terrestrial Ice

Ground ice that is exposed at the shore in ice-rich tundra cliffs is subjected to thermal degradation. The two primary mass wasting processes that result in cliff retreat are (a) slumps and mud or slurry flows, and (b) block falls that are caused by thermo-erosional undercutting (Owens and Harper, 1983). Ground ice slumps, sometime referred to as retrogressive thaw-flow slides, are often significant events that result in slope failure and mud slides that pass through the intertidal zone into the nearshore. Block falls result from the creation of a niche as wave action or simply the presence of sea water thermally erodes the exposed ice. This undercutting leads to block failure, which typically occurs in association with ice wedges in areas with tundra polygons.

Low tundra cliffs frequently are ice rich as the exposed cliff face has high pore-ice content. Despite erosion rates of greater than 1.0 m/month, little sediment is provided for beach development because the cliff face is composed of ice, mud, or peat with little sand or gravel sediment.

By contrast, higher cliffs tend to be predominantly ice poor as the ground ice is concentrated near the tundra surface at the top of the cliff face. On this type of cliff the primary erosion processes are associated with either surface wash during the spring melt and runoff period or by debris slides or active layer glides caused by basal undercutting of the cliff face by wave action. As these cliffs generate sediment for reworking by coastal processes, they are typically associated with sand or sandy-gravel beaches in the intertidal zone.

Where elevations in the coastal zone are low, the ice-rich tundra surface may be drowned or flooded by astronomical spring or meteorological wind tides. The effect is to create a complex coastline of interconnected ponds and channels or of water-filled breached polygons.

3.2.2 Peat and Tundra — “Arctic” Shoreline Types

All twelve Canadian marine shoreline types (Table 3.1) can be found in the Arctic. The physical characteristics of nine of those shoreline types that can be found in both temperate and arctic Canada are described in Environment Canada, 1996a and 1998. Ice shorelines are included in these descriptions. Tundra shoreline types, however, occur only in arctic regions, and peat shorelines often occur in association with tundra environments. These additional arctic shoreline types are described below, and photographs are provided in Section 3.5.4. Snow is not considered a separate shoreline type but the behaviour of oil and snow is discussed in Section 3.3.1. Ice shorelines are described in conjunction with Man-Made Solid Structures (Table 3.1) and the behaviour of oil on ice is discussed in Section 3.3.2.

Three shore types that are common on the arctic coasts that result from the presence of tundra and permafrost in the coastal zone are: (1) tundra cliffs; (2) peat shorelines; and (3) inundated low-lying tundra. Tundra has a continuous plant cover composed of dwarf shrubs, grasses, mosses, and lichens and frequently is characterized by ice-wedge polygons that form as water freezes in contraction frost cracks. This patterned ground is often waterlogged in summer months as melt water is contained by the high polygon rims.

In regions with high relief where the tundra extends to the coast, the underlying permafrost is frequently exposed and produces a variety of ice-rich cliff forms that are unique to arctic regions. The erosion of low-lying tundra or of tundra cliffs can occur by wave or thermal processes and typically is rapid during the open-water season, on the order of metres (m) per month in many areas. This erosion provides large quantities of plant material, usually peat, directly to the shore zone, which can accumulate to form the second unique arctic shore type, peat shorelines. In areas of low relief, the tundra may be drowned at the shoreline to produce the third arctic shore type, inundated low-lying tundra.

Permanent snow patches or ice on the shore zone can be found in the Canadian Arctic and they are common along moderate sloping and steep shores, for example, on Devon, Somerset, and northern Baffin Islands (R.B. Taylor, pers. comm., 2002). Typically there is an ice foot in the intertidal zone with snow in the upper and supratidal zone.

TUNDRA CLIFFS

Tundra cliffs are an erosional feature composed of a tundra (vegetation) mat that usually overlies peat and exposed ground ice. These ice-rich tundra cliffs are distinct and different from eroding unconsolidated sediment cliffs, which may have peat or exposed ice in the upper sections, but are predominantly exposed sediment. As the cliff face retreats, due to thermal erosion melting the exposed ground ice or to a combination of undercutting by wave and thermal erosion, the tundra and peat materials fall to the base of the cliff. The dominant mass-wasting processes on tundra cliffs have been defined as surface wash, ground ice slumps (also termed “retrogressive thaw flow”), debris slides, and thermo-erosional falls (Owens and Harper, 1983; Dallimore *et al*., 1996).

The eroded material may form a mud slurry or may be in the form of fragmented and irregular blocks until reworked by wave action. Erosion rates vary considerably depending on exposure to waves during the open-water season and the height of the cliff. Low erosion rates are on the order of 0.5 metres/year (i.e., less than 0.2 m/month during the open-water season) with high rates in excess of 4.0 m/year (1.0 to 1.5 m/open-water month). The cliff face usually is either exposed ground ice (permafrost) or deposits of slumped peat and tundra. Relatively little beach forming material is supplied to the intertidal zone despite the often rapid erosion rates, so that beaches usually are either narrow or absent in many areas. Eroded peat commonly accumulates at the base of a tundra cliff or may be transported alongshore.

PEAT SHORELINES

Peat is a spongy, compressible, fibrous material that forms by the incomplete decomposition of plant materials and is common along low-lying arctic coasts. Peat can have high water content (80-90% by weight), and thus it can behave like a liquid. It has very low cohesion and thus it has very poor load-bearing capacity. The peat that is eroded from tundra outcrops at the shoreline often accumulates in low-energy, sheltered areas, the same locations where spilled oil is likely to accumulate. In areas where there is a large and continuous supply, it may be transported alongshore to form low barrier beaches. Peat shorelines are not unique to the Arctic, as they occur in Canada at a few locations in New Brunswick and Prince Edward Island, but they are certainly more common in the Arctic.

The peat deposits may occur as: (1) a mat on a beach that may be wet or dry ("dewatered") and is easily eroded and redistributed by wave or current action, or (2) a mobile slurry that may appear like "coffee grounds" in the water, often at the edge of the beach or shore, and that consists of thick mats of suspended peat that may be greater than 0.5-m thick and 5-m to 10-m wide. Usually, the inorganic content of these peat deposits is either very low or completely absent. In Alaska, peat shorelines comprise 1,100 km or 15.5 percent of the shoreline types mapped from Point Hope to the Canadian border.

INUNDATED LOW-LYING TUNDRA

Very low-lying tundra coasts are underlain by ice-rich permafrost. In recognition of the role of thaw processes in the formation of lakes in these tundra areas, the term "transgressive thermokarst coasts" is sometimes used (e.g., Dallimore *et al*., 1996; Hill and Solomon, 1999; Ruz *et al*., 1992). These low-lying coastal areas have been recently "drowned", or flooded by the sea, due to subsidence that results from natural melting of the ground ice (permafrost), or from regional tectonic subsidence. Low-lying areas not normally in the intertidal zone frequently are inundated by salt water at times of spring high (tidal) water levels or wind-induced (meteorological) surges. Strong westerly winds on the Alaskan and southern Beaufort Sea coasts can raise the normal water levels by a meter or more and inundate these low-lying areas to strand logs and debris several hundreds of metres "inland".

Tundra has an undulating surface and may be characterized by patterned ground, such as ice-wedge polygons. When flooded or drowned, these low-lying areas have a complex and convoluted shoreline and typically are a combination of vegetated flats, peat mats, brackish lagoons, and small seasonal streams. The vegetation is salt-tolerant and may be more adapted to drier conditions than the aquatic plants of arctic salt marshes. These areas may include subsiding tundra or vegetated riverbanks and deltas. Inundated tundra has a very complex configuration of interconnected ridges with pools that are underlain by decomposing vegetation.

3.3 OIL BEHAVIOUR ON ARCTIC SHORELINES

The key features of oil behaviour with respect to snow and ice and to the three "arctic" shoreline types are discussed in this section. The behaviour of oil on the other nine shoreline types (Table 3.1) is described in Environment Canada, 1998.

3.3.1 Oil and Snow

Ice and snow on the shoreline significantly alter the physical character of the substrate and, most importantly, can change the surface permeability. A solid impermeable bedrock shore with a layer of snow has a permeable surface layer. A pebble beach with an ice cover has an impermeable surface. Snow is discussed in Section 3.2.1 and in the ASOS form - Box 4B (Section 1.5.1).

