THE IDENTIFICATION AND ASSESSMENT OF POTENTIAL OILED DEBRIS MANAGEMENT SITES TO COMPLEMENT BRITISH COLUMBIA'S EMERGENCY CLEAN-UP EFFORTS OF MARINE OIL SPILLS ALONG JUAN DE FUCA STRAIT

by

Eva Moche

A Practicum
Presented to the University of Manitoba
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MASTER OF NATURAL RESOURCES MANAGEMENT

ABSTRACT

This research project was undertaken to examine the need for oiled debris management sites on the southwest coast of Vancouver Island along Juan de Fuca Strait, and to identify potential oiled debris management sites between Sooke and Tofino based on site specific physical, environmental and social considerations encompassed by site selection criteria. This study involved a literature review, interviews and on-site field surveys. Limitations, constraints and local concerns along the coast were investigated, a suitable size of working area for each of these oiled debris management sites was derived on the basis of the primary factors which would influence the volume of oiled debris which might be generated under a worst case scenario, pertinent site selection criteria were developed, and nine potential sites were identified. The scope of the search for oiled debris management sites was limited to a preliminary investigation for candidate sites which will still require an individual environmental impact assessment. The conclusions are that, although the potential occurrence of a major oil spill in Juan de Fuca Strait would support the requirement for oiled debris management sites, only a very limited number of potential sites are available along the study area. Of these sites, any designated sites should only serve a temporary function as part of a pre-established ultimate treatment and disposal strategy for oiled debris. Also, past experience would urge the approval of any designated sites to be carried out through a public review process whereat the public can express its concerns as well as learn how these sites would complement the overall strategy and infrastructure for British Columbia's Marine Oil Spill Contingency Plan.

ACKNOWLEDGEMENTS

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Gratitude is also extended to Mr. S. Pond of Environment Canada for having arranged for me to obtain a helicopter flight of the study area, to the Canadian Coast Guard for having graciously offered the helicopter and time to closely examine the entire length of the coastal study area, and to all the citizens who offered their time to be interviewed.

I also wish to express special thanks to my Practicum Committee members: Dr. A. Sparling, Dr. R. Cooke, Mr. D. Anderson and Professor T. Henley, for their constructive comments during the development of the practicum, and to Dr. Henson and Dr. Berkes, past and current Directors of the NRI, respectively, for their guidance and assistance.

Lastly, I wish to thank my husband Mr. C. Moche, and my parents Mr. and Mrs. C. Orthodoxou for their unwavering support.

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Section A

INTRODUCTION

A.1 BACKGROUND

March 24, 1989, marked a turning point for Canadians and Americans in their perception of the hazards associated with the marine transport of oil. At 12.04 a.m. on this date, the Exxon Valdez, an oil tanker transporting 200,000 cubic metres of crude oil destined for Los Angeles, ran aground on Bligh Reef in Prince William Sound, Alaska. What followed was the worst marine oil spill disaster in U.S. history up to that time. Almost 41,600 cubic metres were spilled from the vessel. No one was prepared for an oil spill of this size. Over the following days, the area of impact from the oil spill grew in magnitude to cover an area over 7,680 square kilometres, and spoiled 560 kilometres of pristine shoreline in Prince William Sound (The National Response Team, 1989). The confused and delayed response brought on by the unpreparedness of Exxon and government agencies to deal with such a disaster was all too apparent through the news media.

This time Canada was fortunate. The oil spill was caused by an American company and affected only an American coast. Although British Columbians had just finished cleaning up a fouled coastline northwest of the Juan de Fuca Strait as a result of the Nestucca oil spill that had occurred off the coast of Washington on December 23, 1988, the size of that spill was only 2.3% of the size of the Valdez spill. Even then, only a fraction of the spilled oil ended up on the Canadian coast. The immediate question that we as Canadians should be asking ourselves is, if an oil spill of the magnitude of the Valdez spill was to happen off our shoreline, how well are we prepared to address such a situation on short notice along those stretches of our vast shorelines which are exposed to oil tanker traffic or oil exploration and production activities? An American investigation carried out by the U.S. National Response Team immediately following the Valdez spill expressed a similar concern in a report dated May, 1989, and titled "The Exxon Valdez Oil Spill - A

Report to the President". Likewise, a Canadian "Public Review Panel on Tanker Safety and Marine Spills Response Capability", which had commenced holding public hearings in 1989 at numerous coastal communities following the Valdez disaster, said in its interim report to the Minister of Environment that "To date no one has told the panel that they can handle a major spill under any conditions".

The primary lesson learned from the Nestucca and Valdez oil spills is that despite the precautionary measures which may be in place to prevent or minimize the probability of marine oil spill accidents, they cannot be altogether prevented from occurring. Our task, therefore, is to fully prepare ourselves for responding to and mitigating marine oil spills, particularly major spills.

Canada's reaction to the Nestucca and Valdez oil spills has indeed been to investigate our state of preparedness to address marine oil spills, and to determine what improvements and initiatives need to be undertaken so as to better prevent and better respond to the occurrence of marine oil spills. This activity has been carried out on several fronts, that is, provincially, nationally and internationally.

Provincially, Mr. David Anderson was appointed by the Premier of British Columbia to investigate the subject matter. Following four months of public hearings at numerous B.C. coastal communities during the summer of 1989, Mr. Anderson submitted a thorough report of his findings and recommendations to the Premier of British Columbia in a report dated November, 1989, and titled "Report to the Premier on Oil Transportation and Oil Spills". Mr. Anderson's report outlined a total of 184 recommendations.

Nationally, a "Public Review Panel on Tanker Safety and Marine Spills Response Capability" was appointed by the Prime Minister of Canada. The Public Review Panel was busy throughout 1989 and 1990 holding public hearings at coastal communities on the Pacific and Atlantic Ocean, and along the arctic coast. On September 29, 1989, they issued an "Interim Report" which outlined the Panel's mandate and made seven recommendations in advance of their final report because of the urgency of the subject. Their final report, dated September, 1990, was released in November of 1990.

Internationally, following the Nestucca oil spill, the Premier of British Columbia and the Governor of Washington established a Task Force to review the broad subject of oil transportation and handling, oil spill prevention and oil spill response procedures as it related to the west coast situation. Following the Valdez oil spill, which occurred shortly thereafter, the Task Force was expanded to include Alaska, Oregon and California, and was then called the "States/British Columbia Oil Spill Task Force". This Task Force issued an "Interim Report" in December of 1989, followed by a "Final Report of the States/British Columbia Oil Spill Task Force" dated October, 1990.

The preceding investigations thoroughly reviewed virtually every aspect of marine oil spills. Many problems and deficiencies were highlighted, and many recommendations were offered.

Generally, the logical hierarchy approach of managing the problem of marine oil spills is through:

1) prevention of oil spills;

2) isolation of the spill;

3) minimization of extent of oil spill by quick response and containment;

4) treatment; and

5) disposal;

In this regard, a particular area of importance pointed out by the various investigations, and upon which this study has focused, concerns the lack of waste management sites for oiled debris. Although literature sources most commonly speak of oiled debris disposal sites, "disposal" is only one of the activities of waste management. Therefore, this report will henceforth reference the so-called "oiled debris <u>disposal</u> sites" as "oiled debris <u>management</u> sites", with the understanding that oiled debris means any organic or inorganic substance which has been contaminated by way of exposure to oil, or its components or derivatives, through adsorption, absorption or consumption.

A.2 PROBLEM STATEMENT

An immediate problem for British Columbia, concerning marine oil spills, is the lack of predesignated oiled debris management sites for use in the event of major oil spills along the marine transportation route of Juan de Fuca Strait. Given that despite preventative measures, marine oil spills can and will occur, and that better technologies for dealing with the containment and clean-up of spilled oil will inevitably evolve, current oil spill problems will have to be addressed with our current technologies. In this regard, where in-place treatment of a fouled coastline cannot be implemented, the oiled debris would have to be removed, where possible or where necessary, to restore the coastline to an environmentally safe and aesthetic condition. Since the main objective in an oil spill clean-up programme is to react as quickly as possible so as to minimize the environmental damage, predesignated oiled debris management sites located locally along the high risk coastline are required to complement the response programme, particularly during a major marine oil spill. In the absence of such predesignated sites, confusion or disputes in locating appropriate sites can occur, valuable time can be lost while searching for such sites, or environmentally inappropriate sites might be picked on an ad hoc basis. This can translate not only into more extensive environmental damage, but also result in higher lawsuit costs for damage compensation, both of which can threaten the sustainability of off-shore transportation of oil or the development of off-shore oil resources.

A.3 DEFINITION OF THE STUDY

The purpose of this study is to identify and assess potential oiled debris management sites, for the treatment/management of contaminated organic and inorganic materials arising from oil spill incidents along British Columbia's coast by means of the development of site specific selection criteria. The specific study area along British Columbia's coast for this research project is the southwest coast of Vancouver Island, along the Juan de Fuca Strait, between the communities of Sooke and Tofino (see Figure A-1). This area is recognized as a high risk area by the B.C. Ministry of Environment and the "States/British Columbia Oil Spill Task Force".

1.3.1 Objectives

The objectives of the study are:

1. to demonstrate the need for oiled debris management sites by documenting the various problems encountered through past practices of handling and managing oiled debris during oil spill clean-up activities;
2. to determine the appropriate size of land area required for each oiled debris management site based on the worst case volume of oiled debris from a major oil spill, including any additional area which may be required for the storage of associated emergency equipment and supplies;
3. to examine the limitations, constraints and potential concerns associated with the establishment and use of oiled debris management sites;
4. to develop site selection criteria for oiled debris management sites; and
5. to identify potential locations for oiled debris management sites.

1.3.2 Scope of the Study

This study is restricted to identifying and assessing potential areas for oiled debris management sites to complement British Columbia's oil spill contingency clean-up strategy relating to the study area. The potential sites are identified on 1:100,000 scale plans, and are based on an on-site field survey of the study area, on currently available relevant information for this region, and are supported by the development of site selection criteria. This study is not an environmental impact assessment of the potential sites, nor is it intended to suggest their design. Rather, the study only

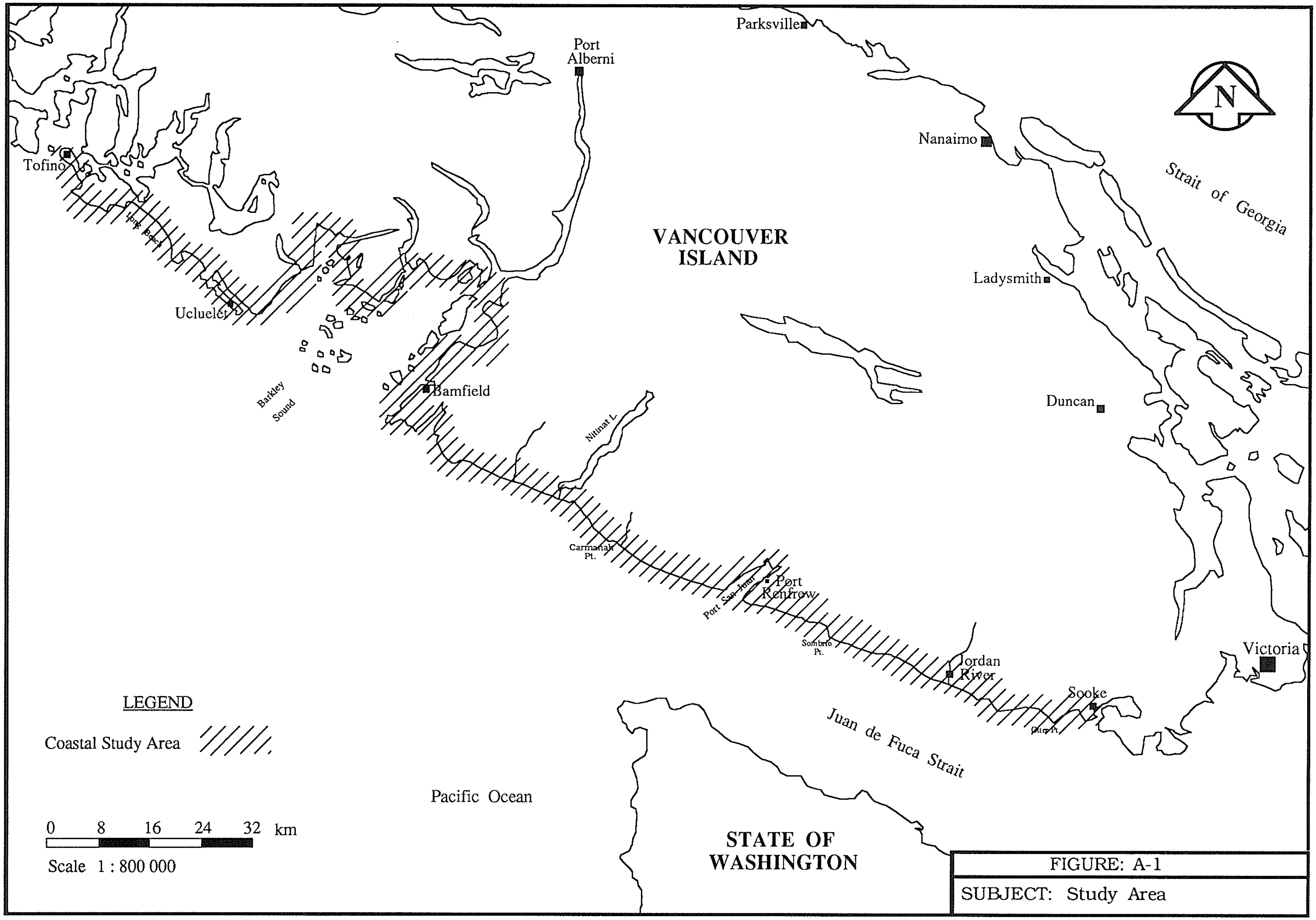

FIGURE: A-1

SUBJECT: Study Area

constitutes a screening process to identify candidate sites for consideration and further evaluation.

Current technologies available for the management of oiled organic and inorganic waste materials at such sites are also discussed in the literature review.

A.4 METHODS

This study entails:

1. a literature review and personal interviews to establish the practices, weaknesses and difficulties associated with the historical handling and management of oiled debris materials arising from the occurrence and clean-up of coastal marine oil spills, as well as to review past approaches used to establish oiled debris management sites;
2. a literature review and personal interviews to characterize the type and volumes of oiled debris materials likely to be associated with major coastal marine oil spills;
3. an examination of physical, environmental and social factors that can influence the site selection and availability of oiled debris management sites supplemented with information obtained from personal interviews with local government officials and provincial agencies responsible for zoning, Crown land tenure and waste site approvals;
4. close communication with government and volunteer oil spill response agencies, complemented with a literature review, so as to develop site selection criteria that can be used for establishing potential oiled debris management sites; and
5. developing maps depicting potential locations for oiled debris management sites which could be designated for emergency use.

