SCAT Shoreline and Nearshore Surveys following the Lake Wabamun Oil Spill

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Abstract

The Shoreline Cleanup Assessment Technique (SCAT) survey following the Canadian National Railway (CN) train derailment and resulting oil spill into Lake Wabamun near Edmonton, AB, Canada, initially involved an aerial reconnaissance. These observations were used to divide the 62 km length of lake shoreline into 7 major shoreline types and 191 segments within 10 operational divisions. An inter-agency SCAT Team was formed to conduct ground surveys to document shoreline physical characteristics and oiling conditions using standard protocols. A nearshore survey involved visual observations using a grid search pattern to locate and map sunken oil. The results of the ground SCAT survey were then evaluated by an inter-agency Treatment Advisory Group (TAG) to set priorities for shoreline treatment and to establish 2005 clean-up endpoints for each shoreline type. A general shoreline treatment plan, agreed upon by the Responsible Party (CN) and government agencies, was used to guide treatment activities for all areas. In addition, site-specific plans for treatment were developed for areas defined as either 'Very Sensitive Areas' or areas requiring a type of specialized treatment; these plans were primarily reed beds and other shorelines considered to be 'ecologically sensitive'. Treatment activities were monitored by government agencies and in late fall 2005 a post-treatment shoreline evaluation and a second SCAT survey were conducted to provide a report of progress prior to winter demobilization.

1. Background

A derailment of CN train cars at 05:39 hours on August 3, 2005 occurred adjacent to Lake Wabamun approximately 60 km west of Edmonton, Alberta, Canada. Of the 46 cars derailed, 25 contained Bunker C and 11 of these cars lost all or part of their loads resulting in an estimated release of 712,000 L of Bunker "C" heavy fuel oil. One car of Imperial Pole Treating Oil was derailed and ruptured to release an estimated 88,000 L of product. The oils saturated the adjacent ground, flowed on the surface, and entered the lake waters on the north shore (approx. 53^0 34.045 N and 114^0 35.201 W) within a few hours of the derailment.

Lake Wabamun is located in the transition zone between the parkland and boreal forest eco- regions. Mitchell and Prepas (1990) present a detailed overview of the physical, chemical, and biological characteristics of the lake in the Atlas of Alberta Lakes. The lake is large (area = 82 km^2), shallow (mean depth = 6.3 m; maximum depth = 11 m), and generally well mixed, usually with well oxygenated conditions in the entire water column during the open-water period (Mitchell and Prepas 1990; Alberta Environment, unpublished data). The lake is moderately to highly enriched with nutrients (Mitchell and Prepas, 1990). Sportfish in the lake include Northern Pike, Yellow Perch, and Lake Whitefish. Compared to other Alberta lakes, the Lake Wabamun watershed has a unique diversity of land uses and human activities. The presence of coal mining, coal-fired power generation plants, farming, major transportation corridors (road and rail), residential, municipal, provincial park, ecological reserve and aboriginal lands and associated activities all influence Lake Wabamun and its watershed. Drier than average conditions have prevailed in the Wabamun Lake area since the early 1990s and have resulted in a gradual decline in lake level. Activities of TransAlta Utilities in the watershed have also contributed to the decline in lake level.

This paper describes the application of the Shoreline Cleanup Assessment Technique (SCAT) process, a fundamental component of the spill response, as well as related activities and issues related to the shoreline cleanup decision-making process.

2. Background to 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 fundamental to the planning and implementation of an effective response and key to shoreline cleanup decision making (Owens and Sergy, 2008). This information is provided in a format that can be interpreted easily and applied by planners and decision makers. The cornerstone of SCAT is to collect and document real-time data on oil and shoreline conditions in a rapid, accurate and systematic fashion. In addition, SCAT surveys can be used for the development of treatment or cleanup recommendations, the development of treatment or cleanup standards or criteria, post-treatment inspection and evaluation and the provision of long-term monitoring. SCAT 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; and the timely provision of data and information for decision making and planning.

The history and details on the SCAT process, surveys, documentation protocols and standards are defined in Owens and Sergy (2004; 2003a; 2000a) and a variety of specific papers describe how SCAT has been used on various spills (Owens et al. 2005; 2002; 2001; 2000b) (Michel et al., 2002). Although SCAT is a familiar part of an oil spill response in many countries and agencies, the bulk of experience has been with marine spills and the technique has not been applied in the freshwater environments of the Prairie Provinces. Nevertheless, the basic elements and principles of SCAT are the same in both marine and freshwater environments (Sergy and Owens, 2011).

The use of the SCAT process was recommended to both Alberta and CN authorities by the Environment Canada (EC) shoreline advisor and subsequently the CN shoreline advisor. Benefits of the approach were quickly accepted and implementation began shortly thereafter with the arrival of the East Coast Response Corporation (ECRC) as the Planning Section for CN.

3. Segmentation of the Shoreline

The first step in any SCAT survey is to divide the shoreline into working units called segments, within which the shoreline character is relatively homogeneous in terms of physical features and sediment type. Low level helicopter aerial video and ground level observations were used to divide the 62 km perimeter of Lake Wabamun into 191 segments within 10 operational divisions (Figure 1). Division boundaries had been pre-established during the oil-on-water phase of the cleanup.