The behaviour and spreading of oil on snow depends on the type of snow (fresh or compacted), air temperature, and the surface character of the location (flat or sloping). Ice lenses within the snow that form by the freeze-thaw process can limit penetration of oil into snow. Conditions under which oil would be spilled on a snow-covered shore or riverbank normally would be associated with a land-based spill, in which the oil spreads or flows downslope from a backshore location, or washes ashore during cold temperatures. Oil stranded on a snow-covered shore likely would be partially contained by the snow as snow is a good, natural sorbent. For light oils, the oil in snow content may be very low (less than 1%).

The oil-in-snow content depends on the oil type and the snow character, the oil content for medium crudes would be higher than for light products. Oil content is lower on firm compacted snow surfaces in below-freezing temperatures and higher for fresh snow conditions. Oil causes snow to melt. Crude oils cause more melting but spread less than gasoline, which moves more quickly in snow and over a larger area. Light oils can move upslope in snow through capillary action as they spread.

Fresh snow that blows over oil tends to stick and migrate into the oil, causing an increase in the volume of material to be recovered. Snow falling onto oil tends to accumulate on the oil surface.

3.3.2 Oil and Ice

The various forms of ice are described in Section 3.2.1, and the six terms used to describe ice types are listed above in Section 3.1.3 and illustrated in Section 3.5.5. These terms are included in the ASOS form in Section 1.5.1 in Box 4B. Nearshore ice conditions are included in the ASOS form in Box 4C in terms of the ice concentration, form, and age (thickness) following the definitions developed by NOAA (2000c).

Ice on the shoreline significantly alters the physical character of the substrate and, most importantly, changes the surface permeability. A pebble or cobble beach with an ice cover has an impermeable surface. Ice in beach sediments (frozen groundwater - see Section 3.2.1) can prevent the penetration of stranded oil. Oil on ice flows downslope and will collect in depressions or enter shore leads if they are present. If continuous shore-fast ice (an ice foot) is present, the ice may protect the shore zone, but if the ice foot has extended beyond the shore zone to include a floating ice layer, oil can migrate through ice cracks and accumulate under the ice.

In most instances, the presence of ice in the shore zone as an ice foot or on the adjacent nearshore water acts to prevent oil on the surface of the water from making contact with the shoreline substrate. Oil washed onto exposed ice surfaces from the sea is unlikely to adhere except in cold temperatures when the air, water, and oil surface temperatures are below 0ºC. Oil present on the shore or riverbank, or that is stranded on the shore-zone ice during a period of freezing temperatures, can become covered and encapsulated within the ice. During a thaw cycle, or if the surface of the ice is melting and wet, oil is unlikely to adhere to the ice surface and would remain on the water surface or in shore leads. Oil may be splashed over the ice edge or be stranded above the limit of normal wave action. The stranded oil can then be incorporated into the shore-fast ice if temperatures fall again below freezing.

In broken ice, without a landfast ice cover, oil may reach the shore and be stranded on the substrate between the ice floes.

Buoyant oil under ice will migrate to the underside of a floating ice sheet, which typically has an uneven surface. A current of 0.4 m/s is usually required to move oil along the underside of the ice. Oil will tend to migrate to pockets on the underside (see ❶ in Figure 3.5) unless ice ridges or keels stop lateral movement❷.

Ice forms by freezing at the ice-water interface. Oil at that interface can become frozen into the ice sheet. As the ice melts on the upper surface and continues to form on the underside, oil will move up through the ice sheet❸ and eventually appear on the upper surface. The primary mechanism by which oil migrates upwards is through brine channels or cracks in the ice❹.

If the oil finds a break in the ice sheet, such as a shore lead or a seal hole, it will flow into the open water❺ and may spill over onto the surface of the ice. Oil in broken ice will tend to collect in leads, unless lateral movement is prevented on the underside of an ice floe. During freeze-up, new ice can form on the underside of a slick.

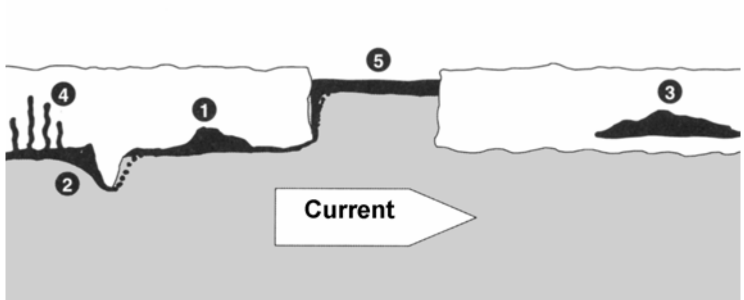

Figure 3.5 Oil In And Under Ice (from EPPR, 1998, pg 6-5)

3.3.3 Oil on Tundra Cliffs

Oil that is washed up on exposed ground ice is unlikely to stick, unless air temperatures are below freezing, and would flow back down onto the beach. If the intertidal zone has fragmented or slumped blocks, oil may pool in the spaces within and between the blocks. This is likely to occur at the top of a beach where both oil and peat blocks would tend to accumulate. Oil may be splashed over a low cliff onto the tundra surface where it would persist beyond the reach of wave or water action. Sediment often is deposited on the tundra as “perched beaches” on exposed coasts during periods of storm wave action or wind surges. Should they become oiled, these would be treated as either sand or pebble-cobble beaches depending upon their character.

Persistence usually would be short due to natural erosion but could be increased if the oil is buried by block falls or incorporated into peat slurries. Oil on the cliff or the slumped tundra blocks, which also erode rapidly, would be reworked and remobilized by wave action. Tundra cliffs often are undercut and are naturally unstable, so that safety is a primary concern during operations on these shorelines.

3.3.4 Oil on Inundated Low-lying Tundra

During the summer season, the sediments and/or peat deposits are often water-saturated so that oil may be restricted to surface areas only. Oil may collect on the water in the many shoreline indentations that typify areas of patterned ground such as breached polygons (Photos 3.23 and 3.24), and remain there until lifted and remobilized by high waters or until freeze-up. Sand, gravel and driftwood may be pushed inland on to the backshore by wave action or storm surges in areas where the tundra surface is level or has a low slope. Driftwood lines indicate the highest water levels that can be generated by meteorological tides (“storm surges”). In some cases, “perched beaches” rest directly on the vegetation or peat mat that often is exposed on the seaward face of the beach ridge.

3.3.5 Oil on Peat Shorelines

Typically, heavy oils (such as crude) will not penetrate deeply into a peat mat, even if dry or dewatered, but may be buried or become mixed with peat where it is reworked by wave action (Little *et al*., 1992). Light (refined) products will likely penetrate peat substrates. If oil does penetrate into the peat mat, there may be relatively little recoverable oil on the surface.

Dry peat can hold large amounts of oil, 1 to 5 kg of oil/per kg of dry peat. Oils that make contact with a peat slurry are likely to be mixed and remain so, especially in the low wave-energy areas where these slurries typically accumulate. The slurry will have an effect similar to that of a loose granular sorbent and will partially contain and prevent the oil from spreading.