A.5 BENEFITS OF THE RESEARCH STUDY

The benefits of this study are that:

- it provides a summary of current management practices for oiled debris;
- it provides an estimate of expected/potential volumes of oiled debris from a major oil spill event;
- it offers background information and site selection criteria to provincial government agencies in the selection of potential oiled debris management sites for emergency use in the event of marine oil spills off the coast of British Columbia; and
- it offers nine candidate sites as potential oiled debris management sites.

The benefits of implementing the study are that:

- the establishment of predesignated oiled debris management sites will improve the response capability to oil spills and reduce the extent of environmental damage by accommodating clean-up crews with an immediately available oiled debris management site;
- the oiled debris management sites may also offer an opportunity for reclamation of some of the oil after the clean-up phase; and
- in providing added protection for the environment, the use of predesignated oiled debris management sites could reduce the long-term environmental cost of marine oil spills through earlier recoveries of shorelines and reduced lawsuits and compensation claims, thereby improving the sustainability of off-shore oil exploration, development and transportation until better alternatives are found.

Section B

LITERATURE REVIEW

B.1 INTRODUCTION

Oil tankers first began moving along British Columbia's coast in the late 1960's with the opening of the Alaska oil fields. Now some 220 tankers, some of them carrying as much as 200-million litres of crude sail by Vancouver Island every month (Western Report 01/23/89), and an ever increasing number steer into Juan de Fuca Strait to unload at the Cherry Point facility in Washington's Puget Sound. Oil spills have already occurred in the region, and have already affected B.C.'s environmentally sensitive coastline. Although considerable expertise exists in the containment, recovery and clean-up of such oil spills, one of the main problems which poses considerable logistic problems for clean-up crews is the temporary storage and eventual treatment and/or disposal of the oiled debris arising from major oil spill events. This problem is only a recent phenomenon for British Columbia because until recently no major oil spills had occurred in this region.

In preparation of searching for and evaluating potential sites for the handling of such oiled debris under emergency conditions, a literature search was carried out on the study area so as to become fully familiar with the physical, climatic, historic, legal, technical and social factors likely to have a bearing on the establishment of oiled debris management sites along the study area.

B.2 COASTAL GEOLOGY AND GEOMORPHOLOGY

The coast of British Columbia lies in the western system of the Cordillera Region, which is made up of three geological areas: the Coast Mountain Range; the Coastal Lowlands; and the Outer Mountain Range. Vancouver Island is featured with two of these geological areas: the Vancouver Island Range, making up part of the Outer Mountain Range;

and the Nanaimo Lowland and Estevan Coastal Plain, making up two out of several divisions of the Coastal Lowlands (McLaren et al., 1983). The full length of the coastal study area traverses all three of these geomorphic regions. The geomorphic characteristics of these regions are attributable to tectonic activity, glaciation and ongoing coastal sedimentary distribution.

During the Cretaceous Period (more than 65 m.y.a.) the oceanic Juan de Fuca Plate collided with the North America Plate resulting in the subduction of the Juan de Fuca Plate under the America Plate. This caused intense deformation and regional metamorphism producing northwest-southeast structural trends and the three distinct geomorphic regions. Typical cross-sections display late Palaeozoic volcanics overlain by a thin horizon of shallow marine shales, sandstone and limestone. These sedimentary sequences are overlain by basaltic resistant lavas from the Permian to Triassic Period, followed by Cretaceous shallow marine carbonates and clastic sedimentary rocks.

The majority of the southwestern coastal region of Vancouver Island is bedrock composed of mid-Tertiary gabbros and basalts and late Tertiary shales, sandstones and conglomerates (McLaren, 1983), as well as unconsolidated Quaternary sediments consisting of till and glacial-fluvial deposits that are the result of the Late Wisconsin (Fraser) Glaciation. The Cordilleran Ice Sheet, which covered Vancouver Island, attained its maximum size about 15,000 years ago (Clague, 1981) followed by a rapid deglaciation. The emergence of the present coastline from this Pleistocene ice sheet occurred less than 11,000 years ago (Holland, 1964), and is regarded to be the result of glacio-isostatic rebound followed by tectonic uplift attributed to plate convergence and subduction activity occurring west of Vancouver Island (Clague et al, 1982). During the last 4,000 - 5000 years, the land areas have risen about 1 - 2 mm/year relative to the sea level, and have exposed coastal features such as sea caves, wave-cut scarps, bars and spits, and beach and dune ridges parallel to the modern shoreline.

Coastal sediments are scarce along the west coast of Vancouver Island because the exposed coastal bedrock is very resistant to erosion. Since it is much easier to clean up a beach than a rocky shore, this scarcity of sediments contributes to the difficulties of cleaning up oiled debris along this coastline. However, where beaches have been formed, such as the extensive beaches between Ucluelet and Tofino, these beaches are the product of the weathering of Tertiary sediments and unconsolidated glacial drift. The continuing exposure of sea cliffs (composed of Tertiary sediments) to the coastal high energy environment provides new sand and gravel deposits which contribute to the sediment accumulation on the beaches.

Common topographic features of this coastal region are the rugged relief of the mountains, and a shoreline characterized by a straight shoreline in the south and a major fjord in the north, which have resulted from erosion attributable to the Late Wisconsin Glaciation.

B.3 COASTAL METEOROLOGY

Climatic conditions along the study area are of significance to oil spill clean-up activities and associated safety concerns, as well as to the establishment, operation and maintenance of oiled debris management sites. Temperatures affect the viscosity of the oil and hence the degree of success in recovery and clean-up. Precipitation increases the water content and weight of the collected oiled debris, induces run-off losses, prevents on-site burning, and presents storage problems for the adequate containment of the collected oiled debris. Winds influence surface currents and wave action, and will thus affect the oil spill distribution and marine accessibility to shorelines. A combination of low temperatures, high precipitation and high winds can affect the morale of clean-up crews and hence adversely affect the efficiency of response measures. In this regard, the Victoria Environment Canada Weather Office was able to supply weather records for three stations along the study area, namely, at Tofino, near Ucluelet and near Sooke. Figure B-1 was developed to depict a summary of the Atmospheric Environment Service data by showing the average monthly data for temperature and precipitation, based on 14 year normals at Sooke, 22 year normals at Ucluelet, and 26 year normals at Tofino.

B.3.1 Temperatures

The temperature graphs in Figure B-1 reveal that the monthly average temperature ranges are comparatively identical along the entire study area. Although the monthly average minimum temperatures are above 0°C, extreme minimum temperatures of -15.0°C, -11.7°C and -13.9°C have been recorded at Tofino, Ucluelet and Sooke, respectively, for December-January. Extreme maximums for these stations in June-July are recorded as 32.8°C, 28.9°C and 29.4°C, respectively (Atmospheric Environment Service).

B.3.2 Precipitation

The precipitation graphs in Figure B-1 reveal less uniformity among the three stations. Quite apparent is the striking increase in precipitation levels between Sooke and Ucluelet, with a moderate additional increase extending to Tofino. The Victoria Environment Canada weather office reports that the increase in precipitation starts just north of Jordan River. At Ucluelet the total average annual precipitation of 3077.3 mm exceeds that of Sooke's 1287.4 mm by 139%, with Tofino's 3288.3 mm exceeding that of Sooke by 155%. This reflects a considerable difference in field conditions which can be encountered westward beyond the Juan de Fuca Strait entrance. The maximum monthly rainfall occurs at Tofino, during December, with the registered monthly average being 480 mm of total precipitation. Snowfall amounts to an insignificant contribution of precipitation, and on the average occurs between Tofino and Sooke on only about 6 to 13 days out of the year. Rainfall, on the other hand, occurs on the average on 195 days out of the year at Tofino and Ucluelet, and 165 days out of the year near Sooke.

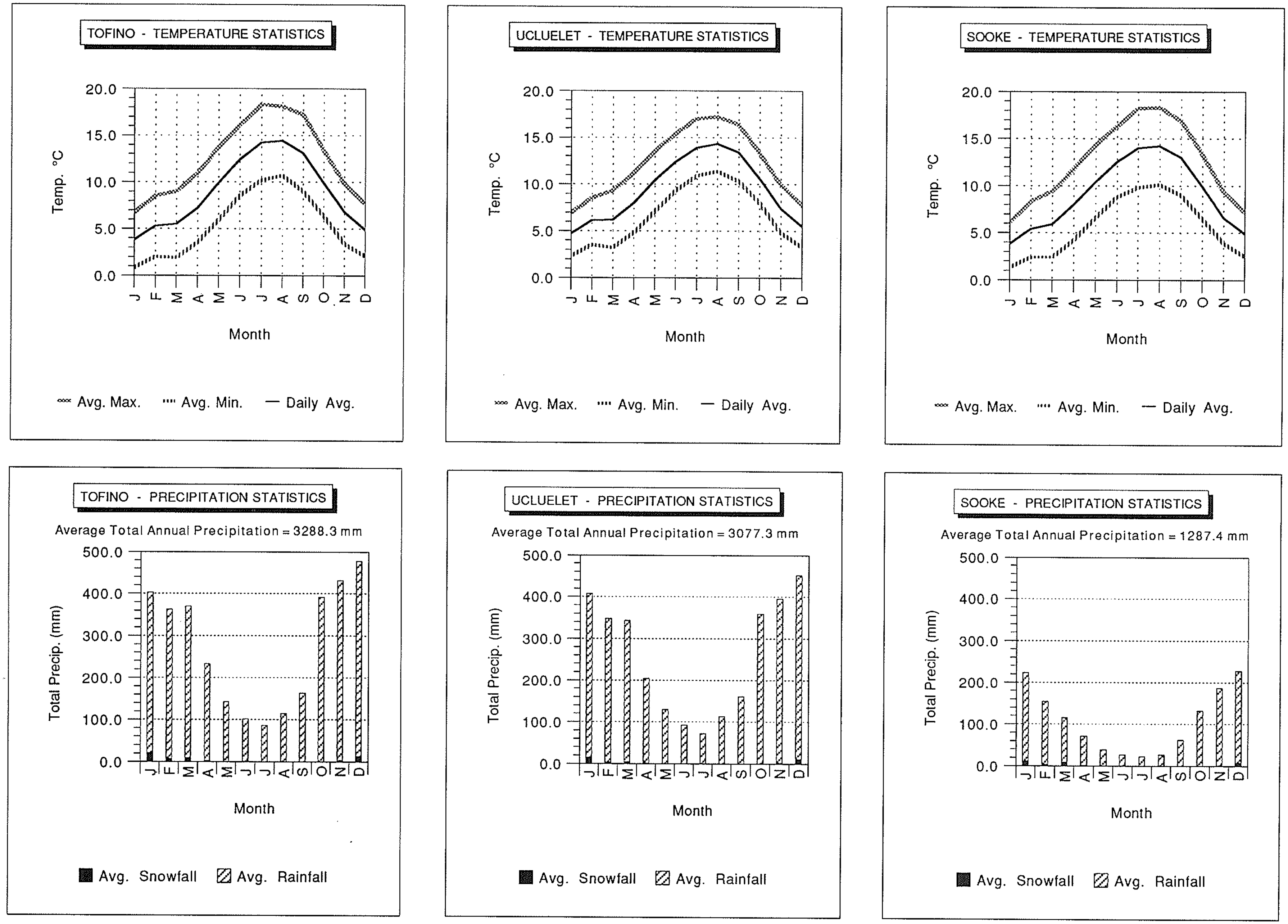

FIGURE B-1 Temperature and Precipitation Graphs for the Study Area

B.3.3 Winds

The winds in Juan de Fuca Strait are considered to play the second most important role (with surface currents playing the primary role) in determining the rate at which spilled oil is transported along the coast. The rate at which the oil is mobilized by the wind is at about 3% of the speed of the wind (Wolferstan, 1981). The wind systems also play a major role in controlling the direction and intensity of wave action on the coastal sediments. This influences the degree of weathering to which an oiled coast will be exposed. In the case of a rocky coastline, the higher the intensity of weathering, the sooner the oil will dissipate. However, along sedimentary coastlines, although some weathering of the oil will occur, the resultant wave action can also cause beached oil to intermix with the loose sediment and be progressively buried. Another consideration respecting winds is in relation to the on-site burning or incineration of oiled debris, and how that might affect the quality of air for nearby residential areas.

In Juan de Fuca Strait the prevailing wind directions are best examined under winter versus summer conditions. In the winter, the prevailing wind direction is from the east and southeast. Between October and March winds at more than 60 km per hour occur for 10 to 15 days each month (Owens, 1977). Maximum hourly wind speeds of 100 km/hr with maximum gust speeds of 130 km/hr have been recorded at Tofino in November and December, respectively, between 1960 and 1980 (Atmospheric Environment Service). In the summer, the prevailing winds are from the west and northwest, and are more moderate in speed compared to the winter winds, with speeds reaching 60 km per hour on only 1 or 2 days per month (Owens, 1977).

B.4 OCEANOGRAPHY

B.4.1 Tides

Tides in Juan de Fuca Strait are typically mixed semi-diurnal with two complete oscillations daily. Fluctuations between high water and low water tidal elevations range from 4.78 metres at Tofino, to 4.05 metres at Ucluelet, to 4.11 metres at Bamfield, to 3.6 metres at Port Renfrew, decreasing in magnitude easterly towards Sooke (Fisheries and Oceans, 1989).

This semi-daily variation in water elevations presents a particularly frustrating problem in the course of shoreline oil spill clean-up activities on shallow-sloped beaches such as Long Beach, and for beach access from the sea to coastlines lined with intertidal flats and rocky platforms of eroded sandstone. Were it not for tides, washed up oil would be kept confined to a narrow width of beach, which would tend to concentrate and minimize the amount of sediment and other debris which would be oiled. However, with the tidal range and shallow-sloped beaches characteristic to the study area, the exact opposite is true.

B.4.2 Currents

The coastal area most likely to be impacted by a marine oil spill will be primarily determined by the mean direction of flow of surface currents within Juan de Fuca Strait. The complexity of predicting the direction of surface currents at any time is evident from the fact that mean direction of surface currents is the vector sum of several types of surface currents acting at the same time. The mean current may be made up of any combination of tidal currents, estuarine currents, Stokes drift, currents caused by steep atmospheric pressure gradients, and wind generated currents. Tidal currents within the Strait are reported to be 0.5 to 1.0 m/s, and 2.0 m/s in restricted areas (McLaren, 1983), and reverse direction in and out of Juan de Fuca Strait every six hours with the changing tide. The estuarian current in the Strait results from river runoff from the mainland. This current is reportedly the strongest on the north side of the Strait with speeds of 0.5 to 1.0 m/s (Wolferstan, 1981). The other currents are more unpredictable, and this has prompted drift card research to verify and adjust computer modelling predictions.