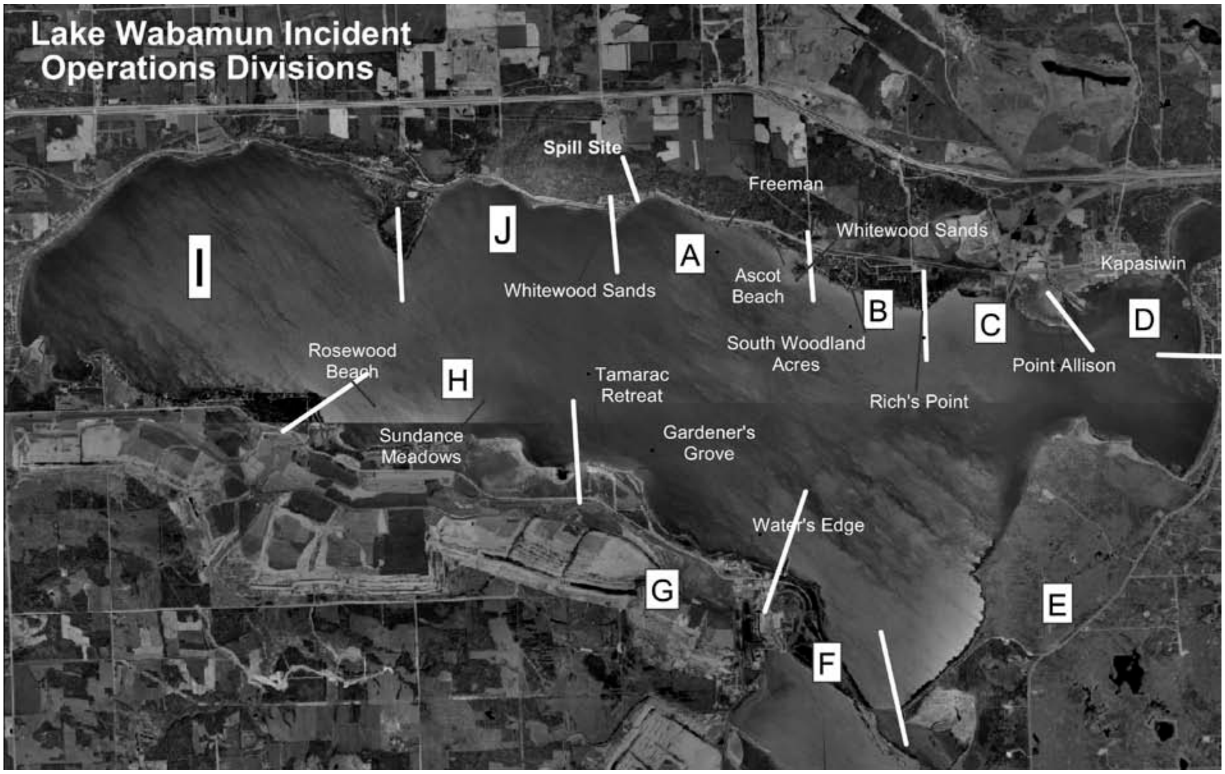


Figure 1. Lake Wabamun SCAT and Operational Divisions

Table 1 lists the standard Environment Canada SCAT freshwater shoreline types (Sergy, 2008). Seven of these shoreline types were identified as primary shoreline types on Lake Wabamun. The 'freshwater marsh' type was further subdivided into two separate categories due to its dominance and the decision to apply different treatment strategies to the different types of marsh habitat.

Table 2 presents the relative abundance of the different shoreline types on Lake Wabamun, as documented by the SCAT survey. Of obvious importance is that the two 'marsh' types represent >70% of the total shoreline. This dominance becomes even more significant when factoring the width of the bulrush/reed bed. Generally, on a lakeshore, the sediment shorelines are relatively narrow and the area subject to oiling is narrow, typically in the order of 1 m. Generally, the shoreline oiling width is similar to the width of the 'swash zone' which is primarily a function of the height of the waves and slope of the beach. Wave energy carries the swash (and oil) a further distance on beaches with flatter slopes, therefore the oiling width will be greater. A storm surge or seiche will result in wider oiling zones. High winds are also capable of tossing spray and oil further inland.

Unlike sediment shorelines, the beds of bulrush/reed are emergent in the water and therefore all stems are at risk from oil on the water surface. The area or width of the bed from shore therefore becomes important. The width of the larger reed beds of Lake Wabamun typically ranged from 200 to 250 m.

Table 1. Environment Canada and Lake Wabamun Standard SCAT Shoreline Types

Environment Canada SCAT Lake Shoreline Types	**Lake Wabamun Shoreline Types**	
Bedrock Cliff / Ramp	×	
Bedrock Platform / Shelf	×	
Man-Made Solid	✓	Includes seawalls
Man-Made Permeable	✓	Includes riprap/gabion baskets/man-made cobble/boulder
Sediment Cliff	×	
Sand Beach	✓	
Mixed Sediment Beach	✓	Previously called mixed sand and coarse sediments
Pebble / Cobble Beach	✓	
Boulder Beach	✓	Includes boulder and cobble – particle mean diameter >6.4 cm
Mud Flat	✓	
Sand Flat		
Peat/Tundra Beach	✓	Includes peat deposits on beach sediments caused by use of peat sorbents
Vegetated Bank	✓	Vegetated cut bank[1]
Marsh/Wetland	✓	Bulrush/Reed Bed[2]
		Wetland Fringe[3]
Swamp	×	
Bog/Fen	×	
Wooded Upland	×	

Key
[1] Vegetated Cut Bank: Vegetation and soil that form a low cut bank at the high-water lake level. Includes oiled brush or tree branches overhanging the shore zone and exposed oiled roots.
[2] Bulrush/Reed Bed: Emergent aquatic plants in the nearshore waters (less than 1.5 m depth) that are rooted in the lake bottom sediments.
[3] Wetland Fringe: Cattails, sedges, peat, or grasses at the lake edge that form the shore zone and may have sand/mud sediments exposed between the plants. Typically wetted, but not submerged at this time.

Table 2. Length and Percentage of Each Shoreline Type on Lake Wabamun

Shoreline Type	Length (m)	% of Total Shoreline
Bulrush/Reed Bed	29,827	47.5
Wetland Fringe	15,100	24.1
Mixed Sediment	6,149	9.8
Vegetated Cut Bank	4,810	7.7
Pebble-Cobble	3060	4.9
Sand	1235	2.0
Boulder-Cobble	959	1.5
Manmade Permeable	637	1.0
Manmade Solid	493	0.8
Peat/Soil	286	0.5
Mud	194	0.3
TOTAL	**62,750**	**100.00**

4. First SCAT Survey and Initial Oiling Conditions

The documentation of the oil on the lake shoreline was carried out by an interagency team representing CN, Provincial agencies, Federal agencies, and community stakeholders. All teams included a member from Alberta Environment (AENV), Environment Canada (EC) and ECRC (Planning Section for CN). Surveys of marsh segments also included Canada Wildlife Service (CWS) and Alberta Sustainable Resource Development (ASRD). Surveys of all First Nations Lands included members of the Traditional Land Use team representing the Paul First Nation. Surveys of private resident lands included a representative of the Lake Wabamun Residents Committee.

The first SCAT team commenced surveys on August 11. On August 13, a second specialized reed bed delineation team was added to identify oiling of critical reed bed habitat and delineate areas for removal of oiled vegetation and stranded (‘trapped’) oil. On August 18, a second SCAT shoreline team was added to accelerate surveys of the sediment shorelines. The length of shoreline surveyed on each day varied substantially, between 600 and 6000 m per day, depending on the type and extent of oiling. The first round of SCAT surveys of the ~62 km of shoreline was completed by August 25, 2005.

The surveys followed standard Environment Canada SCAT procedures (Owens and Sergy, 2000a). The physical shoreline character and the oiling characteristics on a segment-by-segment basis was documented using a Shoreline Oiling Summary (SOS) form that had been adapted specifically for this lake’s shoreline response operation from the standardized Environment Canada template. If no oil was observed in a segment, then the SCAT team also prepared a Segment Inspection Report (SIR) indicating this finding (Figure 2). If oil was observed but the segment met the End-Point Criteria, then the SCAT team prepared a Segment Inspection Report (SIR) form indicating that oil was present but that no further treatment was required. If oil was observed and the segment did not meet the End-Point Criteria, then the SCAT team prepared and signed a Shoreline Treatment Recommendation Transmittal (STRT) form (Figure 3).