3.4 SHORELINE TREATMENT AND CLEANUP

3.4.1 Standard Shoreline Treatment Methods

The treatment or cleanup (Figure 3.6) that may be used on oiled shorelines can be grouped into four basic strategies:

Physical washing, recovery, and disposal	(techniques 2 – 8)
Physical removal and disposal	(techniques 9 – 13)
Physical *in-situ* treatment	(techniques 14 – 16)
Chemical and biological treatment	(techniques 17 – 20)

Environment Canada provides information on the applications and limitations of these methods for the different shoreline types in a series of shoreline treatment cleanup manuals and guidelines (Environment Canada, 1996a, 1996b, 1998; EPPR, 1998). These field guides identify a total of twenty shoreline techniques that are presented in the following Figure 3.6 (adapted from API, 2001). This table is an assessment of the relative potential impact of each technique on the twelve Environment Canada marine shoreline types in the absence of oil. The purpose of this table is to highlight those techniques that have a low potential impact to the substrate and those that might cause additional damage.

	bedrock	man-made solid/ice	sand beaches	mixed sediment	pebble-cobble beaches	boulder beaches	sand tidal flats	mud tidal flats	marshes	peat	low-lying inundated tundra	tundra cliffs
1 natural recovery	–	–	–	–	–	–	–	–	–	–	–	–
2 flooding	●	●	●	◒	●	●	●	●	●	●	●	●
3 low-pressure, cold wash	●	●	◒	◒	◒	●	○	○	●	●	●	●
4 low-pressure, warm/hot wash	◒	●	○	◒	◒	◒	○	○	○	○	○	●
5 high-pressure, cold wash	●	●	○	○	○	◒	○	○	○	○	○	○
6 high-pressure, warm/hot wash	◒	●	○	○	○	◒	○	○	○	○	○	○
7 steam cleaning	◒	●	○	○	○	○	○	○	○	○	○	○
8 sandblasting	○	◒	–	○	○	○	–	–	–	–	–	–
9 manual removal	●	●	●	●	●	●	◒	○	○	○	○	●
10 vacuums	●	●	●	●	●	●	◒	◒	◒	●	●	●
11 mechanical removal	–	–	◒	◒	◒	◒	◒	○	○	◒	○	◒
12 vegetation cutting	◒	●	–	–	–	◒	–	○	○	–	○	–
13 passive sorbents	●	●	●	●	●	●	●	◒	◒	●	●	●
14 tilling/aeration	–	–	◒	◒	◒	–	◒	○	○	○	○	●
15 sediment relocation/surf wash	–	–	◒	◒	◒	–	○	○	○	○	○	●
16 burning	●	●	◒	◒	◒	◒	○	○	◒	○	○	–
17 dispersants	●	●	●	●	●	●	–	–	○	○	○	●
18 shoreline cleaners	●	●	●	●	●	●	–	–	◒	–	–	●
19 solidifiers	–	–	●	●	●	●	◒	◒	◒	●	●	●
20 bioremediation	●	●	●	●	●	●	●	●	●	○	●	●

● = low potential impact ◒ = medium potential impact ○ = high potential impact

Figure 3.6 Summary Of Shoreline Treatment Methods.

API (2001, Chapter 6) presents a set of five similar tables for a range of oil types (I – gasoline; II – diesel and light crudes; III – medium crudes and intermediate products; IV – heavy crudes and residual products; V – non-floating oils). For each of these five oil categories, a comparison is made of the relative environmental impact of each treatment method for sixteen shoreline types including the three arctic shoreline types.

The key issues related to the treatment or cleanup of oiled snow and ice and of oil on the three "arctic" shoreline types are discussed in this section. The treatment of oil on the other nine shoreline types (Table 3.1) is described in detail in Environment Canada,1998.

3.4.2 Snow and Ice Cleanup Methods

SNOW

Response options for oil and snow are covered in detail in a number of manuals or guides (ACS, 1999; Environment Canada, 1996a; EPPR, 1998). The preferred methods for the removal of oil from snow (SNW) include the following:

- ***Manual removal*** using shovels and rakes is appropriate for small amounts of surface or subsurface oil, but practicality decreases as the amount of oiled area and the volume of oiled snow increases.
- ***Vacuum systems*** can recover pooled low- and medium-viscosity oil on the surface of a snow-covered area, or which has been collected in trenches or by containment berms.
- ***Mechanical*** techniques can scrape snow-covered areas for removal and disposal of oil on flat surfaces, or where a mechanical arm can reach the oiled area. These techniques could include melting to separate the oil and snow, or burning.
- ***Sorbents*** remove surface light or medium oil, but sorbent effectiveness decreases as the oiled area or volume of oiled snow increases, or in low temperatures that cause the oil to reach or fall below its pour point.

- ***Burning*** can be used to remove pooled oil on the snow surface or oil that has been contained by berms.

ICE

The full range of response options for oil and ice are covered in detail in a number of manuals or guides for marine or coastal environments and for rivers in winter (ACS, 1999; Environment Canada, 1996a; EPPR, 1998; Lambton, 2002).

The preferred methods for the removal of oil from frozen swash (FSW), frozen spray (FSP), an ice foot (IFT) or grounded floes (GFL) in the coastal zone or on riverbanks include

- ***Physical washing*** from the shore or from a boat or barge if water depths allow as the oil is contained and collected by booms and sorbents or skimmers. This may be effective if water does not freeze and encapsulate the oil.
- ***Flooding*** is appropriate on sloping ice surfaces for light oils, such as diesel, but is of little practical value for heavy or semi-solid oils.
- ***Sorbents*** (passive use or sorbent skimmers), ***vacuum*** units, or ***burning*** all have potential application. Where access permits, vertical rope-mop skimmers may be able to sweep ice surfaces or collect oil from cracks, crevices, and leads. Rope mops can be deployed by crane from the backshore, a barge, or even from an on-ice location.

Oil on a solid ice surface on a lake or at sea can be contained by ***snow berms*** or ***ice trenches*** to minimize the spreading and to make recovery easier. Oil on the surface of solid ice cover or oil/snow mixtures can be removed relatively easily ***manually***, for small amounts of oil, or ***mechanically*** if the ice is not heavily ridged. Oil under ice can be recovered by cutting ***ice slots*** or drilling holes and then ***skimming***. Oil trapped under ice readily flows onto the ice surface once a reservoir is tapped so that containment ***berms*** should be in place for this type of operation. Oil within ice could be reached by an ***auger*** and pumped out or could be removed by ***cutting and removing an ice block*** or blocks and then melting the ice.

3.4.3 Treatment and Cleanup Considerations for Peat and Tundra Shorelines

RESPONSE CONSIDERATIONS FOR TUNDRA CLIFFS

Tundra cliffs are an eroding and often unstable coastal feature. Block falls, slumping, and mud or slurry flows present potential safety hazards during any response operations, particularly in areas where cliff heights are greater than 2 m. Thaw flows and slumps have been observed to creep or flow slowly (N. Snow, pers. com., 2003) , but block falls may be sudden events that occur without warning. Flushing or washing activities may trigger unexpected block falls, slumping, or mud flows.

Erosion of the cliffs by natural processes is normal; therefore, cleanup activities such as low-pressure washing, which result in additional erosion of the cliff face, would not be considered damaging.

Activities should be restricted to avoid trampling or other damage to the tundra surface. In many areas, the beaches that front a tundra cliff are very narrow or absent so that there may be little working area or room to stage equipment. As noted above, the selection of cleaning techniques should take into account minimizing accelerated erosion that could be caused by cleanup. Although this is unlikely to cause significant environmental damage, the vegetation on the tundra is a living community and activities should be designed with that constraint in mind.

RESPONSE CONSIDERATIONS FOR INUNDATED LOW-LYING TUNDRA AND FOR PEAT SHORELINES

Trampling vegetation and the use of heavy machinery should be avoided as this is likely to incorporate oil more deeply into sediments. The load-bearing capacity of these low-lying areas frequently is low during the open-water season but increases following freeze-up. For summer cleanup, crews could use plank walkways or snowshoes to minimize damage and trampling.

Manual oil removal, recovery with sorbents, and flushing, although recommended methods, are also likely to promote foot traffic, which should be minimized as much as possible.

Where the tundra has been oiled, substrate removal and vegetation cropping should be minimized unless the living plant community is very heavily oiled. If vegetation is removed, only the oiled surface, the top 2 to 5 cm, should be picked up if possible to avoid root damage. Response efforts should avoid raking and trampling oil into living plants. Intrusion of the tundra is minimized by using only low-pressure hydraulic washing techniques. Burning should be avoided near living plant communities.

3.4.4 Spill Response Guides and Manuals for Arctic Environments

Two manuals that address arctic habitats and oil spill response have been prepared recently. The *Field Guide for the Protection and Cleanup of Arctic Oiled Shorelines* (Environment Canada, 1996a) contains response decision guides for shoreline protection and treatment as well recommendations on practical response options and on “What to Avoid.” Treatment strategies are presented for thirteen shoreline types that include Tundra Cliff, Peat Shores, and Inundated Low-lying Tundra. As the focus of this guide is Canadian arctic coastal environments, strategies are also described for Peat Environments, Shorelines with Snow and Ice, Response In Remote Areas, Response on Low-Energy Coasts, and on Coasts with a High Tidal Range.