B.4.3 Waves

There are two main types of waves: swell waves, such as those generated in the Pacific Ocean; and sea waves, which are formed in areas of restricted fetch such as in Juan de Fuca Strait. The intensity of wave energy has a significant bearing on the longevity of the oil on the affected coast. In this regard, the coastline west of the entrance to Juan de Fuca Strait is exposed to high level swell wave energy which decreases to moderate level sea wave energy towards the east within the shelter of the Strait. At the western entrance, wave heights exceed 6 metres 10% of the time in the winter, and exceed 3 metres 10% of the time in the summer. Within the fully developed seas in the Strait, the sea waves can reach 1.5 to 3 metres in height (Thomson, 1981).

B.5 COASTAL ENVIRONMENTAL SENSITIVITY

Intrinsic to identifying those stretches of coastline which ought to receive priority environmental protection, or which ought to receive priority and/or specialized clean-up measures in the event of coastal oil spills, is the necessity to produce environmental sensitivity maps for the coastline in question. Such work had been carried out by consultants under contract for Environment Canada in 1987 for the Beaufort Sea area, and resulted in a publication titled "Environmental Atlas for Beaufort Sea Oil Spill Response". Thereafter, in 1990, a similar atlas titled "Oil Spill Response Atlas for the Southwest Coast of Vancouver Island" was also prepared. Among many other advantages, knowledge of the coastal environmental and resource sensitivities can provide some insight into the nature of the waste which would be generated by the remediation measures required for any given area. On the basis of current available literature (Wolferstan 1981, Environment Canada

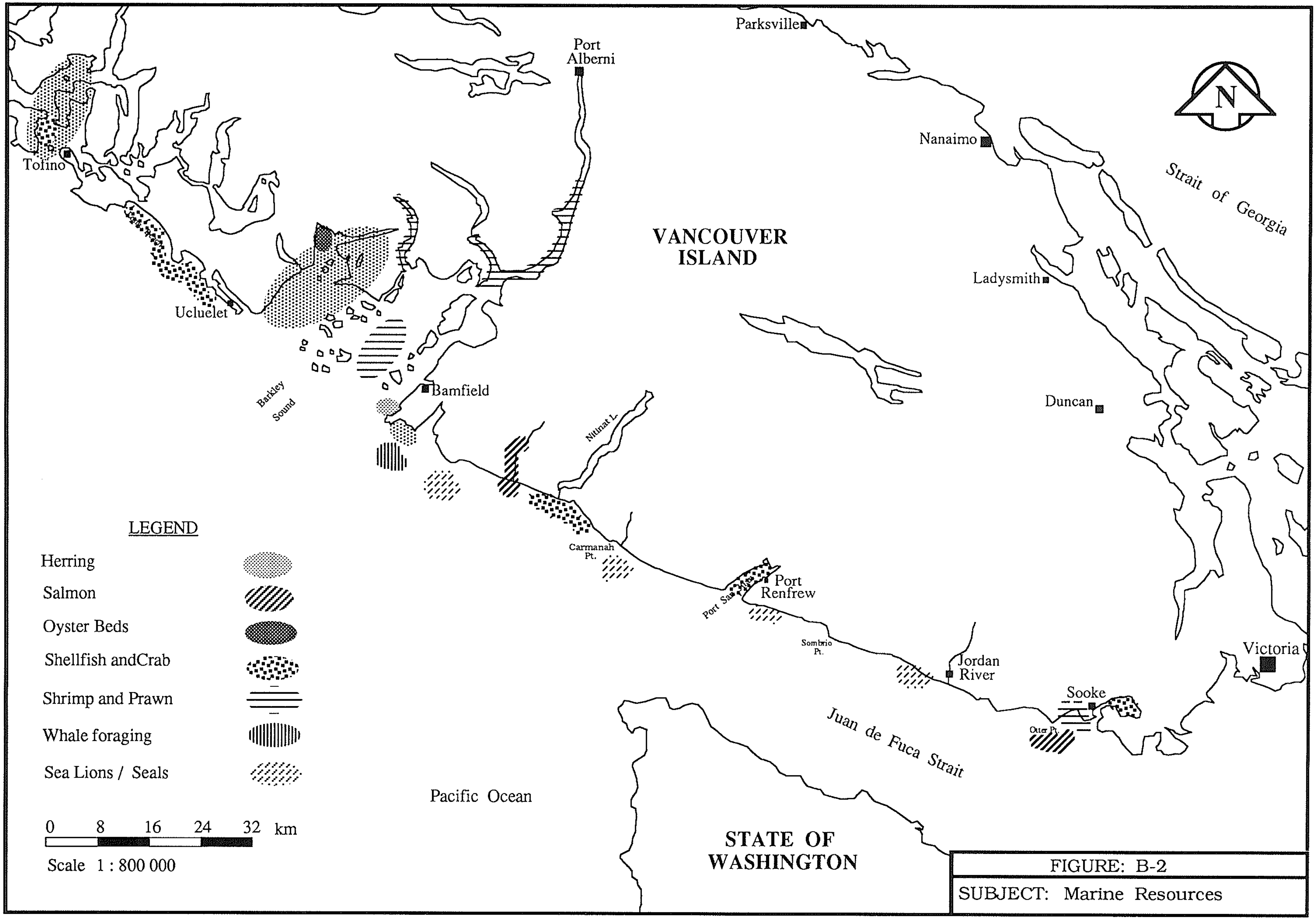

FIGURE: B-2

SUBJECT: Marine Resources

83-4A, and Dickins et al. 1990), some known marine resources indigenous to the coastline of the study area are depicted in Figure B-2. The Oil Spill Response Atlas (Dickins et al., 1990) contains more detailed 1:40,000 scale maps of the coastline from Sooke to Cape Beale which, in addition to other information, highlight the shoreline sensitivity ranging from extreme to low as determined from a sensitivity ranking system which incorporates biophysical and social elements ranked within four major categories: human use, biological resources, shore zone oil residence, and special status areas.

B.6 HYDROGEOLOGY

Information on the hydrogeology within the study area was pursued in order to determine available data on the depth of the groundwater table relative to the corresponding ground surface to assess the potential vulnerability of this resource. In this regard, the Groundwater Section of the Water Management Branch of the B.C. Ministry of Environment gratefully provided a computerized database printout of all the well log data available along the coastal region between Sooke and Tofino. Appendix 'D' contains copies of this data, along with a BCGS Map Area Layout Key figure to assist in locating the approximate locations of the referenced wells. Given that the study area consists of very rugged territory and is sparsely populated, very limited well drilling has occurred along this coastline, resulting in very minimal data.

Unfortunately, most of the available data indicates that the depth to groundwater is unknown, and almost all of the wells are located either very close to the shoreline or clustered in the midst a community. If anything, the data demonstrates the scarcity of hydrology information for the study area. Only site specific drilling investigations in locations of particular interest will yield any meaningful data pertaining to the characterization of surficial water hydrology in those locations.

B.7 HIGH RISK OIL SPILL IMPACT ZONES

In preparation for evaluating potential oiled debris management sites along the coast between Sooke and Tofino, it was considered worthwhile to examine whether any part or parts of this stretch of the coast would be regarded as particularly vulnerable to impact as a result of oil spills within the Juan de Fuca Strait so as to associate some strategic importance to some areas versus others. Studies specifically on this topic were found to have been carried out by the B.C. Ministry of Environment in 1980 and published in an APD Bulletin #9, titled "Oil Tanker Traffic: Assessing the Risks for the Southern Coast of British Columbia". Computer modelling techniques utilizing a "whole ecosystem" type model were used for this purpose. It was concluded that the most immediate probable impact (in 3 days) would occur between Sombrio Point and Bamfield if a spill occurred at the entrance to Juan de Fuca Strait under summer conditions, However, this impact zone would extend as far up as Long Beach within the same time period if the spill occurred during the winter. Other spill site scenarios such as at Cherry Point, or in the Rosario Strait, or east and west of Port Angeles, resulted in probable impacts of ever increasing distance along the study area coastline up to Barkley Sound and Ucluelet, but only after 14 summer days or 7 winter days. The worst case impact zone extended to Tofino and Port Alberni after a 30 day period. In summary, the entire coastal length of the study area is vulnerable in varying degrees to oil spills within the Juan de Fuca Strait, but the area between Sombrio Point and Long Beach would, theoretically, seem to be that length of shoreline within the study area which would most likely to be impacted within the shortest time following a spill at the entrance to Juan de Fuca Strait.

B.8 <u>BASIS OF CONCERN FOR APPROPRIATE OILED DEBRIS MANAGEMENT SITES</u>

B.8.1 Tanker Traffic and Cargo Statistics

Current Documented Traffic

In 1988, 25.4 million m^3 of crude oil were imported to Puget Sound (States/British Columbia Oil Spill Task Force, 1990). This amount constituted 333 tanker trips through Juan de Fuca Strait, with the balance of the crude oil brought in on 35 barges from Vancouver and other distant sources. At the same time, exports of heavy crude from Alberta amounting to 0.91 million m^3 were shipped from Vancouver westward through Juan de Fuca Strait on 14 tanker trips. As well, the Juan de Fuca Strait experienced the transport of another 1.0 million m^3 of refined petroleum products (RPP) via an unspecified number of tanker shipments primarily from California, with many other tanker and barge shipments made from Vancouver refineries to communities on the west coast of Vancouver Island.

Predicted Increases in Traffic

The States/British Columbia Oil Spill Task Force determined that crude oil exports from Alberta fields through Juan de Fuca Strait via Vancouver will shortly increase to 2.2 million m^3 (48 tanker shipments) per year. Pending other approvals, production rates and markets, this tanker traffic could increase to 139 per year by the late 1990's. Also, crude oil imports to Puget Sound are forecast by the Task Force to increase by about 5% per year, although the source breakdown between Alaska and Vancouver is unclear. Additional outbound RPP tanker traffic is also expected to coincide with the expected increases in imports of crude oil, and another 26 outbound tankers per year carrying RPP are expected to pass through Juan de Fuca Strait if Petro-Canada proceeds with its plan to export methyl tributyl ether by tanker from its Port Moody, B.C. facility.

B.8.2 Oil Spill Frequencies

Predictions For the Study Area

Even though various improvements could be made to the shipping and handling of crude oil to reduce the risk of oil spills, risk analysis carried out on the status quo situation indicate that a spill in excess of 159 m^3 (1,000 barrels) of crude or bunker oil from a tanker or barge would probably occur at least once every 2.5 years, with the occurrence of such spills in excess of 1,583 m^3 (10,000 barrels) and also in excess of 15,876 m^3 (100,000 barrels) occurring at least once every 20 and 210 years, respectively (States/British Columbia Oil Spill Task Force, 1990). Increased traffic due to higher exports expected from Alberta worsen these odds.

Recent Publicised Regional Coastal Oil Spill Occurrences

To demonstrate documented public evidence of the potential threat of oil spills to the west coast of Canada, the following chronology outlines a list of oil spill events which have been brought to public attention by newspapers accounts since 1988.

December 23, 1988	875,000 litres of heavy bunker oil were spilled into the Pacific Ocean off Gray's Harbour, Washington, from a barge, the Nestucca, carrying 11 million litres of the oil (Western Report, 1/23/89). The oil slick drifted northward and impacted Canada's Long Beach in the Pacific Rim National Park on the west coast of Vancouver Island.
March 24, 1989	38 million litres of Alaskan crude oil were spilled into Prince William Sound when a tanker, the Exxon Valdez, carrying 200 million litres ran aground on a reef. The spill polluted 1,800 kilometres of shoreline.
November, 1989	1,200 to 2,400 litres of bunker oil were spilled from an unknown vessel into the mouth of Sooke Harbour (Winnipeg Free Press, 11/26/89).

January 20, 1990	218,000 litres of refined oil were spilled from a Canadian fuel tanker which ran aground in Wrangell Narrows at Juneau, Alaska. The tanker was carrying 6.8 million litres of gasoline, diesel fuel, and heating oil. (The Winnipeg Sun 1/22/90).
February 7, 1990	1.5 million litres of Alaskan crude oil were spilled near Huntington Beach off the coast of California from a tanker carrying 79 million litres which had its hull punctured by an anchor (Winnipeg Free Press, 2/10/90).
February 24, 1990	40,000 litres of diesel fuel were spilled into Vancouver harbour as a result of a collision between two ships (Winnipeg Free Press, 2/25/90).

These incidents reflect only regional spills which became public knowledge by virtue of their visibility and the fact that they affected west coast real estate and wildlife. Many marine oil spills never reach the shore and only become another statistic in the Coast Guard records. Internationally, many other major coastal oil spills have occurred since 1988, notably off the coasts of Texas, New Jersey, Peru, Australia and Morocco.

B.8.3 Estimated Quantities of Oil Likely to Reach Shore

Some relevant findings of the States/British Columbia Oil Spill Task Force, which highlight the difficulty associated with predicting the possible amounts of oil likely to affect a shore following a marine oil spill of some given size, were that:

- There is no close correlation between spill size and the length of shoreline impacted. Shoreline impact from an oil spill is more closely related to weather conditions, the wind direction, the tide cycle, time of the year, and the type of shoreline at risk.
- Recovery of oil at sea would be 2 to 3 times more effective under summer conditions than under winter conditions.

- Under the most ideal set of circumstances, no more than 30% of the total volume of oil spilled into the open sea would likely be recovered.
- Reducing response times by as much as 1/2 might only improve recovery efficiencies by 10% at sea.
- The type of oil product has a major effect on the potential offshore recovery effectiveness.
- The Alaska North Slope crude oil has adverse implications for shoreline clean-up efforts because it quickly forms highly stable emulsions (mousse) in the sea, causing the volume of oil to expand by a factor of up to 3 times the original volume spilled.

A computer model of a spill scenario carried out for the Task Force, and based on an oil spill of 30,160 m^3 (190,000 barrels) of crude oil in U.S. waters within Juan de Fuca Strait and impacting Canada, determined that the amount recoverable at sea would be 2 to 3 percent, the time of impact to shore would be 61 hours, the initial length of shoreline oiled would be 80 km, and the volume of emulsified oil on shore would be 87,220 m^3 with the balance of the oil lost at sea. This 87,220 m^3 of oil would represent only the emulsified oil before even considering the additional volumes of debris that would be oiled and would also have to be potentially cleaned up or treated in situ.

B.8.4 Documented Oiled Debris Management Problems

<u>Nestucca Oil Spill Clean-up</u>

In the course of clean-up efforts along the Pacific Rim coast, 450 tonnes of oiled debris were collected (Canadian Coast Guard Western Region, 1989). Oiled debris which was not or could not be burned on shore was, for lack of any suitable local holding site, temporarily stored in plastic bags at the Tofino Airport on a concrete slab within a fenced storage compound. However, this site raised concerns among a nearby native community because they feared that evidenced seepage losses from the storage site would impact the community's nearby domestic groundwater supply. Then, the proposed use of the Port Alberni landfill site by the Provincial Waste Management Branch for the permanent disposal of the oiled debris met with strong local political opposition due to the prevailing opinion that the oiled debris should be delivered back to the party responsible for the spill. As well, an experimental effort to incinerate the oiled debris at the Tofino/Ucluelet landfill site by using a locally constructed mobile incinerator did not prove successful. Consequently, all the oiled debris had to be trucked to Ladysmith on the eastern side of Vancouver Island for incineration. Generally the inadequate arrangements for the handling of the oiled debris caused confusion, clean-up delays, local hostilities and increased waste handling costs.