SCAT Segment Inspection Report - Lake Wabamun Spill

Operations Division: ____________

Segment ID: ________ Survey Number: ______ Survey Date ______

Length: ________

Shoreline Type ________ Backshore Type ____________

SCAT Observations

SCAT Team recommends no further treatment on this site

SCAT Provincial Rep. ____________

SCAT Federal Rep. ____________

SCAT RP Rep. ____________

Figure 2. Segment Inspection Report – August SCAT Survey

SCAT Shoreline Treatment Recommendation Transmittal

Operations Division ________

Segment ID ________ Survey # ______ Survey Date ________

Surveyed Length ________

Shoreline Type ____________ Backshore Type ________

Oiled Area For Treatment

Treatment Recommendations

Figure 3. Shoreline Treatment Recommendation Transmittal - SCAT August Survey

The STRT form described (a) the oiling characteristics, (b) generic treatment methods for generic lake shoreline types, and (c) any segment specific observation or condition that might affect treatment, and details of the modified treatment method for the segment. In the case of reed beds this form included a sub-categorization to match different treatment strategies. The SCAT team was also empowered to identify if the segment qualified as a ‘very sensitive area’ and this would require a unique treatment plan. In the case of reed beds the individual segment plan included a specific delineation of the area to be harvested.

Table 3 summarizes the results of the SCAT survey of the initial oiling conditions. Over 50% (approx 33 km of the total 63 km) of the shoreline perimeter of Lake Wabamun was oiled.

Table 3. Oiled Length, Percent of Oiled Length and Length by Oiling Category for Each Shoreline Type: 11-25 August, 2005.

Shoreline Type	Oiled Length (m)	% of Oiled Length	Length by Oiling Category (m)			
			Heavy	Moderate	Light/ Very Light	No Observed Oil
Bulrush/Reed	23,315	71.3	14,464	4,669	4,182	6,512
Wetland Fringe	4,545	13.9	2,525	786	1,234	10,555
Cobble-Pebble	1,392	4.3	1,268	39	85	1,668
Boulder-Cobble	952	2.9	54	323	575	7
Mixed Sediment	806	2.5	0	260	546	5,343
Vegetated Bank	676	2.1	138	53	485	4,134
Sand	295	0.9	78	30	187	940
Peat/Soil	286	0.9	150	74	62	0
Manmade Perm.	227	0.7	0	0	227	410
Mud	194	0.6	0	194	0	493
TOTAL	**32,688**	**100.0**	**18,677**	**6,428**	**7,583**	**30,062**

Approximately 85% of the oiled shoreline was marsh habitat, with most being bulrush/reed (~71%). Due to their width, the majority of these were classed in the 'heavy' oiling category. In total, there were approximately 23 km (in alongshore distance) of oiled bulrush/reed beds. These beds represent an estimated area of 1,770,000 m^2 or 180 ha. The amount and thickness of oil on each individual reed stem varied from stain (≤0.01 cm thick) to cover (>0.1 cm and ≤1cm thick). In the latter case, the viscous oil was often present as globules attached to the stem. The height of oiling on the stem depended on the height of the waves and water level when oil was present. This value ranged from a few millimetres to the length of the reed.

5. Shoreline Treatment Decision Process

Shoreline treatment decision making was a multi-agency effort. On a day-to-day working level, the three focal players were the federal (EC) and provincial (AENV) shoreline coordinators, and the ECRC Planning Section of CN. Continuous daily input was received from CWS and ASRD and the Lake Wabamun Residents Committee. Input from other government agencies was channelled through the TAG and this group was used as a forum to consolidate government and stakeholder position and opinion on various elements needed in the decision making process.

Primary elements driving shoreline treatment planning, decision-making and operations were the SCAT data, the environmental and social priorities and constraints, the cleanup endpoints, and the treatment techniques/plans. These are further discussed below.

Endpoints: Shoreline treatment or shoreline cleanup endpoints are specific criteria assigned to a segment or unit of oiled shoreline and described in the shoreline treatment plan to define when sufficient treatment effort has been completed for that segment or unit. In effect, the endpoints are the practical definition of 'clean' for that particular shoreline segment of that particular spill (Sergy and Owens, 2008). For the Lake Wabamun spill, endpoints were defined according to national shoreline treatment guidelines under development at the time (Sergy and Owens, 2007). This protocol recommends the use of quantitative endpoint measurements using standard SCAT terminology and definitions. Such an approach has been successfully used on many recent spills (Owens et al., 2005). The endpoints for the Lake Wabamun operation were defined by shoreline type with a distinction being made between (a) shorelines fronting and (b) shorelines not-fronting residences and first nation lands (Table 4). Some modifications to the blanket endpoints were made as required for special areas on a segment-by-segment basis.

Table 4. 2005 Shoreline Treatment End Points for Lake Wabamun Spill

A. Endpoints for Shorelines Fronting Residences and First Nation Lands (and other shorelines with First Nation significance)	
Sand, or Mixed Sand/Gravel Beach	No Visible Surface or Subsurface Oil.
Peat Beach (due to added ‘sphagnum sorbent’)	No Visible Oil
Natural Cobble/Boulder	Stain (<0.01 cm thick) and < 20% distribution
Manmade Cobble/Boulder or Riprap	Stain (<0.01 cm thick)
Vegetated Cut Bank	Coat (<0.1 cm thick) and < 10% distribution on cut bank. Coat (<0.1 cm thick) on larger tree roots (i.e., tree root diameter >5 cm)
Bulrush/Reed Bed	Non-sticky Coat (<0.1 cm thick)
Wetland Fringe	Non-sticky Coat (<0.1 cm thick). Mudflats - no tar balls >2 cm diameter. Total tar balls < 2 cm diameter not to exceed 10% distribution. TAG will be contacted to give specific instructions if questions arise during treatment.
Docks and Pilings	No Visible Oil

B. Endpoints for Shorelines Not Fronting Residences	
Sand or Mixed Sand/Gravel Beach	Coat (<0.1 cm thick) and <10% distribution (Surface). Oil residue as Coat (Sub-surface)
Peat Beach (due to added ‘sphagnum sorbent’)	Coat (<0.1 cm thick) and <10% distribution
Natural Cobble/Boulder, or Manmade Cobble/Boulder or Riprap	Coat (<0.1 cm thick) and <20% distribution,
Vegetated Cut Bank	Coat (<0.1 cm thick) and < 20% distribution on cut bank. Coat (<0.1 cm thick) on larger tree roots (i.e., >5 cm diameter)
Bulrush/Reed Bed	Non-sticky Coat
Wetland Fringe	Non-sticky Coat (<0.1 cm thick). Mudflats - <2 tar balls 2 cm diameter per metre square. Total tar balls < 2 cm diameter not to exceed 20% distribution. TAG will be contacted to give specific instructions if questions arise during treatment.
Piling	Stain (<0.01 cm thick)

Priorities: The strategic priorities were determined by the TAG based on input from the appropriate government agencies and stakeholders. Each Bulrush / Reed Bed with an A-1 and A-2 priority was further prioritized on an individual basis and that rating provided to the Planning Section for integration into the operational planning schedule.