The second manual, the *Field Guide for Oil Spill Response in Arctic Waters*, was prepared for the Emergency Prevention, Preparedness, and Response (EPPR) Working Group of the Arctic Environmental Protection Strategy (AEPS) of the Arctic Council (EPPR, 1998). Section 4 of this field guide includes treatment guidelines for Inundated Low-lying Tundra, Tundra Cliff, and Peat shoreline types, as well as guidelines for “Ice or Ice-Covered Shores” and for “Shorelines with Snow”.

The arctic shoreline types are also included in the U.S. *Environmental Considerations for Marine Oil Spill Response* (API, 2001) and in the publication *Characteristic Coastal Habitats* (NOAA, 2000a). For each shoreline type, these publications include a description of the habitat, predicted oil behaviour, and response considerations. They also include a matrix that evaluates response options for spills of different types of oil.

Manuals have been prepared that focus on the coastal environments of the Alaskan North Slope that include a set of guidelines for response activities on peat (Little *et al*., 1992). Shoreline tactics are described in the *Alaska Clean Seas Technical Manual* (ACS, 1999). A recent manual for the treatment of oil spills on tundra (Athey *et al*., 2001) does not deal with shorelines *per se*, but is directly applicable for any oil spilled above the normal high water level, as might occur during a spring tide or a storm surge.

3.5 JOB AIDS

3.5.1 Photographic Examples of Surface Oil Distribution (Oil Cover)

Photo 3.1 This example of a sand beach shows a

- **"no oil"** (0%) oil distribution in the 'wet' low tide terrace
- **sporatic** (~**5%**) oil distribution in the middle one-third of the intertidal zone (**MI**)
- **trace (<1%)** oil distribution on the in upper one-third of the intertidal zone (**UI**)
- **continuous (95%)** oil distribution above the normal tidal zone, i.e., the supratidal zone (**SU**)

Photo 3.2 Farther along the same sand beach, there is no oil in the supratidal zone. The oil distribution, averaged over the distance that can be viewed, would be described in terms of four across-shore oil zones.

A. **trace** distribution (**<1%**) in the lower one-third of the intertidal zone (**LI**)

B. **continuous** distribution (**100%**) in the middle one-third (MI), and

C. **patchy** distribution (**35%**) in the upper one-third of the intertidal zone (**UI**).

D. **no** oil in the supratidal zone (**SU**).

Photo 3.3 This boulder beach has a **continuous** (**100%**) distribution in the upper intertidal zone (**UI**).

Photo 3.4 This aerial view of the mixed sand-pebble-cobble beach in the lower half of the photograph has

- **<10% (sporadic)** oil in the **LI**,
- **100% continuous** in the **MI and UI**, with
- **no visible oil** in the **SU**.

3.5.2 Sediment Grain Size

Table 3.2 Grain Size Scale

Description (Wentworth Scale)		Grain Diameter (mm)
Boulder		>256
Cobble		64 – 256
Pebble		4 – 64
Granule		2 – 4
Sand	Very Coarse	1 – 2
	Coarse	0.5 – 1.0
	Medium	0.25 – 0.5
	Fine	0.125 – 0.25
	Very Fine	0.0625 – 1.125
Silt		0.004 – 0.625
Clay		0.00024 –0.004

Photo 3.5 Sand – with large tarball (scale is marked in 5-cm and 1-cm squares).

Photo 3.6 Granule (scale is 10-cm long).

Photo 3.7 Pebble (scale is marked in 5-cm and 1-cm squares).

Photo 3.8 Cobble.

Photo 3.9 Boulder.

3.5.3 Examples of Marine and River Shoreline Types

Photo 3.10 Bedrock shoreline.

Photo 3.11 Sand beach.

Photo 3.12 Mixed sediment beach.
Upper: Mixed sand/pebble/cobble beach. From a distance it appears a cobble beach, however, sand and pebble fill interstitial spaces below surface layer of cobble. *Middle.* Mixed sand/cobble. The interstitial sand with surface cobble armour layer is more evident. *Lower.* A mixed sand/granule/pebble without the cobble fraction - often called a sand/gravel beach.

Photo 3.13 Pebble-cobble beach.

Photo 3.14 Boulder beach.

Photo 3.15 Mud tidal flat.

Photo 3.16 Sand tidal flat.

Photo 3.17 River meander.

Photo 3.18 Braided river channel.

3.5.4 Photographic Examples and Key Features of Peat and Tundra Shorelines

This section describes and provides illustrations of three shoreline types that are common to Arctic Ocean coasts.

- Tundra Cliffs (Tables 3.3 and 3.4)
- Inundated Low-lying Tundra (Table 3.5)
- Peat Shorelines (Table 3.6)

These shoreline types are discussed in terms of

- the physical characteristics and processes that are important from an oil spill response perspective
- the potential behaviour of oil that comes ashore, and
- considerations that are important in the development of treatment or cleanup decisions

Tundra cliffs are divided into two types: ***Ice Rich*** – a unique arctic shoreline type; and ***Ice Poor*** – these are the same as eroding unconsolidated sediment cliffs found in lower latitudes except that they have a surface tundra vegetation mat.

Low-lying inundated tundra coasts are also called “transgressive thermokarst coasts” (e.g., Dallimore *et al*., 1996; Hill and Solomon, 1999; Ruz *et al*., 1992) in recognition of the role of thaw processes in the formation of the lakes in areas of tundra that are underlain by ice-rich permafrost.

A fourth arctic shore type is the category of calving glaciers, ice shelves, and permanent ice or snow patches. Ice shorelines are not unique to arctic regions and are regarded as being similar to a “bedrock” shore type for response options and strategies (Environment Canada, 1996a). Permanent ice or snow patches are common in the Arctic and are characterized by an intertidal ice foot typically with snow in the supratidal zone.

Tundra Cliff: Ice Rich

Photo 3.19 Erosion by wave undercutting and thermal erosion that leads to block falls.

Photo 3.20 Mass wasting by ground ice slumps (or “retrogressive thaw flow”) with mud slurry flows.

Table 3.3 TUNDRA CLIFF: Ice Rich

Physical Character

Usually a tundra vegetation mat overlies a peat layer and exposed ground ice (permafrost).

Unstable: erosion rates often >1m/month in the open-water season.

Produce either slumped tundra-peat blocks or mud slurries in the intertidal zone.

Oil Behaviour

Persistence would be short due to natural high erosion rates but could be extended if oil is buried by block falls or incorporated in peat slurry.

Oil would be absorbed by peat and may pool between blocks.

Oil would not stick to wet mud slurries but could mix with them.

Treatment Considerations

Unstable, so safety is a key issue.

Options include natural recovery, manual or mechanical removal, low-pressure wash, and sorbents.

Avoid damage to the tundra surface.

Tundra Cliff: Ice Poor

Photo 3.21 Erosion by basal wave erosion and slope debris slides.

Photo 3.22 Erosion by surface wash.

Table 3.4 TUNDRA CLIFF: Ice Poor

Physical Character

Eroding, unconsolidated sediment cliffs with a surface tundra mat.

Usually have a sand or sand-gravel beach at the base that is supplied by the products of cliff-face erosion.

More stable than ice-rich tundra cliffs.

Oil Behaviour

Same as a sand or sand-gravel beach.

Penetration would occur only for light oils: medium, heavy or weathered oils would remain on the surface but could be buried by wave action.

Treatment Considerations

Manual or mechanical removal; surf washing.

Avoid sediment removal at cliff base.

Inundated Low-lying Tundra

Photo 3.23 Drowned interconnected ponds or channels.

Photo 3.24 Typical inundated high-rim polygons.

Table 3.5 INUNDATED LOW-LYING TUNDRA

Physical Character

- Interconnected ridges and shallow ponds.
- Produced by the drowning of low-land tundra and by polygon breaching.
- Combination of vegetated flats, peat mats, and salt or brackish lagoons.

Oil Behaviour

- Vegetation often is water-saturated, which would limit penetration.
- Oil may be on the water surface in ponds.
- Oil may be deposited some distance inland during a storm surge.

Treatment Considerations

- Avoid trampling and disturbance of tundra surface and minimize vegetation removal: the tundra is a living plant community.
- Typically low bearing capacity may need planks or snow shoes for access.
- Options include low-pressure washing and vacuums or skimmers.