Valdez Oil Spill Clean-up

Oiled debris management difficulties were likewise encountered during the clean-up of the Valdez oil spill in Alaska. Here some 36,300 tonnes of oiled debris required removal. Inadequate waste management plans, sharp debates over the merits of various disposal schemes, coupled with the NIMBY syndrome, meant that oiled debris had to be barged from the Kenai Peninsula Beach area all the way to a landfill site in the State of Oregon at significant cost (Anderson, 1989).

B.9 RECOMMENDATIONS OF INVESTIGATIONS INTO RECENT WEST COAST OIL SPILLS

Many investigations followed the Nestucca and Valdez oil spills, some being more formal than others. As well, many reports and recommendations resulted from these activities which covered the whole spectrum of possible influencing factors, concerns and shortcomings associated with oil spill preparedness and response capability. The following outlines only those recommendations, on a report by report basis, which relate to the problem statement and objectives of this research study.

B.9.1 Nestucca Oil Spill Report (June 1989) - Prepared by the Canadian Coast Guard Western Region

<u>Recommendation No. 7.1</u>

"Permanent waste disposal sites for oiled debris should be established."

<u>Recommendation No. 7.2</u>

"A federal/provincial team should be formed to investigate and make recommendations for future clean-up operations to include:

a) criteria for the selection and use of temporary waste disposal sites,

b) portable methods of waste disposal,

c) acceptable methods for transporting oily waste, and

d) provisions for regular reviews of the above."

B.9.2 Report to the Premier on Oil Transportation and Oil Spills (November 1989) Prepared by David Anderson

<u>Recommendation No. 114</u>

"That the waste Disposal Branch of the Ministry of the Environment prepare and circulate to all coastal municipal and regional governments a "white paper" on oil spill debris disposal proposals."

<u>Recommendation No. 115</u>

"That following consideration of the responses to that "white paper" a plan for oil spill debris disposal be adopted and published."

<u>Recommendation No. 116</u>

"That efforts to develop satisfactory barge transportable incinerator units be continued."

B.9.3 Final Report of the Public Review Panel on Tanker Safety and Marine Spills Response Capability (September 1990)

Recommendation No. 4-17

"To facilitate the disposal of oiled debris resulting from spill clean-up operations:

- the Canadian Coast Guard, as lead agency, ensure that all levels of government involved agree on, and pre-authorize, temporary storage as well as treatment sites for marine spill waste materials along all marine transportation routes;
- landfilling of oiled debris must not be practised where alternatives are possible;
- research into better methods of treating oil spill debris must be undertaken as a high priority."

B.9.4 Final Report of the States/British Columbia Oil Spill Task Force (October 1990)

Recommendation BC-10:

"The Province of British Columbia should prepare an up-to-date emergency collection and disposal plan for oily debris and waste generated from a marine oil spill."

Rationale:

"The existing marine spill emergency response plan for British Columbia does not incorporate a strategy for oily waste collection, disposal or recycling. Debris generated from an oiled coastline can be considerable, as was evidenced by the Nestucca and Exxon Valdez spills, and require a combination of in situ burning, recycling, off-site incineration or landfill."

B.10 B.C. PROVINCIAL STATUTORY PROVISIONS FOR THE MANAGEMENT OF OILED DEBRIS

Although various co-operative and co-ordinated response measures may be undertaken jointly by the federal government and the B.C. provincial government through the understanding of an emergency action plan for addressing marine oil spills, the off-shore containment and recovery of the spilled oil is essentially the full responsibility of the federal government. However, once the oil washes ashore onto the B.C. coast, the B.C. provincial government becomes the lead party responsible for the shoreline clean-up and for the proper waste management of the oiled debris. In this regard, the B.C. provincial government is bound by the provisions of two main statutes, namely: the Environment Management Act, and the Waste Management Act. Additional relevant requirements are outlined in two regulations passed under the Waste Management Act, namely: the Waste Management Regulation, and the Special Waste Regulation.

The Environment Management Act specifies, in Section 2, that the duties, powers and functions of the minister are to manage, protect and enhance the environment by, among other duties, preparing strategies for the protection and management of the environment, and preparing environmental management plans for specific areas of the Province to deal with waste management. An oil spill having caused a fouled shoreline would fall under the general definition of a "detrimental environmental impact" which would justify the applicability of this Act to such a case. Special powers under Section 5 are available to the minister such that the minister could declare that an "environmental emergency" exists since the definition of an "environmental emergency" includes "a spill or a leakage of oil". Under this section, the minister "may order any person to provide labour, services, material, equipment or facilities, or to allow the use of land for the purpose of preventing, lessening or controlling the hazard presented by the emergency". This provision offers extensive powers to the minister, and has far reaching implications in the case of a response to a major oil spill event.

The Waste Management Act sets out provisions for the proper handling and disposal of waste substances. Among the definitions of "waste" under this Act, spilled oil or oiled debris would seem to be captured by the classification of either "special waste" or "any other substance designated by the Lieutenant Governor in Council". Since this writer could find no evidence of spilled oil or oiled debris having been designated as "waste" by the Lieutenant Governor in Council, the only other possibility is that it would be regarded as "special waste". However, upon close examination, whether or not a particular oil can be regarded as a "special waste" is somewhat unclear. According to the Special Waste Regulation, "special waste" includes "dangerous goods" as defined in section 2 of the Transportation of Dangerous Goods Act (Canada), and also "waste oil", which by definition encompasses only refined petroleum based oils or synthetic oils present in the waste by a magnitude of greater than 3% by weight and rendered unsuitable for their original purpose. Unrefined or crude oil does not seem to be captured by the definition of "waste oil". Likewise, whether all petroleum crude oil is captured by the definition of "dangerous goods" is also unclear because, although the Transportation of Dangerous Goods Act specifically lists petroleum crude oil as "dangerous goods", such substances (ie. flammable liquids) are labelled in Schedule II - List II only as Class 3, and are therefore "dangerous goods" only if they have a flash point of 61°C or less. This may reflect a failing in this Act in that no recognition appears to be given to the substance of petroleum crude oil for its components or derivatives which may be poisonous (toxic), ie. a Class 6, or that may be hazardous to the environment or may be a dangerous waste (as determined from a leachate test), ie a Class 9. Although certain volatile organic carbons are singled out in Schedule II and given Classes 3, 6, and/or 9, Classes 6 and 9 are not reflected in petroleum crude oil.

If a particular oil or oiled debris is classified as a "special waste", then that has implications for the Crown as to how it must be handled, transported and disposed of or otherwise treated. Generally, Section 3.2 of the Waste Management Act stipulates that any facility established for the treatment, recycling, storage, disposal or destruction of "special wastes" may only be established and operated in accordance with a permit, approval, order or an approved "waste management plan". Section 4 of this Act goes on to restrict the quantity of "special waste" which may be stored at such facilities by way of the same approval mechanism as Section 3.2. There are also implications for Canadian Coast Guard in the transportation of the "special waste" by way of Section 5. Furthermore, the additional specific requirements of the Special Waste Regulation apply to any person dealing with "special waste" substances unless, through the provision of Section 52 of this regulation, the substance in question is made exempt from the Special Waste Regulation by virtue of qualifying as "dangerous goods" originating from a response to an accidental spill. But this exemption may not apply to all oils because not all petroleum crude oils may necessarily fall into the category of "dangerous goods", and those light crude oils which might initially have been classified as "dangerous goods" might cease to be so after sufficient volatiles have vaporized, while the spilled oil lay exposed to weathering in the sea or on the shore, to cause the flash point to increase to greater than 61° C. Hence, some ambiguity appears to exist concerning the applicability of the Waste Management Act and its regulations under certain circumstances.

In the event of a major marine oil spill having beached on the southwest coast of Vancouver Island the mammoth clean-up problem at hand would have to be dealt with expeditiously, meaning that the classification of oil spilled at sea, and subsequent oiled debris wastes, may have to be predefined in order to avoid any legal ambiguities during the implementation of a marine oil spill waste management plan. Upon such an oil spill event, Section 5 of the Environmental Management Act would in all probability be invoked, and a special pre-arranged "waste management plan", meant to complement a comprehensive marine oil spill contingency plan, would likely be used to address the problem of handling and treating or disposing of waste oil and oiled debris.

B.11 AVAILABLE WASTE MANAGEMENT TECHNOLOGIES FOR OILED DEBRIS

Although not all the spilled oil which reaches a coast will be or will need to be cleaned up, that which can be cleaned up, by virtue of reasonable accessibility to the shoreline in question, will be collected during an oil spill emergency under physical, climatic and tidal conditions that can vary from near ideal to extremely hostile. As well, the type of oiled debris may vary greatly to include such oiled materials as: clean-up sorbents, derelict clean-up equipment, seaweed, dead birds and mammals, dead fish, shellfish, timber, beach sand, pebbles and rocks. Furthermore, the volumes of oiled debris generated can be highly variable. With all these potential variables and unknowns giving rise to countless combinations and permutations of possible quantities and types of waste that might arise, a simple cure-all strategy for dealing with the generated waste is not a realistic expectation.

The type or types of clean-up methodologies employed along the shores may prove to be the only factor by which to influence or manage the amount of oiled debris which would require removal and treatment or disposal. However, no particular clean-up methodology ought be employed only with the goal of minimizing the amount of oiled debris, which may have to be removed, without weighing the long-term environmental consequences of the chosen methodology.

B.11.1 Review of Beach Clean-up Methodologies

Literature (Owens, 1977) indicates that oiled shorelines can be cleaned up or restored by a variety of methods, namely:

1) by manual removal of oiled debris;
2) by mechanical removal of oiled debris using graders, scrapers and/or front-end loaders;
3) by mechanically mixing sediments contaminated with light grade oil;
4) by using inorganic, organic or synthetic sorbents to absorb oil;
5) by applying chemical dispersants;
6) by steam cleaning;
7) by high or low hydraulic pressure cleaning;
8) by sandblasting;

9) by in situ burning,

10) in situ bioremediation of the contaminated soil through the use of nutrients, and

11) do nothing option.

The use of any specific clean-up method is contingent upon site specific conditions relating to the terrain, type of sediment and the environmental sensitivity of the area.

B.11.2 Review of Oiled Debris Management Methodologies

Upon being confronted with an oiled shoreline and associated oiled debris, the oil and oiled debris which has been removed from the shore subsequently constitutes a problem of waste management which literature indicates as being carried out by such methods as:

1) on-site incineration using a mobile incinerator; or

2) temporary storage on or near the affected beach until more suitable disposal methods or disposal sites can be found; or

3) barging the collected oiled waste to a suitable disposal facility where the waste could be incinerated or disposed of in an acceptable manner; or

4) a combination of any of the above.

In the case of major oil spill clean-ups, many literature sources recommend the initial use of temporary storage sites followed by the implementation of various recovery/treatment/disposal options.

B.11.3 Review of Oiled Debris Treatment/Disposal Technologies

Assuming that collected oiled debris has been taken to a waste management site, several options are available for the acceptable treatment/disposal of the oiled debris:

Direct Recovery of Usable Oil

This process or activity simply amounts to reclaiming as much of the oil from the oiled debris as possible through gravitational or mechanical means. This would only be applicable to materials heavily soaked with light oils. The recovered oil could then be recycled in a number of ways, depending on its quality. The balance of the oiled debris could then be treated or directly disposed of, depending on the type of oiled waste involved and the percentage of oil remaining on the waste.

Thermal Volatilization and Recovery of Oil

An example of this pyrolysis technology, is the AOSTRA Taciuk Process (ATP), which was developed from research into extracting oil from the Alberta oil sands and oil shales, and has been used successfully for the thermal remediation of oil contaminated soils (Ritcey and Komery, 1990). The process can accept wastes in physical form varying from solids to liquids, and containing varying concentrations of water, solids and organic contaminants. Initially, the waste material is heated in the preheating zone to affect a separation of the solids, water and organics. This is followed by the pyrolysis in the reaction zone at temperatures of about 500 to 600 °C and terminated with a cooling zone for the heated material. The products are clean solids which would pass the leachate test for landfill sites, gas emissions that would be treated to meet emission standards, water that would require steam stripping or secondary treatment to remove further organics (inorganics such as excessive heavy metals might also require removal), and liquid oil (condensed from vapour oil) which could be recycled or otherwise reused. Mobile units employing this process technology can reportedly accept feed rates up to 13.6 tonnes per hour.

Thermal Volatilization and Destruction of Oil in Oiled Debris

This pyrolysis technology is somewhat similar to the ATP system described above except that no attempt is made to recover the vaporized oil. The vapours produced by heating the contaminated debris are passed through a 760°C afterburner to produce water vapour and carbon dioxide. Hydrocarbon reductions of 86 to 99.3% are claimed, but local air emission standards still have to be met, and scrubber water generated in the cooling and scrubbing of the off-gases will require treatment or transfer to a treatment facility. This technology is applicable to treating waste containing oils with boiling points of up to 426°C and is limited to non-halogenated compounds which would otherwise require a very high temperature afterburner and acid scrubbing equipment. In such a case, straight incineration would probably be considered. Mobile Thermal Volatilization Systems (MTVS) have been successfully employed at feed rates of 9 tonnes per hour (McCartney et al., 1990).

Incineration

Complete destruction of all the oil in oily waste can be accomplished through incineration which involves the complete combustion of all hydrocarbons at temperatures in the range of 1200 °C. Rotary kiln and open hearth type incinerators are the most appropriate for oily waste, although for remote areas smaller mobile kilns can be developed. Incinerators used for domestic waste are not viewed as suitable since chlorides from sea water may give rise to corrosion, and industrial waste incinerators may be too small to handle the large rates of waste material requiring incineration unless a temporary storage stage can accommodate controlling the feed rate. Combustion in these units is self sustaining provided the feed material contains at least 25% oil and no more than 50% water. Some emulsified oils can, however, contain up to 70% water, and would therefore require some preliminary processing to liberate the free water (The International Tanker Owners Pollution Federation Ltd. 1984).

Aerobic Biodegradation (Land Farming)

Land farming, or the cultivation of oily waste, is a common practice that takes advantage of micro-organisms in the soil, in conjunction with oxygen, water, warm temperature and available nutrients to aerobically decompose the hydrocarbons into inert matter. The oily waste, providing it is of suitable size or texture and does not contain more than 20% oil (The International Tanker Owners Pollution Federation Ltd. 1984), would be tilled into the upper 20 cm surface of the soil. Application rates quoted in the literature vary significantly from recommended rates of 60 to 300 tonnes of oil per hectare per year (TERA Environmental Consultants Ltd. 1980), to maximum rates of no more than 400 tonnes of oil per hectare (The International Tanker Owners Pollution Federation Ltd., 1984). Thereafter, it would be periodically retilled, with nutrients added as needed and lime used, if necessary, to control the soil pH. The bulk of the applied oil could take about 3 years to degrade, while some oil components such as resins and asphaltenes, which could comprise about 20% of the original oil, will resist degradation and remain unaffected. Crops or other vegetation may be grown in this tilled oiled debris after the bulk of the oil has degraded. The potential for heavy metal content in the soil, and groundwater contamination, are the usual concerns and depend largely on the intended crop use and the permeability of the soil.