Priority A

- Bulrush/Reed Beds designated as 'very sensitive area' and having a unique treatment plan
- Bulrush/Reed Bed not designated as very sensitive, >0.4m^2 and with oiling greater than a non-sticky Coat
- Wetlands with oiling greater than a non-sticky Coat
- First Nation shoreline with heavy to moderate oiling
- Shorelines fronting residences with heavy to moderate oiling
- Segments including and adjacent to Lake Whitefish spawning habitat

Priority B

- All other shorelines with heavy to moderate oiling
- All other Bulrush/Reed Beds
- Segments including and adjacent to Northern Pike spawning habitat

Priority C

- First Nations shorelines and shorelines fronting residences with light oiling
- All other shorelines with light oiling

Treatment Plans: Shoreline treatment plans were of two distinct types. The first was a 'general' plan, a default that applied to all segments which were not designated as a 'very sensitive area'. The second category was used for those segments identified by TAG or SCAT teams as 'very sensitive' and required a unique segment-specific treatment plan. These latter included:

- Bulrush/Reed Beds designated as sensitive bird habitat. These beds were not accessible from shore and treatment was primarily by harvesting with a reed cutter with manual supplement as required. The decision to harvest rested with the TAG and the plan required approval of the Provincial On-Scene Commander. Harvesting was done in accordance with special deployment instructions developed for each reed bed.
- Segments including and adjacent to Lake Whitefish and Northern Pike spawning habitat.
- All First Nation shoreline.
- Areas with First Nation cultural and/or traditional use.
- Any banks or beaches where sediment removal exceeds criteria specified in the overall treatment plan.

There were some segments where both plans applied, i.e. the 'general' plan applied to the whole segment except for a very small 'very sensitive' area which had its own special plan. An example would be a beaver lodge. Copies of the treatment plans can be viewed on the CN website at www.cn.ca

Treatment Techniques: Shoreline treatment techniques are typically described in Canada on basis of twenty different groups of methods (Owens and Sergy, 2010). At Lake Wabamun, the three primary types of methods used were manual removal, vegetation cutting, and natural recovery. Most of the sediment shorelines were treated using manual treatment methods (hands, rakes, forks, shovels sorbent materials etc.) to remove the oil, oiled sediment, and debris. In small areas of bulrush/reed bed and marsh fringe, the vegetation was cut and removed with powered weed cutters. Mechanical cutters were used in larger bulrush/reed beds. The natural recovery option was applied to those shorelines where SCAT surveys determined that initial oiling was less than the predetermined endpoint and those shorelines which had been cleaned to the level of the endpoint.

SCAT Data Management and Usage: SCAT data was managed in accordance with typical procedures such as described in Lamarche et al., (2005). SCAT observations recorded by hand in the field on paper SOS forms and sketches were transcribed and entered within the computerized ShoreAssess SCAT data management support system (Lamarche et al., 1998) used by ECRC. The data was analyzed, sorted and combined with criteria on endpoints, priorities and techniques. The ShoreAssess system, in combination with a Geographic Information System, was used to produce a variety of reports and outputs used for planning operations. These included on a daily basis: maps showing the oiling category derived from the latest SCAT surveys; reports showing the length of shoreline by oiling category per substrate types, grouped by operations division; reports showing the length of shoreline covered by SCAT surveys within each operations division, including an estimation (in %) of the length of shoreline left to survey; Shoreline Treatment Recommendation Transmittal forms completed for each segment surveyed. Other support tools derived from the computerized SCAT database included: detailed maps of each divisions showing the substrate type of each oil zone, labelled with the oiling characteristics; the uploading of the segment boundaries within GPS units, to help personnel locate the start and end of shoreline segments in the field; the creation of a web site containing detailed maps, oiling characteristics and observations from SCAT and inspection surveys (Lamarche and Martin, 2010).

Monitoring of Treatment Activities: Treatment of shorelines (by Operations) in the field was periodically monitored by CN, ECRC and government agencies. Intense monitoring of mechanical reed harvesting operations was conducted by ASRD or EC-CWS bird specialists.

6. Post-treatment Assessment

A process was established for the Wabamun spill to determine completion of treatment and to reach closure. The approach was conceptually similar to that in recent spills (Owens et al., 2005) and recommended in Sergy and Owens (2007). The generic procedure is as follows.

1. Operations inform Planning that treatment has been completed and endpoints attained in a segment or group of segments.
2. A post-treatment inspection survey of the segment/s is conducted by the SCAT team and/or a team that represents the interests of both the responsible parties and stakeholders (for Wabamun the team was ECRC and a Provincial, Federal, First Nations and Land Owner Representative).
3. The post-treatment inspection survey team would determine either that (i) the end-point criteria have been met and recommend that no further treatment is required for this segment, or (ii) the end-point criteria have not been attained and recommend where work is required to pass inspection.
4. Observations and recommendations of the survey team are documented on an SIR which ultimately goes for approval (for Wabamun, final approval rested with the Provincial On-Scene Commander).

It was quickly realized at Wabamun that final closure could not be attained because there was still mobile oil in the water in form of tar balls that continued to frequent shallow nearshore areas or strand on the shoreline. Because of the situation, a final sign-off and approval would not be given by government or stakeholder representatives during the 2005 operational season. As a result, the initial process was modified such that the same inspection team would not complete the SIR but rather would complete a Shoreline Treatment Evaluation Report. This documented additional protection and treatment action recommended by the technical inspectors and acceptance of the recommendations by the OSC. The evaluation surveys provided a report card to CN on their treatment of Lake Wabamun shorelines.

In addition to the above evaluation inspection, CN decided to mount a SCAT team and SCAT survey to document the actual amount of residual oil. Subsequently, the inspection team and SCAT team's functions were combined.

Findings of the post-treatment evaluation survey in October were that 25 segments would have failed to meet conditions of treatment closure at the time of the survey (i.e. had remaining issues). The two divisions with the most problems were A and G; others were in B, C, F and E. The survey teams identified that those areas with the highest densities of nearshore tar balls were located in Division A,G and E.

2006 SCAT Submerged Oil Surveys

Following the completion of the 2005 cleanup operations and shoreline assessments it was known that submerged oil remained in the lake associated with the reed bed environments and adjoining shorelines. In order to evaluate this remaining oiling, a new SCAT protocol was developed in conjunction with the 2006 SCAT field program to find and document the submerged oil.

Due to the aerial extent, the constraints of water depth and to avoid detrimental effects to lake vegetation, the submerged oil surveys were broken into two separate groups; a boat based group and a shore based group. The general guidance for distinction of survey area for the two groups was wadeable water depth. For the shore group, the extent of the submerged/sunken oil survey was from the water line to a depth of 0.5 metres, with the boat group covering the zone beyond 0.5 meters.

The procedure consisted of making visual observations continuously along a recorded track line, Figure 4, and recording the changes in submerged oiling conditions and locations with GPS waypoints, Figure 5. Observation techniques (Figure 6) included visual with the naked eye, visual using a view-box and dipnet or scoop for verification.