Peat Shoreline

Photo 3.25 Spit formed by the alongshore transport (towards the camera) of peat.

Photo 3.26 Two flying spits of peat that have formed at the downdrift end of a small island.

Table 3.6 PEAT SHORELINE

Physical Character Spongy cohesive or granular material produced from tundra erosion. May be an uncohesive wet or dry beach deposit with a low bearing capacity or a mobile slurry mat.
Oil Behaviour Crude or heavy oils would not penetrate: dry peat would adsorb medium and light oils. Peat slurry is similar to a loose granular sorbent and would reduce the spreading of oil.
Treatment Considerations Avoid trampling and mixing oil into dry or wet peat mats. Low bearing capacity may need planks or snow shoes for access. Options include manual removal, flushing, and vacuums.

"Perched Beach"

Photo 3.27 "Perched beach" of sand and gravel on top of a low (3-m high) eroding tundra cliff.

Driftwood Line

Photo 3.28 Driftwood lines: one at the spring high tide level and a higher one over 250 m inland on the tundra.

Source Material Related to the Behaviour of Oil and Treatment Options for Arctic Shoreline Types

- ACS, 1999
- API, 2001
- Athey *et al*., 2001
- Environment Canada, 1996
- EPPR, 1998
- Little *et al*., 1992
- NOAA, 2000a
- Owens and Harper, 1983
- Owens and Michel, 2003

3.5.5 Photographic Examples of Shoreline Ice and Snow Conditions

This section provides an illustrated guide to the seven terms (with their abbreviations) that are used to describe shore-zone snow and ice conditions:

SNW ***Snow***
FSW ***Frozen swash***
FSP ***Frozen spray***
IFT ***Ice foot***
IPR ***Ice-push ridge***
GFL ***Grounded ice floes***
GLC ***Glacier ice***

Photographic examples are provided of nearshore ice conditions and of a typical winter shore-zone snow-ice combination. Further examples of nearshore ice are provided in the "Observers' Guide to Sea Ice" (NOAA, 2000c) that can be downloaded from:

http://response.restoration.noaa.gov/oilaids/seaice/seaice.html

Snow SNW

Photo 3.29 Snow on the supratidal zone of a beach.

Photo 3.30 Snow on the supratidal zone of a marsh.

Frozen Swash FSW

Photo 3.31 Frozen swash.

Frozen Spray FSP

Photo 3.32 Frozen Spray - by definition, FSP would be present only in the supratidal zone.

Ice Foot IFT

Photo 3.33 Initial IFT growth phase with frozen swash (FSW) in the middle and upper intertidal zones.

Photo 3.34 Next stage with additional FSW ice in the middle intertidal zone.

Photo 3.35 Mid-winter ice foot (IFT) with tidal cracks and nearshore 10/10 compact ice.

Photo 3.36 Thaw stage with a remnant ice foot (IFT) in the upper intertidal zone.

Ice-push Ridge IPR

Photo 3.37 Ridge of sediment created by ice push (IPR) in the supratidal zone.

Grounded Floes GFL

Photo 3.38 Grounded floes (“ice cakes” <20m) in the middle and upper intertidal zones.

Photo 3.39 Shore ice pile up (courtesy R.B. Taylor).

Photo 3.40 Grounded multi-year floes (“ice cakes” <20 m and “small floes” 20-100 m).

Photo 3.41 Grounded floes ("ice cakes" <20 m) in the upper intertidal zone: macrotidal environment - Bay of Fundy.

Glacier Ice GLC

Photo 3.42 Floating tidewater glacier front that is retreating primarily by thermal erosion.

Photo 3.43 Active calving tidewater glacier front.

Nearshore Ice

Photo 3.44 9/10 very close pack of nilas and young grey-white brash ice and ice cakes.

Photo 3.45 Nearshore: 10/10 compact nearshore young grey-white brash ice and ice cakes. Offshore: 4/10 – 6/10 open drift.

Photo 3.46 10/10 compact ice.

COMBINATION SHORE ZONE SNOW AND ICE

Photo 3.47

A Nearshore Zone – Open

B Lower Intertidal Zone – FSW

C Upper Intertidal Zone – IFT

D Supratidal Zone - SNW

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3.7 CONVERSIONS

Length

1 centimetre	=	0.394 inches
1 inch	=	2.54 cm
1 foot	=	0.3048 metres
1 kilometre	=	0.6214 statute miles
1 kilometre	=	0.5399 nautical miles
1 metre	=	3.281 feet
1 nautical mile	=	6076 feet
1 nautical mile	=	1.852 kilometres
1 nautical mile	=	1.1508 statute miles
1 statute mile	=	1.609 kilometres

Area

1 acre	=	43,560 $feet^2$
1 acre	=	0.4047 hectares
1 hectare	=	2.471 acres
1 hectare	=	10,000 $metres^2$
1 square kilometre	=	0.3861 $miles^2$
1 square mile	=	640 acres
1 square mile	=	2.60 $kilometres^2$
1 square nautical mile	=	848.8 acres
1 square nautical mile	=	1.326 statute $miles^2$

Speed

1 knot	=	0.514 cm/second
1 knot	=	1.688 feet/second
1 knot	=	1.15 statute (st.) miles/hour
1 st. mile/hour	=	0.869 knots
1 st. mile/hour	=	0.45 metres/second
1 metre/second	=	1.95 knots
1 metre/second	=	3.28 feet/second
1 metre/second	=	2.24 st. miles/hour

Volume

1 barrel (U.K.)	=	35 Imperial gallons (approximate)
1 barrel (U.S.)	=	42 US gallons (approximate)
1 barrel (U.S.)	=	5.6 $feet^3$ (approximate)
1 barrel (U.S.)	=	159 litres (approximate)
1 barrel (U.S.)	=	0.16 $metres^3$ (approximate)
1 cubic foot	=	6.2288 Imperial gallons
1 cubic foot	=	7.4805 US gallons
1 cubic foot	=	0.1781 US barrel
1 cubic foot	=	28.316 litres
1 cubic foot	=	0.02832 $metres^3$
1 cubic inch	=	16.39 $centimetres^3$
1 litre	=	0.22 Imperial gallons
1 litre	=	0.2642 US gallons
1 litre	=	0.00629 US barrels
1 litre	=	0.03532 $feet^3$
1 litre	=	1000 $centimetres^3$
1000 litres	=	1 $metre^3$
1 cubic metre	=	220.0 Imperial gallons
1 cubic metre	=	264.172 US gallons
1 cubic metre	=	6.289 US barrel
1 cubic metre	=	35.31 $feet^3$
1 cubic metre	=	1000 litres
1 Imperial gallon	=	1.2009 US gallons
1 Imperial gallon	=	0.02859 US barrels
1 Imperial gallon	=	0.1605 $feet^3$
1 Imperial gallon	=	4.546 litres
1 millilitre	=	1 $centimetre^3$
1 US gallon	=	0.83268 Imperial gallons
1 US gallon	=	0.02381 US barrel
1 US gallon	=	0.13368 $feet^3$
1 US gallon	=	3.7853 litres

PART 4 - FIRST RESPONDER GUIDE

4.1	**SUMMARY OF SURVEY STEPS**
	Identification of the Survey Team Pre-spill Mapping and Segmentation Aerial Observations Ground Observations
4.2	**THE "SHORT" OILING SUMMARY FORMS**
4.3	**INSTRUCTIONS TO COMPLETE THE FORMS**
4.4	**TERMS AND DEFINITIONS**

In many cases, the First Responders to spills in arctic or remote regions will be regional inhabitants, and they are in the best position to conduct a rapid initial assessment on the nature of the shoreline oiling. Up-to-date, accurate information on shoreline oiling conditions is very important to planning the response and making decisions on cleanup. In some cases, First Responders will continue with the assessment survey teams as additional support personnel arrive on scene.

The shoreline, where land and water meet, is the area where oil usually becomes stranded. This guide includes marine shorelines, lake shorelines, and the shoreline or banks of rivers and streams. The systematic description of oiled shorelines or riverbanks involves field surveys to describe the location and character of stranded oil. Data are recorded by the First Responders on standard "short" forms that are described in this section of the Field Guide, which is intended as a stand-alone document. Cross references to the main body of the Field Guide indicate where more detailed or additional information can be obtained.