Anaerobic Biodegradation (Landfilling)

Landfilling of oiled debris involves the deep burial of the waste matter, usually along with other sanitary waste, at permanent disposal sites where there is minimal threat to groundwater pollution. The deep burial of the oiled matter in a properly operated landfill site eliminates the presence of oxygen, and minimizes leaching. Under this condition, only anaerobic micro-organisms, which thrive in the absence of oxygen, can be counted on to gradually decompose the oil, but the process is very slow. Literature recommends that the oiled debris disposed of in this fashion should not contain more than 20% oil since compaction techniques might otherwise cause the emergence of some oil to the surface (The International Tanker Owners Pollution Federation Ltd., 1984).

B.11.4 Waste Storage/Disposal Site Liners.

Waste disposal sites, whether intended for short or long-term purposes, are normally lined with an adequate thickness of soils demonstrating a hydraulic conductivity of at least 10^{-7}cm/s, or less, to ensure the proper containment of leachates and prevent the contamination of local groundwater (Manitoba Hazardous Waste

Management Corporation, 1988 and CCME, 1991). Such a condition may occur naturally or may have to be engineered through the importation and compaction of selected soils. Where less than ideal conditions exist, or where zero loss criterion is mandatory, such sites are enhanced with impervious liners, usually made of synthetic flexible material. The principal purpose of soil or synthetic liners is to restrict or prevent, respectively, the loss of leachates from the disposal site into the environment beyond the site.

In evaluating synthetic liners, consideration must be given to their resistance to attack by liquid fuels, ductility at low temperatures, puncture resistance, resistance to weathering and their bonding durability. Generally, literature concerning synthetic material liners points out two main problems for the cause of liner failures:

1) <u>Improper choice of liner material for the type of waste</u>

   The Environmental Protection Agency (EPA) had carried out research in the late 1970's on various potential liner materials and concluded that oily wastes could not be safely contained with asphalt liners. Likewise, bentonite liners were found to be unsuitable for strong wastes containing both aqueous and oil phases. Also, the EPA warns that a generic class of synthetic material like polyvinyl chloride (PVC) can have substantially altered qualities depending on the type of ingredients added to the mix. As well, the reactive characteristics of different wastes are different from each other. Hence, the synthetic material to be selected should be tested on the type of waste to which it will be subjected.

   Some testing done by EPA on liners for oiled debris concluded that, for short-term storage, polyethylene and polypropylene were the most effective liner materials (Farlow, 1980). A more recent publication, the CCME "National Guidelines for Landfilling of Hazardous Waste", published in April, 1991, indicates that high density polyethylene (HDPE) is presently the material of choice for synthetic liners because it exhibits "good tensile strength and elongation properties, high tear and puncture resistance, good low temperature brittleness properties, and excellent resistance to attack from a wide variety of chemicals".

2) Improper installation of the liner

Improper installation is cited as the main reason for liner failures. In this regard the federal Environmental Protection Service had carried out some research in 1976 and concluded that, assuming the all the joints are properly seamed, even a thin non-reinforced synthetic membrane can be suitably protected through the careful preparation of the bedding and a substantial cover of fine-grained overburden (Thornton, 1976). They also recommend that, ideally, the membrane should be sandwiched between two cushioning layers of bedding material such as sawdust, foamed polyurethane, or fine grained soil. Such a double liner system is normally associated with leachate collectors which are placed at the lowest elevation between the two liners for the purpose of testing the ongoing integrity of the inner liner or for recovering leachates which have passed through the inner liner.

B.12 STATE-OF-THE-ART FOR ESTABLISHING OILED DEBRIS MANAGEMENT SITES

Very little literature is available on the establishment of oiled debris management sites for potential marine oil spill events, particularly the appropriate siting of such facilities along a coast. As well, past oil spill incidents have not been well documented, if at all, on the actual procedures employed in the clean-up and management of oiled debris, nor on the amount of oiled debris generated versus the amount of oil estimated to have reached shore. Much more attention has so far been given to examining the technological aspects of prevention, containment, and clean-up methodologies associated with oil spills onto coasts under various cases of coastal geomorphology. However, the following material summarizes the literature that has been reviewed concerning the establishment of oiled debris management sites.

B.12.1 EPA Viewpoint

In 1978 the EPA published a report titled "Oil Spill Debris - Where to Put the Waste". The Report outlined: the results of a survey of how several states approached the problem of disposing of oiled debris; what the various options might be for proper treatment/disposal of such waste; and some site selection criteria to be considered in establishing disposal sites. Of particular interest is that the option of long-term anaerobic storage/disposal (deep durial) is their lowest ranking disposal option because of the slow rate of natural degradation and the potential for leachate contaminants. However, the report does recognize the need for temporary storage facilities so as to facilitate the orderly implementation of other more preferred methods of oil reclamation/treatment/disposal options.

B.12.2 Approach Taken on the Beaufort Sea Coast

In assessing Canada's state of preparedness for arctic and marine oil spills, the Public Review Panel noted the lack of pre-designated coastal oiled debris management sites, but gave credit to Tuktoyaktuk, on the Beaufort Sea, for being exceptionally well prepared in this regard. Report (EPS 3-EC-79-3) titled "Oiled Debris Disposal and Storage Sites: Beaufort Sea Coast", prepared in 1979, discusses the approach taken in this arctic region. It outlines: site selection criteria; design guidelines; construction guidelines; reclamation guidelines; limitations on construction, utilization and reclamation; and geological and access considerations for the siting of potential temporary storage as well as permanent oiled debris landfill disposal sites located along the Beaufort Sea Coast. Aerial photographs in this report depict the precise locations of numerous proposed temporary and permanent disposal sites, and associated sea access routes for emergency use. This information was further complemented in 1987 with environmental sensitivity maps compiled into an "Environmental Atlas for Beaufort Sea Oil Spill Response" (Dickins et al., 1987) onto which the proposed disposal sites were superimposed. Still outstanding, however, is the mechanism for formally approving or designating the proposed disposal sites (written communication from EPS, Yukon Branch, 01/18/90).

B.12.3 Previous Work Undertaken on B.C. 's Coast

In 1980 TERA Environmental Consultants Ltd. were contracted to carry out a study for the federal Environmental Protection Service on the subject of "Site Selection Guidelines and Locale Identification for the Disposal of Oil Contamination Debris Resulting from an Oil Spill in Southwestern Coastal B.C.". The consultant's task was to select suitable sites for anaerobic burial, landfilling, or incineration of oil spill debris. In the course of these activities, certain selection criteria were outlined, some potential sites were identified, and the pros and cons of the alternative disposal methods were discussed.

In 1983 the federal Environmental Protection Service, Pacific and Yukon Region, compiled a "Shoreline Protection and Clean-up Manual" covering the southwest coast of Vancouver Island from Bamfield to Victoria. This report provides a broad range of valuable information on 1:50,000 scale maps regarding coastal physical environment features, resource sensitivity, access limitations, and recommended countermeasures to assist in the planning of oil spill response programs. Although the legend in these maps made provisions for the identification of oil collection points, oil burning sites and oil disposal sites, no such items were identified on the maps.

In 1984 the federal Environmental Protection Service, Pacific and Yukon Region, compiled a "Shoreline Protection and Clean-up Manual" covering the Port of Vancouver. The make-up of this report is very similar to the preceding report of 1983, but also stopped short of identifying oil collection, burning and disposal sites.

B.12.4 Site Selection Criteria for Oiled Debris Management Sites

Table B-1 summarizes the site selection criteria used by the EPS, TERA Environmental Consultants and the EPA, as discussed in sections B.11.1 to B.11.3. The guidelines or criteria used for oiled debris management sites at Tuktoyaktuk, for example, cannot necessarily be used as a blueprint for other parts of Canada because this study was unique to the arctic climate where seasonal limitations and physical constraints play an important and decisive role in the location, access and terrain stability of such sites. Likewise, the site selection criteria offered by the TERA Environmental Consultants and by EPA for oiled debris management sites are geared towards the regions involved in their respective studies. Each geographical region will present some different and/or additional problems which must be considered, and in that regard the Juan de Fuca study area presents its own unique challenge.

TABLE B-1

SUMMARY OF AVAILABLE SITE SELECTION CRITERIA FOR OILED DEBRIS MANAGEMENT SITES

	EPS (1979)	TERA CONSULTANTS (1980)	EPA (1980)
Category	For Disposal Pits	For Burial Sites	For Disposal Sites
Size		• ≥ 25 ha.	
Terrain	• Not on alluvial fans or active flood plains unless on high terraces. • Not in recently drained lakes, taliks or large icing zones. • Not in low lying sedge meadows.	• Not on bedrock. • Not in quarries, unless excavated to clay. • Not in wetland areas. • Not in areas subject to flooding.	• Should not be located on porous soil overlying potable groundwater. • Should not be located in an area subject to flooding. • The site should not be a source of water pollution.
Surficial Materials		• Should be fine-grained (marine clays or tills). • > 1.5 m thick. • No bedrock outcrops or shallow surficial deposits.	• A clay layer between the site and groundwater would offer the best protection for the ground-water.
Surficial Gradient	• Terrain should be as level as possible. • > 50 m from toe or crest of slopes > 10°. • ≥ 100 m from the toe or crest of slopes > 15°.	• ≤ 5% slope.	
Distance Req'ts	• Inland of maximum storm surge zone. • As close as possible to the beach. • 1.5 m above and 100 m away from the high water mark of streams, rivers and lakes. • > 3 km from a settlement. • Not directly upstream of a settlement. • > 1000 m from significant fish overwintering pools.	• > 5 km upstream of wells. • > 500 m downstream of wells. • > 500 m from surface water. • > 250 m from buildings or farmland.	• Sites should be situated as closely as practical to the point(s) where oiled debris is (or might be) collected or stockpiled.
Elevation	• 3 m above sea level.		
Land Use	• Not within bird sanctuaries. • Not within wildlife reserves. • Not within International Biological Protection study areas. • Not within municipal or Dept. of National Defense control areas.	• Surrounding land use should be considered.	• Site should be compatible with on-site and adjacent land use.
Access		• Access should be taken into consideration.	• Existing or constructed access roads should be all-weather construction.

Section C

METHODOLOGY

The following discussion outlines the activities which were carried out to achieve the identified objectives of this study. Generally, the approach taken towards undertaking this research study was to first carry out a literature review, followed by on-site field work to collect data and to view the study area, followed by an evaluation of all the compiled information for the purpose of achieving the objectives of this study. After it became apparent that available regional data did not correlate well with actual field observations, more emphasis was placed on personally examining the study area for obvious desirable physical characteristics regarding gradients, soil conditions, accesses and apparent land uses. Initially, areas closer to the shores were emphasized for examination. However, when it became apparent that the physical conditions close to the coast were so disagreeable, the field survey had to be focused on territories farther inland.

C.1 <u>LITERATURE REVIEW</u>

The literature review aspect of this study had commenced early in September of 1989, during the development of the draft proposal phases of the study. Many sources were searched for literature ranging from general subject matter on oil spills to specific material relating to the waste management of oiled debris. These sources included: B.C. Ministry of Environment, Environment Canada, Canada Coast Guard, Fisheries and Oceans, interlibrary loan material, U.S. and Canadian Task Force reports, and magazine and newspaper articles. The "Bibliography" section of this practicum outlines all the literature which was selected as relevant to this study and which was referenced for the purposes of compiling this practicum.

C.2 AERIAL SURVEY

Courtesy of the Canadian Coast Guard, a coastal aerial survey of the entire length of the study area was provided on July 6th, 1990, with the use of a helicopter. The trip commenced at Victoria, proceeded to Sooke and followed the coastline at low level flying all the way up to Tofino and back, with excursions deep into Barkley Sound, Pachena Bay and Port San Juan. This opportunity was used to gain an appreciation of the difficulty of the terrain, to identify potential convenient sites for oiled debris management, and to photograph and take videos of those areas deemed of interest to this study for future reference.

C.3 GROUND SURVEYS

The most important aspect of this study was the field work. This activity was scheduled for the month of July in order to ensure the least likelihood of interruptions due to foul weather. A close examination of the study area off available road maps revealed that the logical manner of surveying the study area would be to break it up into five major units, that is:

1) Sooke <-> Port Renfrew,

2) Port Renfrew <-> Bamfield,

3) Bamfield <-> Port Alberni,

4) Port Alberni <-> Ucluelet, and

5) Ucluelet <-> Tofino.

The purpose of this activity was to scout the entire study area by land in order to obtain sufficient data for achieving objectives 3, 4 and 5, and in order to gain an appreciation of the complexities that would be associated with the siting of suitable oiled debris management sites within this rugged territory. This activity also included undertaking interviews, collecting soil and rock samples, and documenting the observations with notes, voice recordings, still photos and camcorder videos. The following sections and subsections expand upon the nature of this activity as broken down into the five units of the study area. The chronology of the actual field activities was dictated by various logistical factors, and is reflected in Figure C-1. However, the following discussion of the methodology is fashioned in a summarized and non-chronological manner in order to present a less fragmented overview.

C.3.1 Sooke to Port Renfrew

This stretch of the study area was travelled back and forth for a total of 5 days. At first, the initial focus was on the coastline in order to examine its physical features and to appraise the availability and quality of marine access from and to Highway No.14 and logging roads that tie into Highway No. 14. This review was restricted by the limited vehicle access to the coastline, although some logging roads and foot paths offered an alternative access. The best coastal viewing access locations were at such locations as King Creek, Otter point, Muir Creek, French Beach, Juan de Fuca Viewpoint, Point No Point, Sandcut Beach, River Jordan, China Beach, Mystique Beach, Sombrio Point, Botanical Beach, Botany Bay, Port Renfrew and the provisional Pacific Rim National Park on Port San Juan near Port Renfrew.

C.3.2 Port Renfrew to Bamfield

This section of the study area is comprised of the West Coast Trail which traverses the entire length of the Pacific Rim National Park along this coast. Aside from access by foot, this territory is totally inaccessible apart from some limited marine access, and helicopter access to certain shorelines. In order to get a first hand appreciation of the complexities of this section of the study area, the entire West Coast Trail was hiked. This venture, which lasted six days, helped to identify detailed information about this area which cannot be obtained from any map.