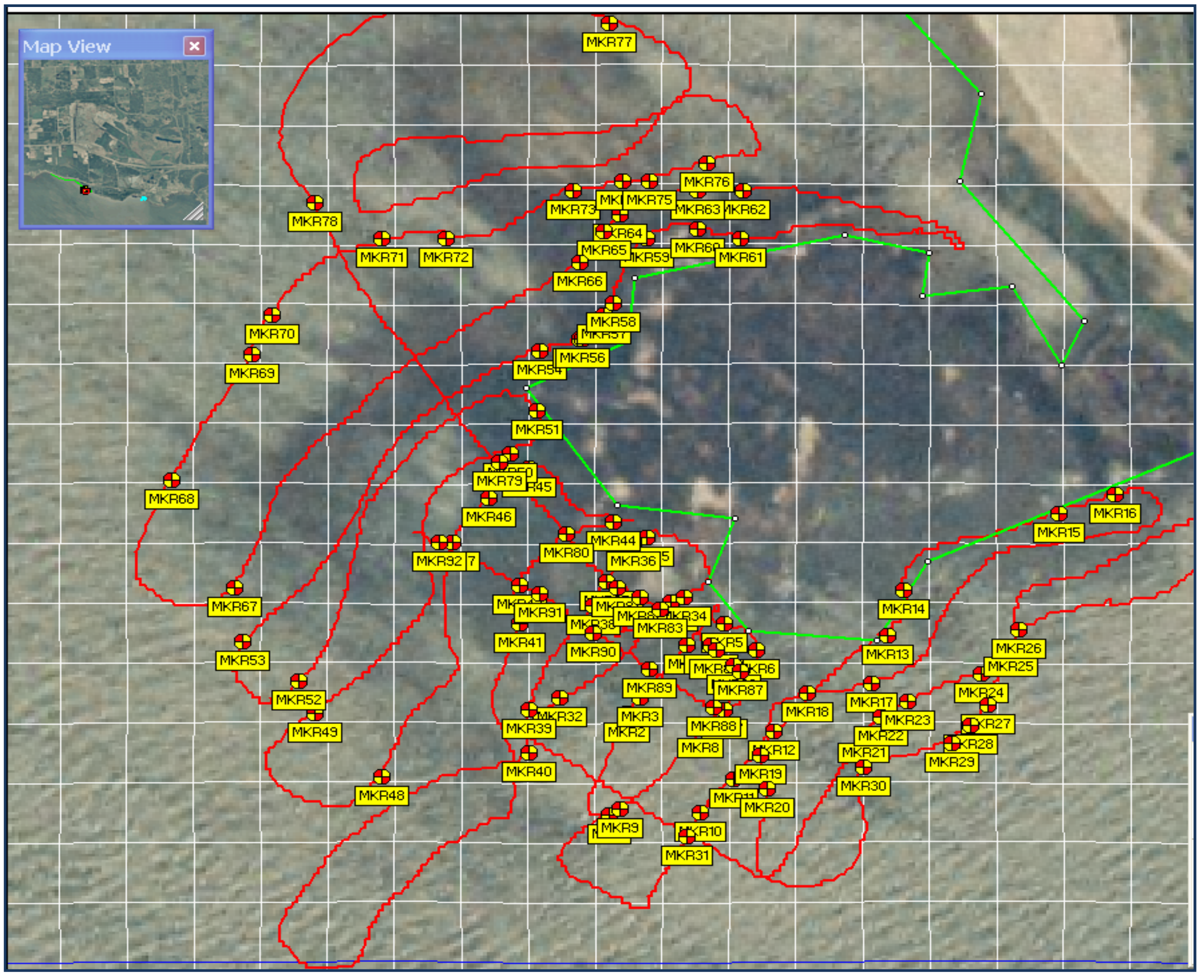
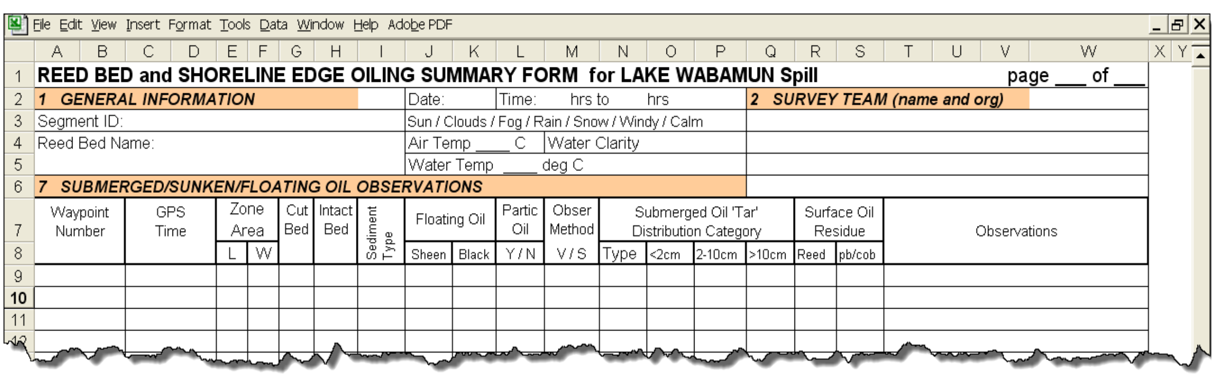


Figure 4. Reed bed survey track lines and oiling change waypoints



Waypoint Number	GPS Time	Zone Area L	Zone Area W	Cut Bed	Intact Bed	Sediment Type	Floating Oil Sheen	Floating Oil Black	Partic Oil Y / N	Obser Method V / S	Submerged Oil 'Tar' Distribution Category Type	<2cm	2-10cm	>10cm	Surface Oil Residue Reed	Surface Oil Residue pb/cob	Observations

REED BED and SHORELINE EDGE OILING SUMMARY FORM for LAKE WABAMUN Spill — page ___ of ___

1 GENERAL INFORMATION: Segment ID: / Reed Bed Name: / Date: / Time: hrs to hrs / Sun / Clouds / Fog / Rain / Snow / Windy / Calm / Air Temp ____ C / Water Clarity / Water Temp ____ deg C

2 SURVEY TEAM (name and org)

7 SUBMERGED/SUNKEN/FLOATING OIL OBSERVATIONS

Figure 5. 2006 Submerged oiling summary form

Figure 6. Submerged oiling observation techniques

The initial program design was to survey on a 20 m grid over the reed beds. This proved to be difficult due to restrictions in water depth, exposed reed beds and general navigation with winds on a small shallow draft boat.

To overcome these limitations a technique was developed that included on-board real-time GPS navigation system that allowed the team to continuously view where they had surveyed and fill in areas. Tracks were run in multiple directions across the areas to provide overlap which allowed QAQC of survey observations.

To maintain a repeatable measure of oiling concentrations within a specified area it was determined under normal conditions the observers could visualize, at any instance, an area approximately one by two metres. Extending this along the track line produced a continuous record of observed oiling two metres on either side of the boat, Figure 7. Where oiling was not the same on opposite sides of the boat the worst case was recorded

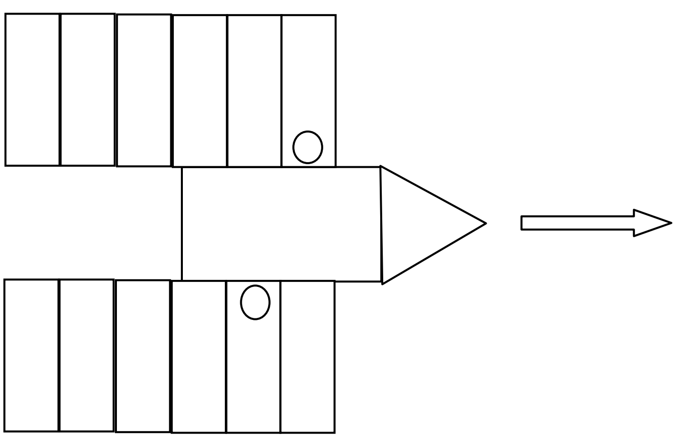


Figure 7. Continuous boat survey observations –1 m. x 2 m. along track line.