Preparation for the SCAT surveys can be carried out well in advance of any actual spills (pre-spill), for example by training those who would be involved with assessment surveys or by mapping the character of shorelines and rivers in the region. However, if necessary, this preparation can also be completed after the spill and prior to the SCAT survey (pre-survey).

4.1 SUMMARY OF SURVEY STEPS

STEP 1 – IDENTIFICATION OF THE SURVEY TEAM

Pre-spill or pre-survey planning involves the identification and training of individuals who will be the First Responders (Section 1.2.5). ***Team rosters*** are established so that individuals are prepared to undertake field surveys at short notice. The teams include archaeologists or cultural resource experts for incidents where a spill occurs in an area were there are known or suspected archaeological or cultural resources.

STEP 2 – MAPPING AND SEGMENTATION

A key element in the preparation for a field survey is to map the ***shoreline*** or ***riverbank types*** and to map the ***coastal*** or ***river channel character*** (Sections 2.2.1 and 3.1.4). This essential step divides the coast or river into working units known as ***shoreline segments*** or ***river reaches*** within which the shoreline or riverbank is relatively uniform in terms of physical character and sediment type (Section 1.3.1 and 1.3.2).

Segment boundaries are established on the basis of prominent physical features (such as a headland), changes in shoreline, riverbank, or sediment type, or where there is a change in the backshore character that would affect the operations activities. Segments or reaches have a unique numbering scheme. If segments have not been created as part of the pre-spill mapping, they will be created during either the aerial survey (Step 3) or the ground survey (Step 4).

Mapping and segmentation may be completed pre-spill or at the time of the spill. If a segment or reach has been defined by pre-spill or aerial survey mapping, but the oil is not uniformly distributed within the segment or reach, then ***divide the segment or reach into sub-segments based on the alongshore change in oiling conditions***.

STEP 3 – AERIAL OBSERVATIONS

If the spill covers an area that cannot be surveyed on the ground in less than a few hours, approximately half a day, then First Responders carry out an ***aerial reconnaissance*** to define the overall scale of the problem (Section 1.3.4). The purpose of the aerial reconnaissance is simply to cover relatively large areas in a short time period.

For large spills or for spills in remote areas where ground access is impractical or difficult, First Responders carry out an ***aerial survey*** to prepare a map or maps that show the locations of stranded oil and the distribution and character of that oil. An aerial survey documents the shoreline and riverbank types and surface oiling conditions in a systematic manner typically using ***video mapping techniques*** (Section 1.3.4) and can cover an extensive area to provide a level of detail of sufficient accuracy for mapping purposes. This information is the foundation for the development of regional strategies and plans, for segmentation of the shoreline or river, and for the definition of lengths of oiled shoreline or riverbank in terms of shoreline or riverbank types and the oil character.

STEP 4 – GROUND OBSERVATIONS

First Responders carry out ground surveys to systematically document shoreline oiling conditions within the affected area so that cleanup operations can begin as soon as possible. These surveys involve the completion of the **"Short" Arctic Shoreline** or **"Short" Winter Riverbank Oiling Summary Forms** (Section 4.2) and drawing a sketch of the segment or reach (Section 1.6). If First Responders have been trained for this type of shoreline survey, they can choose to use the standard Arctic Shoreline Oiling Summary Form (Section 1.5.1) or one of the other standard forms described in Section 2.2.2.

Ground surveys typically are the primary source of detailed data and information. This systematic documentation of the location, character, and amounts of surface and subsurface oil in all of the segments within the affected area is the foundation for planning and implementing the shoreline treatment or cleanup operations. Coastal surveys are typically conducted during the 2-hour period before and after the predicted time of the low tide.

4.2 THE "SHORT" OILING SUMMARY FORMS

Two forms have been developed for First Responders so that accurate information can be collected quickly. One form is designed for use on shorelines in the Arctic or during winter months - the **"Short" Arctic Shoreline Oiling Summary (ASOS) Form** - and the other is intended for rivers in winter - the **"Short" Winter Riverbank Oiling Summary (WRBOS) Form**. The forms can be copied from the following pages or downloaded in .'pdf' format or as an MS Excel spreadsheet from www.polarisappliedsciences.com. Instructions for the two "short" forms are provided in Section 4.3 and key terms and definitions are given in Section 4.4.

Insert file - Short Arctic SOS - shortASOS

"SHORT" ARCTIC SHORELINE OILING SUMMARY (ASOS) FORM for ______________ Spill Page ___of ___

1 GENERAL INFORMATION | Date (dd/mm/yy) | Time (24h): standard/daylight | Tide Height
Segment ID:
Operations Division: hrs to hrs rising / falling
Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________ | Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ___ deg C.

2 SURVEY TEAM # ______ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment Length*** ________________ ***m*** ***Segment Length Surveyed*** ________________ ***m***

Start GPS: LATITUDE ________ deg. ________ min. LONGITUDE ________ deg. ________ min.
End GPS: LATITUDE ________ deg. ________ min. LONGITUDE ________ deg. ________ min.
Differential GPS Yes / No

4A SHORELINE TYPE ***select only one primary (P) oiled shoreline, snow, or ice type and any number of secondary (S) types***

BEDROCK : ___ ***MAN-MADE SOLID :*** ___ | ***SEDIMENT BEACH :*** | ***SEDIMENT FLATS :*** Mud Flats ___
cliff/vertical ___ sloping ___ platform ___ | Pebble-Cobble ______ Sand ___ | Sand Flats ___ Sand-Gravel ___
MARSH or WETLAND: ____ | Mixed Sand-Gravel ___ Boulder ___ | Peb-Cob ___ Boulder ___
Tundra Cliff : ice rich ___ ice poor ___ ***Peat Shoreline:*** ____ ***Inundated Low-lying Tundra:*** ____
Frozen Swash: ____ ***Frozen Spray*** : ____ ***Ice Foot*** : ____ ***Grounded Ice Floes:*** ____ ***Glacier :*** ____ ***Snow:*** ____

4B NEARSHORE ICE CONDITONS

CONCENTRATION:	***FORM:***	***THICKNESS:***
estimate ice cover in tenths	estimate average size of floes (circle one)	estimate thickness (circle one)
____ ***/ 10***	< 2m 2-20m 20-100 > 100m	< 0.1m 0.1 - 0.5m 0.5 - 2.5m > 2.5m
	Tidal Cracks at Shoreline ?: Y / N	

4C COASTAL CHARACTER ***backshore character — select only one primary (P) and any number of secondary (S) types***

CLIFF or HILL : ___ : est. height ______ m | Beach ___ Delta ___ Tidal inlet ___ Marsh/Wetland ___
slope: gentle (<5°)___ medium___ steep (>30°)___ | Barrier beach ___ Dune ___ Channel ___ other __________

5 OPERATIONAL FEATURES debris Y / N oiled? Y / N debris amount: ______ bags OR ______ trucks
direct backshore access Y / N suitable backshore staging Y / N
alongshore access from next segment Y / N access restrictions ______________

6 ZONE ID ________ ***Description of Oil Conditions in Supra / Upper / Mid / Lower Intertidal Zone (circle one)***

Oil Band	**Surface Oil Distribution**	**Surface Oil Thickness**	**Surface Oil Character**	**Subsurface Oil** *Penetration*	**Subsurface Oil** *Burial*
Width ***Length***	< 1%	Film	Fresh Liquid	< 1 cm	***Clean Layer :***
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	5 - 10 cm	______ cm
SEDIMENT or SNOW and ICE TYPE(S) :	51 - 90%	Cover	Tar Patties	> 10 cm	***Oiled Layer :***
	91 - 100%	Pooled	Asphalt Pavement		
	____ %	____ cm	____ other	____ cm	______ cm

7 ZONE ID ________ ***Description of Oil Conditions in Supra / Upper / Mid / Lower Intertidal Zone (circle one)***

Oil Band	**Surface Oil Distribution**	**Surface Oil Thickness**	**Surface Oil Character**	**Subsurface Oil** *Penetration*	**Subsurface Oil** *Burial*
Width ***Length***	< 1%	Film	Fresh Liquid	< 1 cm	***Clean Layer :***
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	5 - 10 cm	______ cm
SEDIMENT or SNOW and ICE TYPE(S) :	51 - 90%	Cover	Tar Patties	> 10 cm	***Oiled Layer :***
	91 - 100%	Pooled	Asphalt Pavement		
	____ %	____ cm	____ other	____ cm	______ cm

8 COMMENTS ***cleanup recommendations—ecological/recreational/cultural/economic issues & constraints—wildlife obs.***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

Sketch Yes/No **Photos** Yes/No (Roll # ________ Frames______) **Video Tape** Yes/No (tape #_____) ver.01/04

Insert file - short WRBOS

"SHORT" WINTER RIVER BANK OILING SUMMARY (WRBOS) FORM for _______________ Spill Page ___ of ___

1 GENERAL INFORMATION	Date (dd/mm/yy)	Time (24h): standard/daylight	**Water Level**
Segment/Reach ID: **L or R**			low-mean-bankfull-overbank
Operations Division:		hrs to hrs	falling-steady-rising
Survey by: Foot / ATV / Boat / Helicopter / Overlook / ________		Sun / Clouds / Fog / Rain / Snow / Windy / Calm :: Air Temp + / - ___ deg C.	