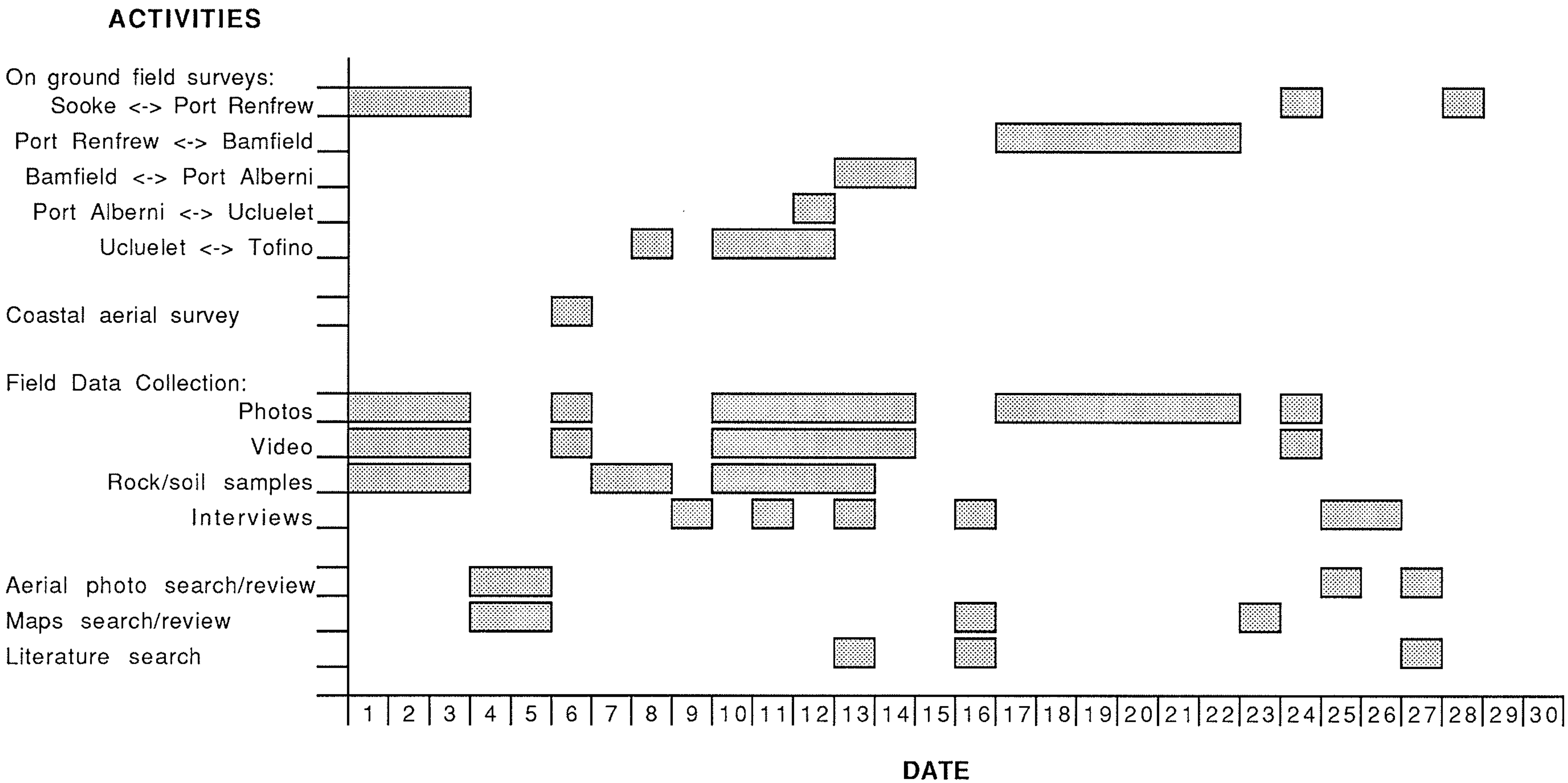

FIGURE C-1 FIELD ACTIVITIES SUMMARY - JULY 1990

C.3.3 Bamfield to Port Alberni

The return to Port Alberni by ferry from Bamfield offered a marine viewpoint of the coastline between Bamfield and Port Alberni, but this coastal area was also covered on another trip by travelling via vehicle from Port Alberni to Bamfield and back. Vehicle access to the coast, apart from that at Bamfield, was offered at only one location, being Sarita, a logging transfer depot where cut timber was introduced into the waterway for transport to Port Alberni. At Bamfield, a surveillance of the surrounding land resulted in the search being limited to two logged out areas, one about 2 kilometres south of Bamfield on an elevated terrain, and another similar though steeper terrain further west near Black Lake. The access to the closed Bamfield solid waste disposal ground was located, and Pachena Bay was assessed for access via the West Coast Trail information station.

C.3.4 Port Alberni to Ucluelet

This area was travelled by road and offered only one suitable access via road to Toquart Bay in Barkley Sound. Much of the area has been previously logged and replanted and, as such, the thick regrowth greatly obscured visibility and discouraged further exploration of off-road sites. This area was an active logging area, so extreme caution had to be exercised. The road to Toquart Bay led past Maggie Lake and the Macoah Indian Reserve No. 1 to a provincial trailer camp site and boat launch area just west of Toquart Bay. The road to Toquart Bay terminated for public access before reaching Toquart Bay because it was an active logging road. The view from this point indicated an active logging depot on the shore for the transfer of cut timber to Port Alberni via water transport. Again, the examination and accessibility of the hinterland was discouraged by very dense regrowth.

An access to Loudon Channel in Barkley Sound was attempted via a road through Port Albion and the Ittatsoo Indian Reserve No. 1. This attempt was terminated by very poor road conditions that deteriorated to a hazardous trail beyond the Indian reserve.

C.3.5 Ucluelet to Tofino

This stretch of the study area was explored for five days. The entire coastline from Tofino to Ucluelet was explored for accessibility by beach landing crafts, as well as by vehicles via Highway No. 4. Also, currently used and formerly closed solid waste disposal sites in the area were examined, and some potential oiled debris management sites were surveyed. Soil samples were collected at various locations, municipal water sources were investigated, and nine personal interviews were held with local government staff, municipal officials and residents concerning the previous Nestucca oil spill clean-up.

The survey of the coast and interior parts included on-site inspections of Tofino, Tonquin Beach, McKenzie Beach, Chesterman Beach, Cox Beach, the closed six-mile dump site, Radar Hill, Schooner Cove, the Tofino Airport, Grice Bay, Esowista Indian Reserve No. 3, Long Beach, Combers Beach, the active municipal solid waste disposal ground, Wickaninnish Beach, Florencia Bay, Big Beach, Little Beach, Terrace Beach, Ucluelet, Amphitrite Point, and the MacMillan Bloedel logging area east of the Clakamucus Indian Reserve No. 2.

C.4 INTERVIEWS

Preceding the field work and throughout the period of the ground surveys between Sooke and Tofino, numerous interviews of key people were undertaken in order to establish some facts surrounding difficulties encountered during the Nestucca oil spill clean-up, to solicit views and opinions regarding the designation of oiled debris management sites for future use, and to gain some insight into local jurisdictional frictions. These interviews were not formally formatted or otherwise restricted to a fixed questionnaire for the specific reason of allowing those being interviewed the complete freedom to express themselves. It was reasoned that this approach would structure the interview in a positive manner by offering a more relaxed atmosphere and providing the greatest potential for allowing them to stress what was important to them from their perspective. The following provides a summary of all those individuals who were interviewed:

Date	Location	Name	Title/Affiliation
May 16, 1990	Vancouver	Mr. Steve Pond	Environment Canada
May 17, 1990	Victoria	Mr. David Anderson	Consultant / Advisor
		Mr. John Bones	Director of Coastal Resources B.C. Ministry of Environment
May 18, 1990	Vancouver	Mr. C. Doogan	Canada Coast Guard
June 6, 1990	Edmonton	Mr. Fred Beech	Environment Canada
July 9, 1990	Long Beach	Mr. Mac Elder	Chief Park Warden
July 9,1990	Tofino	Ms. Fiona McCallun	Friends of Clayoquot Sound
		Ms. Shelley Milne	Friends of Clayoquot Sound
		Ms. Penny Barr	Mayor of Tofino
		Mr. Lindsay Armstrong	Volunteer Coordinator
		Mr. David Lablonde	Volunteer Coordinator
July 11, 1990	Ucluelet	Mr. Erik Larsen	Mayor of Ucluelet
	Long Beach	Mr. Dan Vedova	Parks Canada
	Tofino Airport	Mr. Don Williamson	Parks Canada
July 11,1990	Schooner Cove	Ms. Nicole Gervais	Esowista Indian Reserve
July 12, 1990	Long Beach	Mr. Gordon McLean	Parks Canada
July 13, 1990	Bamfield	Mr. Murray Claughton	Community Councillor and owner of Seabeam Fishing Resort
July 16, 1990	Victoria	Mr. Yoon Chee	Senior Planner, Capital Regional District
		Mr. John Britt	Supervisor, Capital Regional District
July 25, 1990	Victoria	Mr. Neil Coward	Manager, Provincial Emergency Program
		Mr. William Hubbard	Land Officer, Crown Lands

Date	Location	Name	Title/Affiliation
July 26, 1990	Port Alberni	Mr. Jim McManus	Senior Planner, Alberni-Clayoquot Regional District
		Mr. Richard Lucas	Emergency Coordinator, Nuu-Chah-Nulth Tribal Council
July 26, 1990	Nanaimo	Mr. Bob Davies	Ass. Environmental Safety Officer Waste Management M.O.E.

C.5 AERIAL PHOTOS AND MAP RESEARCH

Four days in total were spent at Maps B.C. in Victoria to locate and examine available aerial photographs of the study area. Unfortunately, most of the aerial photographs were fairly outdated. The latest available aerial photos were taken in 1984 with others dating back to the mid-70's. This presented a problem in using the photographs for identifying the most currently available disturbed logging sites and logging roads which might offer vehicle access towards remote stretches of the coast. The outdated photographs did not reflect the many newer logging developments which were evidenced during the field survey because the surficial terrain affected by logging activities can change dramatically over a period of only two to three years. In total, 185 black and white aerial photos were examined and arranged in segmented mosaics for examination with a stereoscope to determine coastal and terrain landforms, surficial geology, road accessibility, beach accessibility and land use. Xerox copies of each aerial photo were also taken for future reference. Appendix 'A' contains the full list of all the referenced aerial photos.

Numerous maps were also obtained for research and reference from Maps B.C. in Victoria, from the Geological Survey of Canada office located in Vancouver, from the Capital Regional District office, from Parks Canada and from MacMillan Bloedel's information office in Tofino. Appendix 'B' contains a full list of all the referenced maps. These maps were used to obtain such information as: geological features, surficial material genetic descriptions, soils textures, terrain and landforms, vegetation types, climatic features, relief, topographical classes, road accesses, Indian reserves and parks locations and boundaries, land zonings, and regional district boundaries.

2) The absence of a predesignated oiled debris management site resulted in emergency waste management sites being selected in an arbitrary manner without the benefit of a thorough environmental review and public approval.

3) In the absence of a predesignated oiled debris management site, Parks Canada was forced to select a site at the Tofino airport for the temporary storage of oiled debris collected off the beaches from the Long Beach Unit of the Pacific Rim National Parkland. This site drew criticism and concern from the nearby Esowista Indian Reserve for the inadequate containment of the stored oil and the potential threat it posed to the nearby domestic groundwater supply that served the native community.

4) The absence of a predesignated oiled debris waste management site caused the Tofino/Ucluelet municipal solid waste disposal site to be initially used for the disposal of collected oiled debris. That action had to be terminated by the Nanaimo Waste Management Division of the Ministry of Environment because this site is regarded as undesirable even for its regular use.

5) The absence of a predesignated oiled debris management site forced the Waste Management Division to specify its preference for disposing of the oiled debris at the Port Alberni municipal solid waste disposal site. However, that proposal was rejected by the Regional District office and resulted in the development of political friction over provincial versus the local government jurisdiction over the control of local resources.

6) The absence of a pre-designated oiled debris management site ultimately meant that the oiled debris had to be hauled at considerable expense to Ladysmith for incineration.

D.1.2 Discussion

In all fairness, the field interviews also drew attention to other smaller but unrelated problems which helped to aggravate the clean-up and waste management process. Notably, the inadequate strength of the issued clean-up bags were no match for the heavy oil and water soaked sand and seaweed, and the payment of a fee for each bag filled contributed to the collection of more waste matter than may have been necessary. As well, the lack of frequent pick-up of collected oiled debris off the beaches caused the incoming tides to bury, disperse or wash away the debris which had been collected and stored in bags by clean-up volunteers.

The initial justification for pursuing oiled debris management sites stemmed from the repeated recommendations for such facilities by several Task Forces in response to the Nestucca and Exxon Valdez oil spills. Although the total list of encountered problems as identified above in Section D.1.1 do not in themselves justify the need for oiled debris management sites, they do add support for such facilities by highlighting the problems which developed in their absence. The essence of the situation is that environmentally inappropriate action, or no action, may be taken with respect to the handling of oiled debris if no predesignated oiled debris management sites are offered, or if no other alternatives to such sites are offered as part of the overall infrastructure of a marine oil spill response strategy. The final justification for such sites can only be demonstrated through a comprehensive marine oil spill response and shoreline clean-up contingency plan wherein the oiled debris waste management plan would outline the functional role and restrictive use of oiled debris management sites in relation to the overall strategy for managing the oiled debris from cradle to grave, that is, its collection, handling, storage, treatment and/or disposal.

D.2 **<u>OBJECTIVE No. 2</u>** *To determine the appropriate size of land area required for each oiled waste management site based on the worst case volume of oiled wastes from a major oil spill, including any additional area which may be required for the storage of associated emergency equipment and supplies.*

D.2.1 Results

The theoretical size of any single oiled debris management site would simplistically be a function of the quantity of oil and oiled debris which could be expected to be collected under a worst case oil spill scenario, and the number of such facilities within the region of coastline that might be affected. However, the volume of washed up oil and the volume of oiled debris that would be generated at such a time could also be expected to be a function of the type and volume of oil spilled, the location of the spill, climatic and atmospheric conditions, the quantity of oil which could be recovered, the net direction of ocean currents, the degree of emulsification of the oil with the sea water, the quantity likely to reach shore, the extent of affected shoreline which would be potentially accessible for clean-up, the type of materials that would be oiled on the shore, and the amount of oil and oiled debris which could be treated in situ. This information, when analyzed for a worst case scenario, ought to provide a reasonable expectation of the magnitude of the oiled debris problem which may have to be addressed. A literature review of recent investigations into oil spill predictions and scenarios for the Juan de Fuca Strait has offered some clues in this regard. The following attempts to summarize the complexity of the matter and provide some quantitative estimates:

$A = (q / d) + \text{misc. allowance}$

A - means the surface area of a waste management site

q - means volume of oiled debris transported to each waste management site

d - means the vertical depth (height) of storage misc. allowance - means additional area required for expansion and/or equipment storage

where, $q = Q/n$

Q - means total volume of oiled debris collected

n - means number of readily available sites

		<u>estimates and worst case assumptions</u>
where, $Q = f$ [	V, volume of oil spilled	41,600 m^3
	O, type of oil spilled	Alaskan crude
	L, location of spill	Juan de Fuca Strait
	M, month or time of year	winter
	R, % of oil recovered at sea	2%†
	B, % of non- recovered oil beached (balance lost at sea)	74%†
	SF, swell factor (emulsification)	3.98†
	A, % of shoreline being accessible	31% E
	D, type of oiled debris	coarse grained clastics
	T, % of oil not treated in situ	90% E
	BF] bulking factor for oiled debris requiring removal.	4 E

† - From Table 2, p. 33 of the Final Report of the States/British Columbia Oil Spill Task Force
E - means estimated.

therefore,
$$\begin{aligned} Q &= V \bullet (1-R) \bullet B \bullet SF \bullet A \bullet T \bullet BF \\ &= 41{,}600 \bullet 0.98 \bullet 0.74 \bullet 3.98 \bullet 0.31 \bullet 0.90 \bullet 4 \\ &= 134{,}000 \text{ m}^3 \end{aligned}$$

then, if the number of sites "n" = 6, and the depth of debris "d" = 1.5 metres,

$$A = \frac{134{,}000}{6 \times 1.5} = 14{,}888 \text{ m}^2$$ or about 1.5 hectares per site.