A matrix was developed that provided a quick and easy categorization for the submerged oil, Table 5, Figure 8, and a framework for treatment priorities. The oil distribution category combined with size was used to set the 'submerged oiling category'. These categories were assigned a numeric value 1, 2 and 3 which reflects the priority assigned to treatment (with 1 being the highest priority).

Table 5 Submerged oil concentrations and distribution matrix

Oil Distribution		SIZE (Diameter)		
Category	Number/2 m^2	< 2 cm	2-10 cm	> 10 cm
Low	≤ 2	3	2	1
Moderate	3-8	2	1	1
High	>8	1	1	1

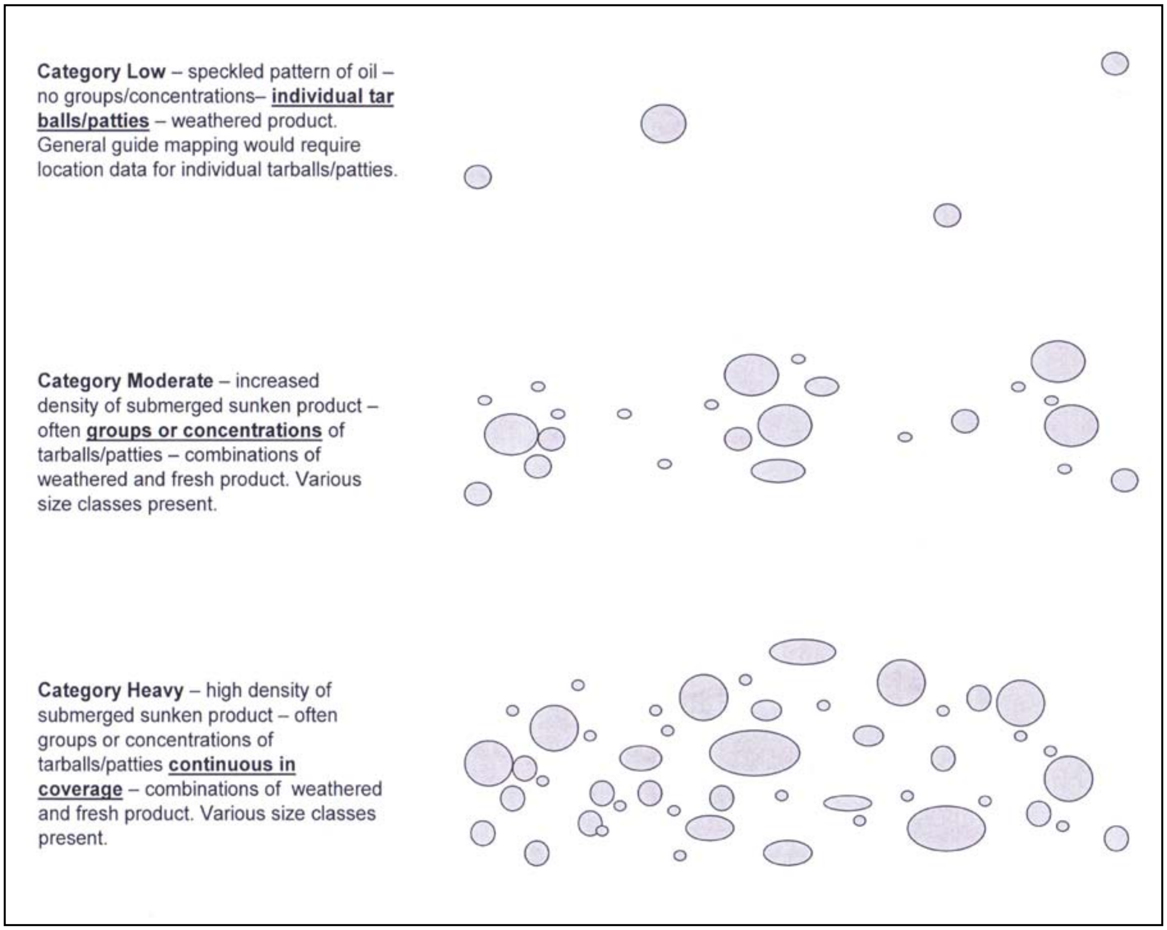


Figure 8. Submerged oiling categories.

The data collected during the SCAT submerged oil surveys was processed to provide oiling concentration and distribution maps, Figure 9, and to delineate work areas for operations, Figure 10.