2 SURVEY TEAM # ______ ***name***	***organization***	***contact phone number***

3 SEGMENT ***Total Segment/Reach Length*** ___________ ***m*** ***Segment/Reach Length Surveyed*** ___________ ***m***

Start GPS: LATITUDE ________ deg. ________ min. LONGITUDE ________ deg. ________ min.

End GPS: LATITUDE ________ deg. ________ min. LONGITUDE ________ deg. ________ min.

Differential GPS Yes / No

4A RIVER BANK TYPE ***select only one primary (P) oiled river bank type and any number of secondary (S) types***

BEDROCK : ____ ***MAN-MADE SOLID :*** ____ ***UNCONSOLIDATED :*** Clay ____ Mud ____ Sand ____

cliff/vertical ____ sloping ____ platform ____ Mixed Sand-Gravel ____ Pebble-Cobble ____ Boulder ____ Rubble ____

Marsh/Swamp ____ Peat ____ Vegetated ____ Shell Hash ____

Tundra Cliff : ice rich _____ ice poor _____ ***Peat Shoreline:*** _____ ***Inundated Low-lying Tundra:*** _____

Frozen Swash: _____ ***Frozen Spray*** : _____ ***Ice Foot*** : _____ ***Grounded Ice Floes:*** _____ ***Snow:*** _____

4B RIVER ICE CONDITONS

CONCENTRATION:	***FORM:***	***THICKNESS:***
estimate ice cover in tenths	estimate average size of floes (circle one)	estimate thickness (circle one)
_____ **/ 10**	< 2m 2–20m 20–100 > 100m	< 0.1m 0.1 – 0.5m 0.5 – 2.5m > 2.5m
	fast ice at bank Y / N	

4C RIVER VALLEY CHARACTER ***backshore — select only one primary (P) and any number of secondary (S) types***

CLIFF or BLUFF: est. height _______ m | canyon ____ confined or leveed channel ____ flood plain valley ____

slope: gentle (<5º)____ medium____ steep (>30º)____ | straight ____ meander ____ anastamosed ____ braided ____

4D RIVER CHANNEL CHARACTER ***circle or select as appropriate***

est. width : < 1m 1–10 m 10–100 m >1000m ______m **est. water depth :** <1 m 1-3 m 3-10 m >10 m ____ m

shoal(s) present Y / N **point bar present** Y / N **bar-shoal substrate :** silt / sand / gravel / cobble / boulder / bedrock / debris

seasonal water level: low / mean / bank full / overbank flow **est. change over next 7 days :** falling — same — rising

5 OPERATIONAL FEATURES debris? Y / N oiled? Y / N debris amount: _______ bags OR _______ trucks

direct backshore access Y / N suitable backshore staging: Y / N

alongshore access from next segment Y / N access restrictions: ________________________________

6 ZONE ID __________ ***Description of Oil Conditions in Lower / Upper / Overbank Zone (circle one)***

Oil Band	**Surface Oil Distribution**	**Surface Oil Thickness**	**Surface Oil Character**	**Subsurface Oil** ***Penetration***	**Subsurface Oil** ***Burial***
Width **Length**	< 1%	Film	Fresh Liquid	< 1 cm	***Clean Layer :***
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	5 - 10 cm	________ cm
SEDIMENT or SNOW and ICE TYPE(S) :	51 - 90%	Cover	Tar Patties	> 10 cm	***Oiled Layer :***
	91 - 100%	Pooled	Asphalt Pavement		
	________ %	______ cm	__________ other	________ cm	________ cm

7 ZONE ID __________ ***Description of Oil Conditions in Lower / Upper / Overbank Zone (circle one)***

Oil Band	**Surface Oil Distribution**	**Surface Oil Thickness**	**Surface Oil Character**	**Subsurface Oil** ***Penetration***	**Subsurface Oil** ***Burial***
Width **Length**	< 1%	Film	Fresh Liquid	< 1 cm	***Clean Layer :***
	1 - 10%	Stain	Mousse	1 - 5 cm	
m x m	11 - 50%	Coat	Tarballs	5 - 10 cm	________ cm
SEDIMENT or SNOW and ICE TYPE(S) :	51 - 90%	Cover	Tar Patties	> 10 cm	***Oiled Layer :***
	91 - 100%	Pooled	Asphalt Pavement		
	________ %	______ cm	__________ other	________ cm	________ cm

8 COMMENTS ***cleanup recommendations—ecological/recreational/cultural/economic issues & constraints—wildlife obs.***

(for ALL sub-segments record: sub-segment ID, length, length surveyed,and GPS start/end fixes)

4.3 INSTRUCTIONS TO COMPLETE THE "SHORT" FORMS AND DRAW A SKETCH

The two "short" forms are similar in most respects. Only Boxes 4A and 4C/4D are different, as these provide information on the physical character of the shoreline segment or the river reach.

The following is a recommended sequence of activities to survey a segment or reach.

- If the segment or reach has been defined by pre-spill or aerial survey mapping, then walk the full length of the segment to make a preliminary evaluation of the location of oil within it boundaries. Define sub-segments if the oiling is not uniform alongshore within the segment or reach.
- If segments or reaches have not been defined by pre-spill aerial survey mapping, then select appropriate segment boundaries (Sections 1.3.1 and 4.1), walk the length of the segment to make a preliminary evaluation of the location of oil, and to locate the boundaries with GPS coordinates.
- While walking the segment or reach, one member of the team draws a sketch map to show the key physical features and the location(s) of oil within the segment or reach (see below and Sections 1.6 and 4.2).
- While walking the segment or reach, dig pits or trenches to determine if oil penetrated or is buried, and take photographs or videos of characteristic oiling conditions.
- The team discusses the key features and the oiling conditions, and then one person completes the form as described below.
- Before leaving the segment or reach, the team checks the sketch and makes revisions if necessary, after having completed the form, and checks that all of the relevant boxes in the form have been completed.

Enter the name of the spill incident at the top of the form.

Complete BOX 1 to record the site location, date, time, and weather conditions.

- If the shoreline or river has not been divided by pre-spill or aerial survey mapping, the team will decide on the segment boundaries (Section 1.3.1) and assign a Segment ID.
- If the segment or reach has been defined by pre-spill or aerial survey mapping and the team decides to create sub-segments then add "**- A**", "**- B**", etc. to the Segment ID.
- If an Operations Division has been created, this number or letter should be inserted in Box 1.
- Tide height is obtained from tide tables.
- Air temperature is estimated.

Complete BOX 2 to record survey participants.

- Enter the team number, if one has been assigned, and the names of all the people on the team along with their organization's name.
- Enter contact phone numbers as these are important if questions arise later about information that has been recorded on the form.

Complete BOX 3 to define the limits of the segment/reach or of the surveyed section.

- Segment or reach length is estimated
- If only a portion of the segment or reach is surveyed, then the length of that portion is estimated.
- If the survey team has a GPS unit, one member of the team records the latitude and longitude of the segment boundaries or of the section that is surveyed.

Complete BOX 4A to describe the physical character of that part of the shore zone or riverbank that is oiled.