Allowing for manoeuvring space, engineering works and equipment storage, each site should have a minimum working area of about 3 hectares.

D.2.2 Discussion

In arriving at a worst case scenario volume of marine oil spill, the quantity of oil spilled from the Exxon Valdez has set the precedence for the west coast region. Although it could be argued that a tanker's entire cargo could be spilled, or that perhaps two tankers could collide and spill their contents, such arguments would be based on probability analyses of hypothetical events which could be easily counter argued. What cannot be argued against is the fact that 41,600 cubic metres of oil can be and have been spilled during a single spill event. If it can happen once, then it could happen again. Therefore, at the very least, it would be prudent to prepare for what we now know can occur in this region without be criticized for being overly cautious.

Alaskan crude is regarded as the worst type of oil that could be spilled in this area. This is because of its high viscosity and its characteristic to emulsify at sea into a water-in-oil emulsion (chocolate mousse), which can cause its original volume to expand by a swell factor "SF" in the order of 3 to 4.

The worst case scenario for the study area is to have the spill occur in the Juan de Fuca Strait and within the winter season. Based on the literature review, a spill in this location has been evaluated by computer modelling techniques to likely affect the majority of the study area shoreline, and the winter conditions would limit the recovery of oil at sea to the greatest degree. From a clean-up point of view, a spill affecting the majority of the study area shoreline, as opposed to the majority of the spill ending up along a more confined region, would be considered the worst case scenario because of the higher ratio of oiled debris to beached oil which would have to be cleaned up.

The percent of affected shoreline "A" which can practically be cleaned up would be those stretches that offer access by land or sea, and which offer clastic cover along the shore so as to permit a proper and safe footing for human activity. The 31% figure was arrived at by comparing the approximate total length of beaches (100 km) indicated on available topographic maps in relation to the approximate linear length (320 km) of the coast along the study area.

The percent of oil treated in situ on shore (10%) is a rough estimate to account for those instances and locations where in-place treatment techniques (chemical application, combustion, etc.) might be used instead of removing the oil or oiled debris. This would leave a balance of 90% of untreated beached oil requiring removal.

The remaining untreated beached oil which would be coated and/or inter-mixed with water and organic and inorganic matter on the shore would constitute the volume of oiled debris requiring removal and waste management. The volume of oiled debris which could be expected from the contamination of organic and inorganic materials could be expressed as the product of a bulking factor "BF" times the volume of remaining beached untreated emulsified oil. This bulking factor can obviously be a highly variable number given the variability in size, type and quantity of materials which might become oiled. The estimated bulking factor of 4 allows for a ratio of 3:1 of debris to oil.

D.3 <u>OBJECTIVE No. 3</u> *To examine the limitations, constraints and potential concerns associated with the establishment and use of oiled debris management sites.*

D.3.1 Results

The field investigations carried out in July of 1990 identified numerous limitations, constraints and potential concerns which could have a significant bearing on the location and operation of oiled debris management sites.

1) <u>Non-current Information</u>

A striking observation which became apparent in the course of the field investigations was the lack of up-to-date information on the study area. Outdated government aerial photos taken between 1970 to 1984, and outdated logging maps supplied by the industry, portrayed information which did not correlate with the actual field findings. Areas which were portrayed as recently cut were in fact already in the process of regrowth, and some forest areas depicted as virgin territory were already clear-cut. Information on current land tenure to various timber areas was also very difficult to acquire. Available 1:125,000 topographical maps, developed in 1974-75 and illustrating the land tenure status are highly unreliable. The Crown Lands office also has no current compiled information which can at a glance offer a current distinction between parcels of land which are still vacant Crown land, or which are leased and to whom they are leased. Such information apparently has to be sought from the Land Titles Office. At that office, it was determined that such information can only be obtained through individual search requests on each legal parcel of land. Access to a land titles computer data base in order to undertake one's own search is likewise not available to the public. This situation posed a serious encumbrance to preparing for field investigations and in obtaining more detailed information on potential oiled debris management sites observed in the field.

Although the Minister of Crown Lands announced in May of 1990 that the B.C. government had committed itself to embarking upon a computerized Geographical Information System (GIS), this state-of-the-art information management and mapping system will take many years before it reaches a level of practical application, meaning that in the meantime, the search for potential oiled debris management sites will be limited to labour intensive trial and error field investigations.

2) <u>Access</u>

About two thirds of the coast along the study area is served by paved and gravel coastal highways. However, with the exception of the coastline between Tofino and Ucluelet, very few direct vehicular accesses are available from the highways to the shoreline, particularly between River Jordan and Port Renfrew, and along the Barkley Sound coast between Bamfield and Ucluelet. The entire stretch of the West Coast Trail between Port Renfrew and Pachena Bay has no vehicle access whatsoever. Since oiled debris management sites will require access by motorized vehicles to bring in or take out oiled debris, or to bring in mobile incinerators, etc., it will be imperative that road access to these sites be available. Only transfer sites, used to collect oiled debris for further transfer by barge or helicopter to a designated oiled debris management site, could be located behind the high tide line at marine accessible beaches along the West Coast Trail coastline. Therefore, the West Coast Trail coastline seems to be beyond reach at this time for a conveniently situated oiled debris management site. Here, whatever oiled debris can be accessed will have to be barged out, air lifted out, treated on site, or allowed to biodegrade in-place.

Sea access to the shoreline along the study area for use by marine crafts to land clean-up crews, or for use by barges to pick up and transport oiled debris, is limited in many ways. Due to the scarcity of coastal sediments along the study area accounts, only about 30% of this coastline offers potentially accessible beaches, with the balance being composed of hazardous bedrock. Of these potentially accessible beaches, some are barely accessible with barges even at high tide because of very shallow sloped beaches, or not accessible at low tide because of hazardous exposed or shallow rocky platforms. Even if the physical conditions were ideal, high wind conditions, high wave conditions and/or strong currents might interfere with access attempts. Therefore, any dependence on sea access to a shoreline during an oil spill clean-up campaign is very unreliable.

3) Topography

A common criteria usually associated in literature with the establishment of waste management sites is the high desirability for level to shallow sloped topography. In this regard, the study area offers very limited locations with these qualifications. Most level areas were observed to be already developed for recreational use, for homesteads, for subdivisions, and Indian Reserves, or they are associated with low lying estuaries. The balance of the territory, within reasonable proximity to the coast, was confirmed to be hilly to very steep, and intersected with numerous gullies and waterways.

4) Land Use

A significant constraint to the establishment of oiled debris management sites is the restriction of any desirable area by virtue of its current use. In this regard, any areas occupied by communities and cottages, or set aside as parks and Indian reserves were excluded from consideration. The balance of the land in the study area is timber land which is either vacant Crown land or Crown land leased out as Tree Farm Licence (TFL) areas, or land privately owned as tree farms or for other purposes. However, it would be undesirable to disturb a virgin timber site if a clear-cut area was already available in the proximity. Locating, inspecting and evaluating such clear-cut sites posed a problem in many instances because numerous TFL areas had their access roads blocked to vehicle traffic. Other TFL areas were posted as active logging areas wherein the use of the active logging roads for exploration could have posed a serious danger. Hence, the land use of these areas posed an obstacle to exploration even though the logging roads opened up territory. Another difficulty with the establishment of oiled debris management sites in these areas is the potential legal problem which may be associated with acquiring the necessary lands if these lands are secured by the logging industry under long-term leases, or if they are privately owned. Under the Environment Management Act, the Minister is allowed to use any land deemed necessary only in the situation of an emergency. Hence a perceived difficulty is foreseen in acquiring desirable sites which are not clearly vacant Crown land, unless successful negotiations are achieved.

5) Precipitation

The literature review, field investigations and numerous interviews of people knowledgeable about the study area, clearly pointed to the high degree of precipitation as being the most important factor which will influence how the oiled debris management sites can be used. Environment Canada weather data indicates that the study area is subjected to an annual precipitation ranging from 1287 millimetres at Sooke to 3288 millimetres at Tofino. Field investigations during the month of July, 1991, showed the soils to be damp, or containing ponded water where drainage was poor, when it hadn't rained all month. Some areas are even described as rain forests. The high precipitation rates also affect the local hydrogeology by raising the water table, or creating saturated soil conditions. These conditions, supported with the advice obtained in the course of the interviews, would rule out the practicality of using dyked disposal or storage areas, or pits, for the exposed storage or landfilling of oiled debris. A problem with attempting to provide sites in this region is associated with the migration of fugitive oil into the environment, such that the sites would have to be designed to collect all the contaminated precipitation run-off. As a worst case scenario, the average total precipitation at Tofino during the month of December is 479 millimetres. This means that, given an area of one hectare with fine grained soils where the precipitation runoff is being contaminated by contact with oiled debris, 4,800 m^3/hectare/month, or 160 m^3/hectare/day, of contaminated water would have to be collected and treated prior to its release into the environment. To treat such a daily volume of contaminated water could become unmanageable. The site might also become so saturated as to be unworkable or inaccessible for landfilling during high precipitation periods. Landfilling also presents a potential hazard for groundwater contamination, and the Canadian Public Review Panel even recommends that "landfilling of oiled debris must not be practised where alternatives are possible". If groundwater contamination were not a factor, and landfilling was employed, the limited availability of suitable sites could well fill up the designated areas after one or two major oil spill events such that more sites would be required.

6) <u>Containment</u>

The high amount of precipitation in this region presents a serious constraint and engineering problem in regards to the design and operation of the oiled debris management sites. Although probably quite costly, the ideal solution may be to initially use the designated oiled debris management sites for temporary storage only, by bringing the debris to these sites, or collecting it on these sites, in large 3 cubic metre steel containers with hinged lids to seal off precipitation, similar to the portable garbage containers or tubs used at construction sites. With such containers the oiled debris could readily be hauled to or from the waste management site, the oiled debris could be kept well contained and sealed from precipitation, and no further spreading of contaminants by rehandling of the material would occur. The debris could, thereafter, be incinerated on-site using a mobile incinerator, or hauled at an accommodating rate to a central incinerator, or otherwise treated, so that over time the holding capacity of the site can be reclaimed for the next spill event. Inasmuch as good containment would be very desirable, the practical limitation may be the number of containers on hand in preparation for a worst case spill event. Therefore, site selection criteria would still have to consider the permeability of the surficial soils (for the protection of groundwater) and the location of nearby surface waterways in the event of oiled debris overload.

7) Social Attitudes

The potential constraints which local or regional social factors might pose along the way towards establishing designated management sites for oiled debris were best obtained from the personal interviews held throughout the field investigations. The spectrum of people contacted, as evident from the list shown in Section C-4, ranged from politicians to environmentalists to volunteer workers to native people and government staff. The following appear to be the main issues which surfaced, and are presented in a generalized manner rather than specific to any community since the survey was not taken in a statistical fashion for the purposes of relating trends in attitudes to any particular community:

a) *The oiled debris should be sent to the party responsible for the oil spill.*

This attitude was expressed as the counter argument for establishing oiled debris management sites. Essentially, it was stated that the polluter should be sent all the oiled debris rather have the victims of the spill left to manage the waste and deal with the long-term environmental problems which may be associated with its mismanagement. The point made was that if the infrastructure was put in place to accommodate oiled debris from marine oil spills, then that might be construed as meaning that the coastal citizens have become resigned to oil spill events, when in fact the message which they want to send is their outrage against such occurrences.

b) *The not in my back yard (NIMBY) syndrome.*

The NIMBY syndrome was expected to be more widespread, but was not a major issue in the course of the interviews. Some communities expressed opposition to such sites being located near their community, although if it was absolutely necessary then they would consider temporary sites, with the number of sites kept minimal so that they might receive better maintenance than would several small sites. Other communities felt less adverse to the establishment of such sites so long as they were temporary and properly managed. However, the true attitudes of the local populace on this issue in any one area may not really surface until they are confronted with having to consider a proposed oiled debris management site in their vicinity. Depending on how the stakeholders end up perceiving these sites, their attitude will either make or break the proposal.

c) *Native concerns.*

The concerns of native groups, as it might impact upon establishing oiled debris management sites, is singled out as a specific item because it concerns only the native people within the study area. In essence, they point out that whatever sites are considered for acceptance, they would have to be involved in the approval process and in the operation of the sites. This stems from the unsettled land claims issues, such that in the interim they claim rights to all the lands at issue. They also express the necessity for co-management of such facilities because of the potential impact that these facilities might have on factors which influence their livelihood.

d) *Control over use of resources.*

Another social attitude which surfaced, and which has the same undertones as the native issue although it has instead escalated into a power struggle between the provincial and the municipal government level, is who should have the control over local resources. This issue came to light when the province wanted to dispose of the Nestucca oiled debris at the Port Alberni municipal solid waste disposal site (WDS), whereas the municipality was of the opinion that they should have the right to deny its use. The municipality's arguments for denial were that the municipality should have full control over the management of the WDS because the majority of the community was against receiving the oiled debris, and because the existing WDS has a finite limit and is expected to serve the region for many years to come. A loss of control would eventually force them to seek other alternative and more expensive avenues of waste management. This municipal posture for more control over land resource uses may have a bearing on the final selection of any sites proposed by the province for consideration as oiled debris management sites.