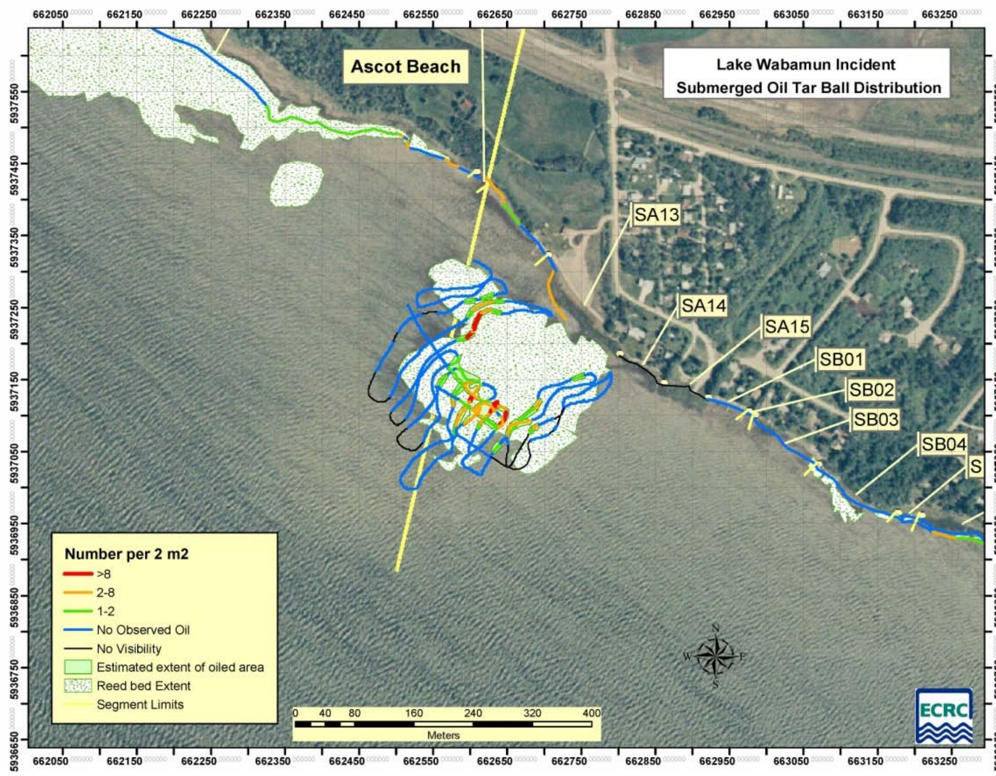


Figure 9. Survey track lines indicating the submerged oiling categories

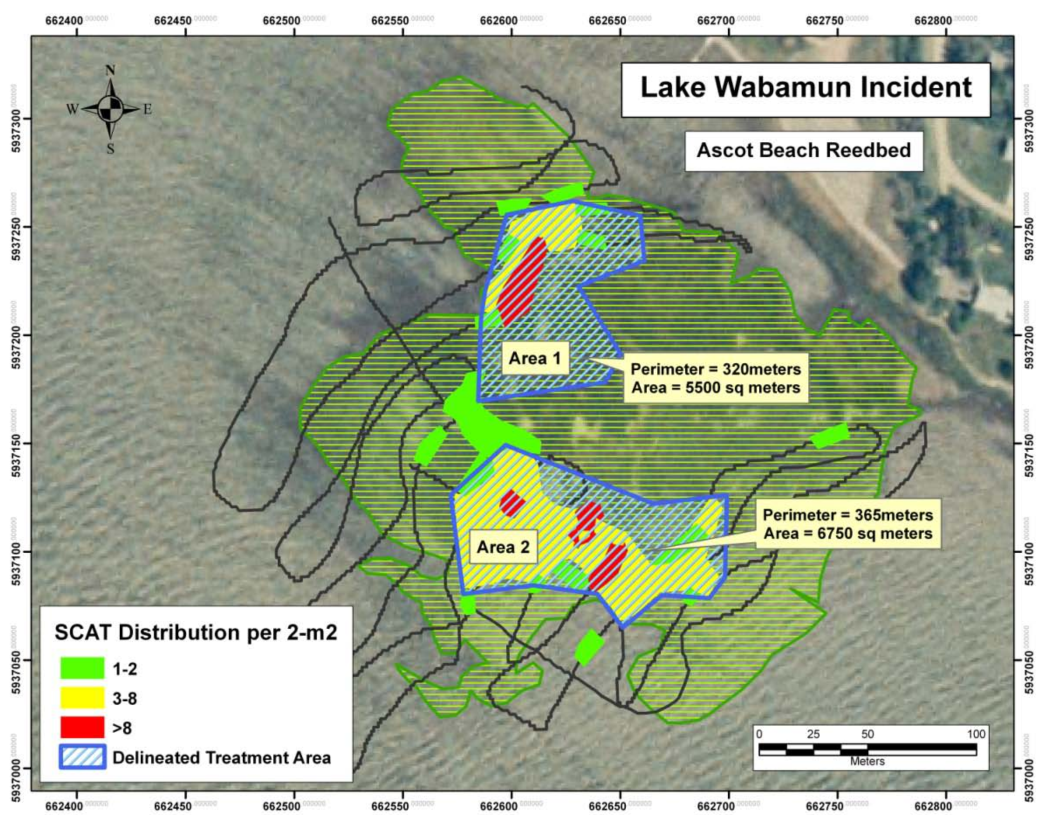


Figure 10. Operational map indicating areas to be treated with suction dredge

The treatment of submerged oiling data necessitated the creation of data tables and software components used to capture, process and report nearshore and reed bed oiling conditions (Lamarche and Martin, 2010).

Nearshore oiling conditions were directly incorporated within the ShoreAssess system, where they could be entered as oil zones (Figure 11). Each oil zone was defined as a line within a GIS, manually drawn by following the shoreline between recorded waypoints, with associated attributes corresponding to the recorded oiling conditions. The length of each submerged oil zones was calculated as that of the length of the line representing it in the GIS.

7 Nearshore Submerged Oiling Conditions

Oiled Zone ID	Dist. from shore	Zone Area		Cut Bed	Intact Bed	Sediment Type	Floating oil		Partic Oil	Obs. Method	Submerged oil tar distribution category				Surface Oil Residue	
		Length m	*Width* m				*Sheen*	*Black*			*Type*	*<2cm*	*2-10cm*	*>10cm*	*Reed*	*Pb/Cob*
UA	0	10	0	☑	☑	Sand Mud	☐	☐	☐	V	NOO	0	0	0		
UB	0	19	0	☑	☑	Sand Mud	☑	☐	☐	V	W	0	H	0		
UC	0	78	0	☑	☑	Sand Mud	☐	☐	☐	V	W	0	L	0		
UD	0	5	2	☑	☐	Sand Mud	☑	☑	☑	V	NOO	0	0	0		

Figure 11. Example of nearshore tar ball observations data

For reed bed oiling, the data was made-up of:

- Paper forms where submerged oiling characteristics were noted for each waypoint (corresponding to the start of a submerged oil zone)
- GPS track lines, showing the path of the survey
- Numbered waypoints within a GIS compatible format

This information was used to produce reports and maps through the following process:

- All reed bed observations waypoints was entered within an ACCESS data tables, along with the oiling characteristics associated with the start of each point (Figure 12)
- Within the GIS, a function was developed to automatically create reed bed submerged oil zones from the reed bed waypoints table. The function would ‘clip’ the portion of the GIS track line located between two waypoints (Figure 13) and associated it with the largest observed tar ball density form within each of the tar ball size categories.
- A polygon layer was manually added using the GIS polygon editing tool. This would enable a (very) rough estimate of the area containing observed tar balls.
- A Reed Bed tar ball density map would then be produced (Figure 9 and Figure 14).

Reed Bed and Shoreline Edge Submerged Oiling Summary Forms for Lake Wabamun Spill

1. General Information		Date 24-May-2006	Time: from 15:22 to: 16:33	2. Survey Team:	
Reed Bed ID	RBB11B	Sun ☑ Clouds ☐ Fog ☐ Rain ☐ Snow ☐ Windy ☐ Calm ☑		Doug Reimer	NOO : No Observed Oil NV : No Visibility
Reed Bed Name **Rizzie Beach**		Air Temp 16 C	Water Clarity: Poor	Mike Watmought Gavin Berg	- : No Data H : >8 tars / 2 m2 M : 3-8 tars / 2 m2
Survey No	1	Water Temp 15 C		Leanne Zrum	L : 1-2 tars / 2 m2

GPS Waypoint No	LZ Time	Zone Area		Cut Bed	Intact Bed	Sediment Type	Floating oil		Partic Oil	Obs. Method	Submerged oil tar distribution category				Surface Oil Residue		Observations
		Length m	*Width m*				*Sheen*	*Black*			*Type*	*<2cm*	*2-10cm*	*>10cm*	*Reed*	*Pb/Cob*	
1	14:20:03	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
2	14:21:02	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	L	NOO			Nostoc
3	14:21:15	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
4	14:23:21	0	0	☑	☐	Sand	☐	☐	☐	V		NV	NV	NV			
5	14:24:37	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	NOO	NOO			Single tar ball
6	14:25:07	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
7	14:25:17	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
8	14:28:27	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	L	NOO			
9	14:28:50	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
10	14:29:50	0	0	☑	☐	Sand	☐	☐	☐	V		NV	NV	NV			
11	14:30:29	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
12	14:34:24	0	0	☑	☐	Sand	☐	☐	☐	V		NV	NV	NV			
13	14:35:11	0	0	☑	☐	Sand	☑	☑	☐	V		NOO	NOO	NOO			Mud with pebble-cobble
14	14:37:05	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	M	NOO			
15	14:37:38	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	L	NOO			
16	14:37:55	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
17	14:39:24	0	0	☑	☐	Sand	☐	☐	☐	V		NV	NV	NV			
18	14:40:20	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
19	14:43:45	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	L	NOO			
20	14:44:02	0	0	☑	☐	Sand	☐	☐	☐	V		NOO	NOO	NOO			
21	14:44:28	0	0	☑	☐	Sand	☐	☐	☐	V	W	NOO	L	NOO			