- For the ***shoreline or riverbank type***, select only one primary type (P) that best describes the oiled area, and select as many secondary types (S) as are appropriate.
- The definitions of sediment terms are provided in Section 4.4.
- Photo examples of the shoreline types are given in Section 3.5.3 and 3.5.4 and of snow and ice features in Section 3.5.5.

Complete BOX 4B to describe the nearshore or river ice conditions.

- The ***concentration*** is the ice cover in the area adjacent to the shoreline or the riverbank and is estimated in tenths.
- The ***form*** is the size of the ice floes in the immediate area adjacent to the shoreline or the riverbank. Circle one of the four choices. If there is solid ice cover (10/10) then also note if there are any parallel cracks at the shoreline or riverbank.
- For the ice ***thickness*** circle one of the four choices.

Complete BOX 4C to describe the character of the backshore area where operations would stage or deploy.

- For the ***coastal*** or ***river valley character***, select only one primary oiled type (P) that best describes the area where operations would stage equipment or would access the oiled area, and select as many secondary oiled types (S) as are appropriate.

Complete BOX 4D (<u>RIVER "short" form only</u>) to describe the character of the river channel.

- Estimate the ***channel width*** and ***water depth*** by circling one of the four choices or by entering a number.
- Indicate if a ***shoal*** or shoals and a ***point bar*** are present and then circle the character of the substrate (material).

- The definitions of the substrate sediment terms are provided in Section 4.4.
- Circle the appropriate river water level at the time of the observations and, if possible, indicate if the water level is expected to rise or fall.

Complete BOX 5 to describe features that affect access to or within the oiled area.

- Circle the choices as appropriate and comment on any access restrictions.

Complete BOX 6 to describe the oiling condition within the segment or reach.

- First circle the Tidal or Riverbank Zone(s) in the top line of the box to indicate the location of the oil that is described in this box.
- If there is no surface oil in the segment or reach then enter "**0**%" at the bottom of the ***Surface Oil Distribution*** column.
- If there is no subsurface oil in the segment or reach then enter "**0 cm**" at the bottom of the ***Subsurface Oil – Penetration*** and ***Burial*** columns.
- If Surface Oil is present:
  - ✓ Enter the ZONE ID, beginning with A in the lowest tidal or riverbank zone if there is more than one oil band.
  - ✓ Estimate the ***Length*** and ***Width*** of the ***Oil Band***.
  - ✓ Enter as many of the ***Sediment or Snow and Ice Types(s)*** as appropriate for the ***Oil Band*** using the abbreviations given in Section 4.4.
  - ✓ Circle the appropriate boxes for ***Surface Oil Distribution****,* ***Surface Oil Thickness***, and ***Surface Oil Type****.* Terms and definitions for these surface oil conditions are provided in Section 4.4. Additional guidance is given in Section 3.1.1.

- If Subsurface Oil is present:
  - ✓ Refer to Section 4.4 for guidance on the definition of Subsurface Oil
  - ✓ Circle the depth of ***Penetration*** or enter a number in the bottom box

  OR

  - ✓ for ***Burial*** enter a number in the ***Clean Layer*** box, to record the thickness of the clean layer of sediment above the buried oil layer, and enter a number in the ***Oiled Layer*** box to record the thickness of the buried oil layer.

Complete BOX 7 to describe the oiling condition if there is more than one Oil Band within the segment or reach.

- If there are more than two oiled bands then complete a second page to the form and note the number of pages at top right "Page______ of ______".
- To describe more than two Oil Bands only complete Boxes 6 and 7 on the additional pages.

Complete BOX 8 to describe physical, ecological, or cultural features or access/staging.

Complete the line below BOX 8 to indicate if a sketch has been drawn and if photographs or videos have been taken.

- If only one page of the form is used enter **Page 1 of 1** at top right.

Draw a SKETCH MAP with the physical layout of the segment or reach and the location(s) of oil within the segment or reach.

- Draw the lines of the Lower / Middle / Upper / Supra Tidal zones within the shoreline segment or the Lower / Upper / Overbank Zones within the river reach.
- Mark the location(s) of the oil and the ZONE ID from Box 6 or 7 for each oil location.
- Mark the locations of all pits or trenches with an open triangle for pits/trenches with no oil and fill in the triangle if penetrated or buried oil is found. Include the ZONE ID from Box 6 or 7 for each oil location.
- Add an approximate scale and north arrow.
- Add any other information that might be useful to interpret the "Short" Form or be useful for Operations when they arrive at the segment or reach (such as possible staging areas, cliffs, bluffs, nearshore rocks or reefs, etc.)
- ***Make sure that the Segment ID and Date are included at the top of the Sketch Map*.**

4.4 TERMS AND DEFINITIONS

SEDIMENT TERMS

Clay: cohesive or stiff mud

Mud: <0.06 mm diameter

Sand: 0.06 - 4 mm diameter

Mixed Sand-Gravel: sand with pebbles and/or cobbles

Pebble: 4 - 64 mm diameter

Cobble: 64 - 256 mm diameter

Boulder: > 256 mm diameter

Rubble: man-made combination of sand, pebbles, cobble, or boulders

INTERTIDAL ZONE TERMS

Lower Intertidal Zone -- the lower approximate one- third of the intertidal zone

Mid Intertidal Zone -- the middle approximate one-third of the intertidal zone

Upper Intertidal Zone – the upper approximate one- third of the intertidal zone

Supratidal Zone – the area above the mean high tide that occasionally experiences wave activity; also known as the splash zone

RIVER ZONE TERMS

Lower Bank — exposed only during low flow conditions

Upper Bank — under water only during bank-full river stage

Over-bank = flood plain — inundated only by over-bank flow during flood conditions

SNOW AND ICE TERMS (see also photographic examples in Section 3.3.5)

FSW ***Frozen swash***

FSP ***Frozen spray that is above the intertidal zone***

IFT ***Ice foot***

IPR ***Ice-push ridge***

GFL ***Grounded ice floes***

GLC ***Glacier ice***

SNW ***Snow***

SURFACE OIL THICKNESS

This term refers to the average or dominant oil thickness within the segment or zone. It is described according to the following categories.

PO ***Pooled or Thick Oil*** — generally consists of fresh oil or mousse accumulations >1 cm thick

CV ***Cover*** — >0.1 cm to ≤1 cm thick

CT ***Coat*** — >0.01 cm and ≤0.1 cm thick; can be scratched off with fingernail on coarse sediments or bedrock

ST ***Stain*** — ≤0.01 cm thick; cannot be scratched off easily from coarse sediments or bedrock

FL ***Film*** — transparent or translucent film or sheen

SURFACE OIL CHARACTER

This term provides a qualitative description of the form of the oil.

FR ***Fresh*** — unweathered, low viscosity oil

MS ***Mousse*** — emulsified oil (oil and water mixture) existing as patches or accumulations, or within interstitial spaces.

TB ***Tar Balls*** — discrete balls, lumps or patches on a beach or adhered to rock or coarse-sediment substrate. Tar ball diameters are generally <10 cm.

PT ***Tar Patties*** — discrete lumps or patches of oil on a beach or adhered to the substrate. Tar patties are generally >10 cm.

AP ***Asphalt Pavement*** — consists of a cohesive mixture of oil and sediments.

SUBSURFACE OIL

When oil has penetrated sediments, the vertical width or thickness of the oiled sediment, snow or ice (subsurface) layer is recorded. When oil has been buried by sediments, the top and bottom boundaries of the lens are recorded. The bottom boundary is equal to the maximum depth of oil penetration. Due to uncertainty in defining the beach surface and differentiating the boundary between surface and subsurface, the following guides have been developed and are further illustrated in Figure 3.4.

- **Fine sediments** (pebble/granule/sand/mud) and/or fine mixed sediments; the subsurface begins at 5 cm below the beach surface. For the purpose of measurement, the beach surface is the 0 cm reference level.
- **Coarse Sediments** (pebble/cobble/boulder) and armoured beaches; the subsurface begins at the bottom of the first layer of surface material (i.e., disregard the surface layer). For the purpose of measurement, the beach surface reference point (0 cm) begins at the bottom of the first layer.
- **Asphalt Pavement;** Where AP exists on the surface, the subsurface begins at the underside of the pavement. For the purpose of measurement, the beach surface reference point (0 cm) begins at the top surface of the pavement