Reed Bed: ID **RBB11B** Name **Rizzie Beach** Survey: No 1 Date 24-May-2006 Page 1 of 4

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Figure 12 Reed bed (offshore) tar ball observation data form

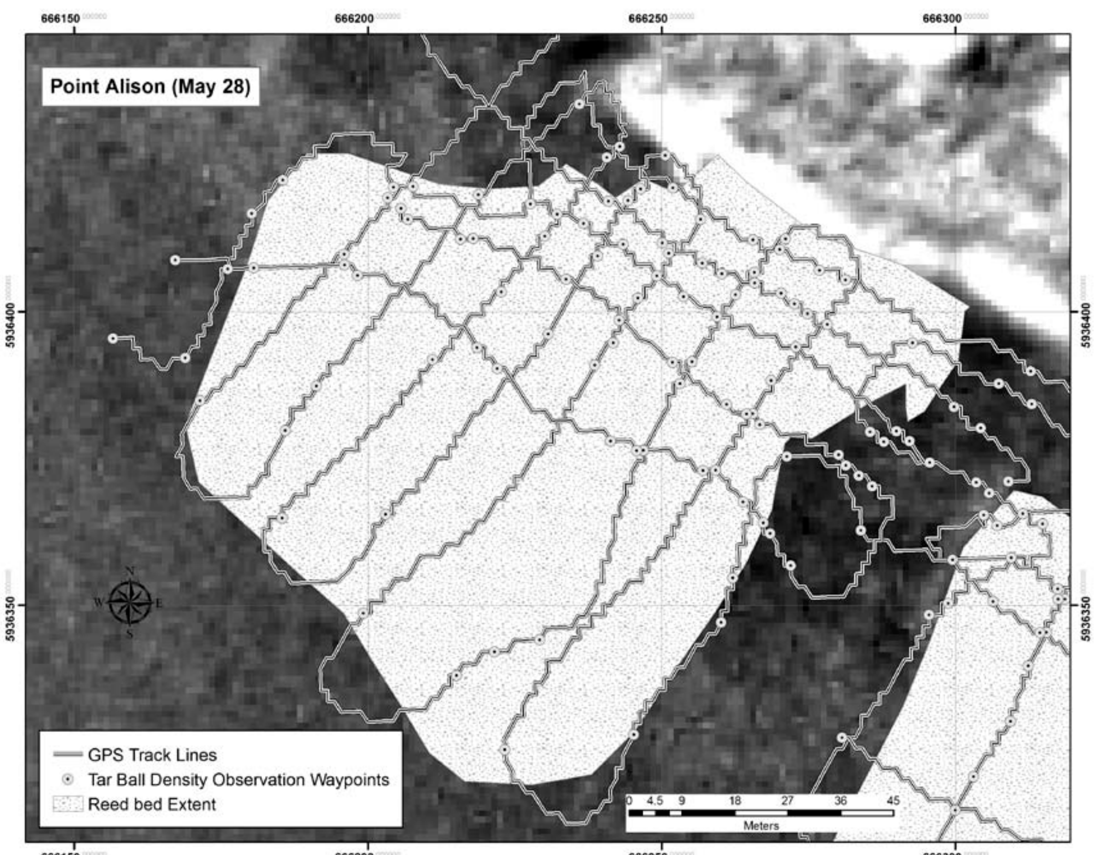

Figure 13 Reed bed submerged oil zones

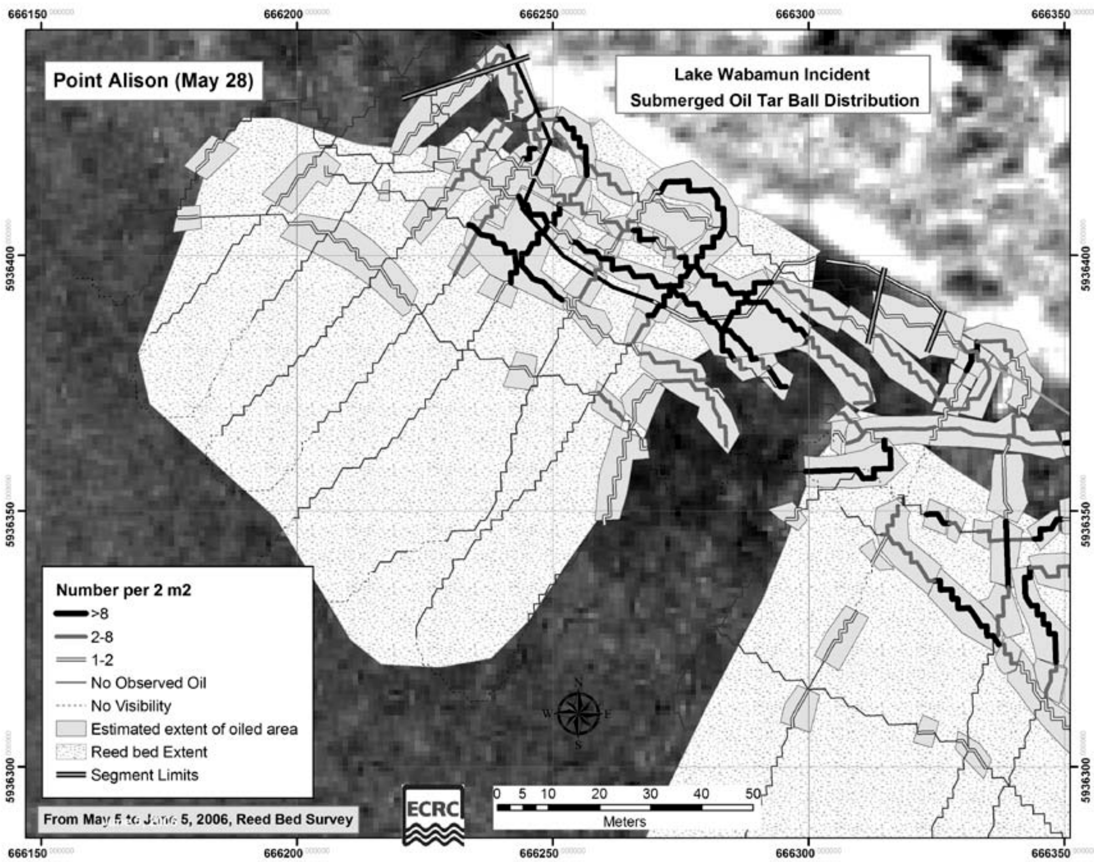

Figure 14   Example of a map illustrating reed bed tar ball observations

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