8) Operational Concerns

a) Inherent in the strategical use of the oiled debris management sites is the question of how these sites will merge effectively into the oiled debris clean-up measures initiated in response to a marine oil spill. To serve as an effective utility in such a situation, the means and ways of getting the oiled debris from the beach to the designated oiled debris management site must be outlined in a master response plan. That is to say, the functionality of these sites for beaches which have no road access would be questionable unless alternate methods of transporting the oiled debris from the beach to the designated management site are identified for implementation by the response teams.

b) The term "temporary", in regards to oiled debris management sites, is referenced in the recommendations of the Coast Guard and the Public Review Panel (see section B.8), as well in the B.C. Environment document titled "OIL SPILLS - A Strategy for British Columbia". This word is ambiguous in the sense that it may have a different meaning to different people. That is to say, it may be construed by some that the facility per se will therefore not be a permanent fixture. Yet, when they see a constructed area with stored equipment, and perhaps the facility surrounded by a fence, they will realize that the facility is permanent and may feel that they have been duped. Others may interpret the word "temporary" as meaning that the oiled waste will be stored on the site for a very short period, such that if it happens to remain on site longer than their expectations, these people may become upset. Clearly, one of the goals of mustering and maintaining public support for this oil spill clean-up initiative should be to eliminate any source of confusion or ambiguity concerning the eventual establishment and use of any designated oiled debris management sites. In that regard, the clear meaning of "temporary" sites will have to be spelled out by the Ministry of Environment.

c) If designating a site as a permanent oiled debris management site, the understanding will be that the oiled debris will be taken to this site, possibly processed and treated there, with all or the remainder thereof permanently disposed of on location. However, if the site is designated as a "temporary" site, it raises the question, what is the next step? That is, the temporary sites must be seen to be part of an integrated response plan. Hence, the use of temporary waste management sites will only gain credibility if the plan for the ultimate manner of disposal is specified by the Ministry of Environment.

d) Given that the local preference is for temporary waste management sites, providing secure containment of temporarily stored oiled debris will be a major technical and financial consideration if a state of preparedness for a worst case scenario is to be realized.

D.3.2 Discussion

The foregoing discussion points out a wide spectrum of limitations, constraints and potential concerns associated with the establishment of oiled debris management sites. Some were visibly apparent while others only surfaced during the process of gathering information. The social concerns were easily obtained through the interviews because the people were very eager to express themselves. Overall, it would seem that the field study satisfied objective No. 3, with the conclusion that considerable difficulties will be associated with the designation, design and use of oiled debris management sites within this study area.

D.4 **<u>OBJECTIVE No. 4</u>** *To develop site selection criteria for oiled debris management sites (within the study area).*

D.4.1 Results

The literature review section had identified some recent cases of waste management sites that were justified on the basis of certain site selection criteria relevant to the nature of the waste and the general territory being considered for waste management sites. However, the study area for this project requires its own specific site selection criteria to test a site's physical, environmental, legal, social compatibility with the realities of the study area. In this regard, Table D-1 has been prepared to incorporate information obtained from the literature review, the field survey, maps and interviews. Since a strict singular site selection criteria could preclude the potential for any oiled debris management site if such criteria cannot be satisfied at any location within the study area, the site selection criteria have been developed to accommodate the rational selection of a site on the basis of qualitative choices which can be made with the full conscious knowledge that they may not be ideal but would be better in relation to other sites. Therefore, the criteria have been developed to reflect the relative virtues of various factors on a scale from preferable to unacceptable.

<u>Proposed Site Selection Criteria:</u>

1) Potential sites should be accessible by an existing road system.

   Preferable: all-weather paved road

   Acceptable: all weather gravel or logging road

TABLE D-1

SITE SELECTION CRITERIA

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road ☐	all-weather gravel road ☐	logging road ☐	no access ☐
Land Tenure	vacant prov. Crown land ☐	leased prov. Crown land ☐	privately owned ☐ federal Crown land ☐	Indian Reserves ☐ under land claim ☐
Land Use	clear-cut timberland ☐	regrown clear-cut timberland ☐	uncut timberland ☐ agricultural land ☐	residential land ☐ ecological reserves ☐ wildlife sanctuaries ☐ wildlife management areas ☐ designated parks ☐ historical sites ☐
Soil Cover	clay ☐ silty clay ☐ glacial till ☐	sandy clay ☐ loam ☐ silt ☐	sandy loam ☐ loamy sand ☐ gravelly loam ☐	sand ☐ gravel ☐ bedrock ☐
Soil Cover Thickness	10 to 5 metres ☐	5 to 2 metres ☐	2 to 1 metres ☐	< 1 metres ☐ bedrock ☐
Surficial Gradient	0 to 2 % ☐	2 to 9 % ☐	9 to 20 % ☐	> 20 % ☐
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres ☐ ≥ 5 kilometres ☐ ≥ 500 metres ☐ ≥ 3 kilometres ☐ ≥ 250 metres ☐ ≥ 100 metres ☐ ≥ 100 metres ☐	 500 to 400 metres ☐ 5 to 4 kilometres ☐ 500 to 400 metres ☐ 3 to 2 kilometres ☐ 250 to 200 metres ☐ 100 metres ☐ 100 metres ☐	 400 to 300 metres ☐ 4 to 3 kilometres ☐ 400 to 300 metres ☐ 2 to 1 kilometres ☐ 200 to 150 metres ☐	 < 300 metres ☐ < 3 kilometres ☐ < 300 metres ☐ < 1 kilometres ☐ < 150 metres ☐ < 100 metres ☐ < 100 metres ☐
General Location Considerations				in wetland areas ☐ in a 100 yr floodplain ☐ areas subject to tsunamis ☐
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast ☐	northeast ☐ south ☐	north ☐ southwest ☐ west to northwest ☐ (and > 5 km away)	west to northwest ☐ (and < 5 km away)
Available Working Area	> 5 hectares ☐	5 to 4 hectrares ☐	4 to 3 hectares ☐	< 3 hectares ☐
Public Visibility	secluded ☐			visible from highway ☐
Public Acceptability		public endorsement ☐		public opposition ☐

Marginal:	logging road
Unacceptable:	no access

Rationale:

In order to be established, used and maintained, access for construction vehicles, waste haulage trucks and personnel carriers must be available to, or near to, the potential site. A readily accessible potential site can also be more accurately surveyed for environmental acceptability as opposed to a remote inaccessible site. As well, additional land and money need not be sacrificed for the development of a road which may serve a very limited purpose. Paved roads or good gravel provincial roads are the best choices because they are designed to carry heavy axle loads and can accommodate two way traffic to and from the site during a spill clean-up event. Logging roads are generally narrow, not well graded, and may have sharp curves and poor drainage provisions, thereby rendering them as less desirable forms of access.

2) Potential sites should be located on land which is either presently owned by the Province of British Columbia, or which offers a reasonable potential of being acquired by the Province.

Preferable:	vacant provincial Crown land
Acceptable:	leased provincial Crown land
Marginal:	- privately owned land - federal Crown land
Unacceptable:	- Indian Reserve land - lands currently under litigation for aboriginal title

Rationale:

These criteria are necessary to gauge the degree of encumbrances which might be encountered in wanting to develop a potential site. A potential site located on provincial Crown land would offer the least complications to the Province in that its use would pose no legal encumbrances, and its availability would not be compromised by difficult negotiations as might be encountered in the case of private land or, to a lesser degree, with Crown land under lease. Federal Crown land would be a very marginal qualifier because most of these lands are designated for specific national uses (ie. military, airports, harbours, parks, etc.). Indian reserve land, or land presently at issue under native land claims, is regarded to be out of the question because of the heritage significance and the legal implications.

3) Potential sites should be located on land which offers the least land use conflict by virtue of the potential site's land use as well as the surrounding land use.

Preferable:	clear-cut timberland
Acceptable:	regrown clear-cut timberland
Marginal:	- uncut (virgin) timberland - agricultural land
Unacceptable:	- residential land - ecological reserves - wildlife sanctuaries - wildlife management areas - national, provincial, regional or municipal parks - historical sites

<u>Rationale:</u>

These land use criteria are essential in that the prevailing land use or land use designation is a clear indicator of its environmental value. In this regard, land which offers the least potential environmental conflict is regarded to be wilderness timberland which has already been grossly disturbed by clear-cut logging practices. The unacceptable land use categories arise from social, heritage and environmental concerns, and are protected by law, as by the Special Waste Regulation 63/88 under the Waste Management Act, as well as other statutes.

4) Potential site should be selected on the basis of the best available type of soil.

Preferable:	- clay - silty clay - glacial till
Acceptable:	- sandy clay - loam - silt
Marginal:	- sandy loam - loamy sand - gravelly loam
Unacceptable:	- sand - gravel - bedrock (assumed to be fractured)

Rationale:

Even if an oiled debris management site is not used for landfilling, and every effort is made to keep the oiled debris contained, the potential always exists that spillage can occur and that precipitation can become contaminated, with the concern being contaminated runoff draining off the site or contaminated leachates being lost to the groundwater. Contaminated runoff is more easily controlled than percolation losses through the soil column. Therefore the best measure of protection which can be provided (aside from impermeable liners) is to find surficial deposits (of adequate thickness) which will impede percolation losses. In that regard, clay and clayey soils or glacial till would offer the best natural retardation of seepage losses. Thereafter, silty and loamy soils would serve to retard seepage but with decreasing efficiency proportional to the increasing content of sand and other coarse-grained soils. Bedrock is unacceptable because it should be regarded as fractured and therefore highly permeable.

5) Potential sites should be selected with due consideration for soil cover thickness.

Preferable:	5 to 10 metres
Acceptable:	2 to 5 metres

Marginal:	1 to 2 metres
Unacceptable:	< 1 metre

Rationale:

Three main reasons govern the desirability for an adequate thickness of surficial deposits. First, the rate of seepage losses is a function of the distance through which the fluid travels. Second, sufficient surficial deposits will allow for the development of engineered earthen works to divert runoff from the waste management site and to selectively impound contaminated waters. Third, where the gradient of a site is steep, a sufficient thickness of soils would allow for the development of terraced plateaus to reduce the rate of precipitation runoff, minimize erosion, and offer a more level working area.

6) Potential sites should have as level a gradient as possible.

Preferable:	level to very gently sloping	0.0 - 2 %	0 - 1.1°
Acceptable:	gently to moderately sloping	2 - 9 %	1.1° - 5.1°
Marginal:	moderately to strongly sloping	9 - 20 %	5.1° - 11.3°
Unacceptable:	steeply sloping	> 20 %	> 11.3°

Rationale:

The selected gradient breakdown almost corresponds directly to the B.C. provincial soils and terrain map gradient descriptions, except that the cut-off between strongly sloping and steeply sloping has been raised from 15% to 20% to allow for the development of terraced sites where the lack of moderately sloping land in a strategical area might otherwise preclude the positioning of a potential oiled debris management site.

7) Potential sites should be selected on the basis of adequate setback distances from key environmental, public health and aesthetic considerations.

Item	Preferable	Acceptable	Marginal	Unacceptable
From surface waters	≥ 500 m	500 - 400 m	400 - 300 m	< 300 m
From wells (upstream)	≥ 5 km	5 - 4 m	4 - 3 m	< 3 km
(downstream)	≥ 500 m	500 - 400 m	400 - 300 m	< 300 m
From nearest community	≥ 3 km	3 - 2 m	2 -1 m	< 1 km
From nearest dwelling	≥ 250 m	250 - 200 m	200 - 150 m	< 150 m
From unstable slopes	≥ 100 m	100 m		< 100 m
From a Holocene fault	≥ 100 m	100 m		< 100 m

Rationale:

Literature suggests a variety of distance criteria respecting various concerns. However, the majority of the concerns can be distilled down wanting to protect surface waterways (and the wildlife and fisheries they support), wanting to protect groundwater (in regards to its resource value as an immediate or potential drinking water supply), and wanting to provide an adequate buffer between a waste management site and a community or individual dwelling, and wanting to protect the integrity of the site from unstable soil or geological conditions.

8) Potential sites should not be located in wet or flood prone areas.

Unacceptable: in wetland areas

in a 100 year floodplain

in an area subject to tsunamis

Rationale:

These criteria are drawn from the minimum siting standards in Part 2 of the Special Waste Regulation B.C. Reg. 63/88.

9) Potential sites should be located downwind of settlements along the path of the prevailing wind direction (unless sufficient distance separates the site from the settlement).

Preferable:	- site located east to southeast of nearest settlement
Acceptable:	- site located northeast or south of nearest settlement
Marginal:	- site located north or southwest of nearest settlement
	- site located west to northwest of nearest settlement but more than 5 km away
Unacceptable:	- site located west to northwest of nearest settlement and less than 5 km away

Rationale:

In the event that on-site incineration is to be exercised at the waste management sites, the impact of air pollution must be taken into consideration. This impact on nearby residents can be minimized if the emissions of volatile organic carbons from the stored oiled debris or the emissions resulting from its incineration are not transported towards residential areas by the wind. In this regard, the study area presents different prevailing wind directions for the summer versus the winter. However, in this writers opinion, volatilization would be more active during warmer weather, and incineration would most likely be implemented during the summer months to take advantage of the higher ambient temperatures and lower precipitation rates, such that we need only concern ourselves with the summer prevailing winds blowing from the west and northwest direction. The distance criterion is a subjective matter which can be adjusted to suit local sensitivities.

10) A potential site, as a complementary component of other additional sites, should have a potential working area of sufficient size to render the facility capable of accommodating its share of the waste management space requirement for a worst case oil spill event.

Preferable:	> 5	hectares
Acceptable:	4- 5	hectares
Marginal:	3 - 4	hectares
Unacceptable:	< 3	hectares

Rationale:

Section D.2.1 attempted to portray the expected volume of oiled debris which might arise from a worst case oil spill scenario, assuming an even distribution of oil along the study area coastline and presuming that six oiled debris management sites might be established. On this basis, a minimum area of 3 hectares was arrived at as a basic working area for each such site. Any potential site which might offer a greater available working area would, of course, be preferable for greater flexibility in operation and for potential expansion.

11) Potential sites should be located such that they are not openly visible from high traffic routes.

Preferable:	secluded
Unacceptable:	visible from highway

Rationale:

Most of the study area is a prime tourist attraction frequented by numerous parks and commercial establishments that make their livelihood from the tourism trade. To maintain the aesthetic appearances of the coastline and the frequented travel routes, any potential oiled debris management sites should be located so as not to detract from the scenery.

12) Selected potential sites should be adopted with due consideration for the public acceptability of the proposed sites.

Acceptable: public endorsement

Unacceptable: public opposition

<u>Rationale:</u>

Public participation is crucial to the long-term acceptance of any potential site, despite its technical attributes, prior to being formally designated. This would likely take the shape of formal or informal public hearings for local residents and native communities with the goal of offering all pertinent information, providing alternative choices, discussing expressed concerns, and incorporating the input of the local people into the final decision process.

D.4.2 Discussion

The site selection criteria have been developed on the basis of some past approaches, existing regulations, and field conditions relevant to the study area. Generally, the objective of developing site selection criteria for the study area has been achieved by developing a tabular guide with a built-in flexibility of criteria ranging from preferable to unacceptable in recognition of the difficult field conditions within the study area. The flexibility would allow for a conscious choice to be made between alternative sites based on the full knowledge that compromises may have been made due to the absence of more preferable conditions.

D.5 <u>OBJECTIVE No. 5</u> *To identify potential locations for oiled debris management sites (within the study area).*

D.5.1 Results

On the basis of information obtained through the field survey, interviews, available aerial photographs and maps, and the site selection criteria developed for this study area, a

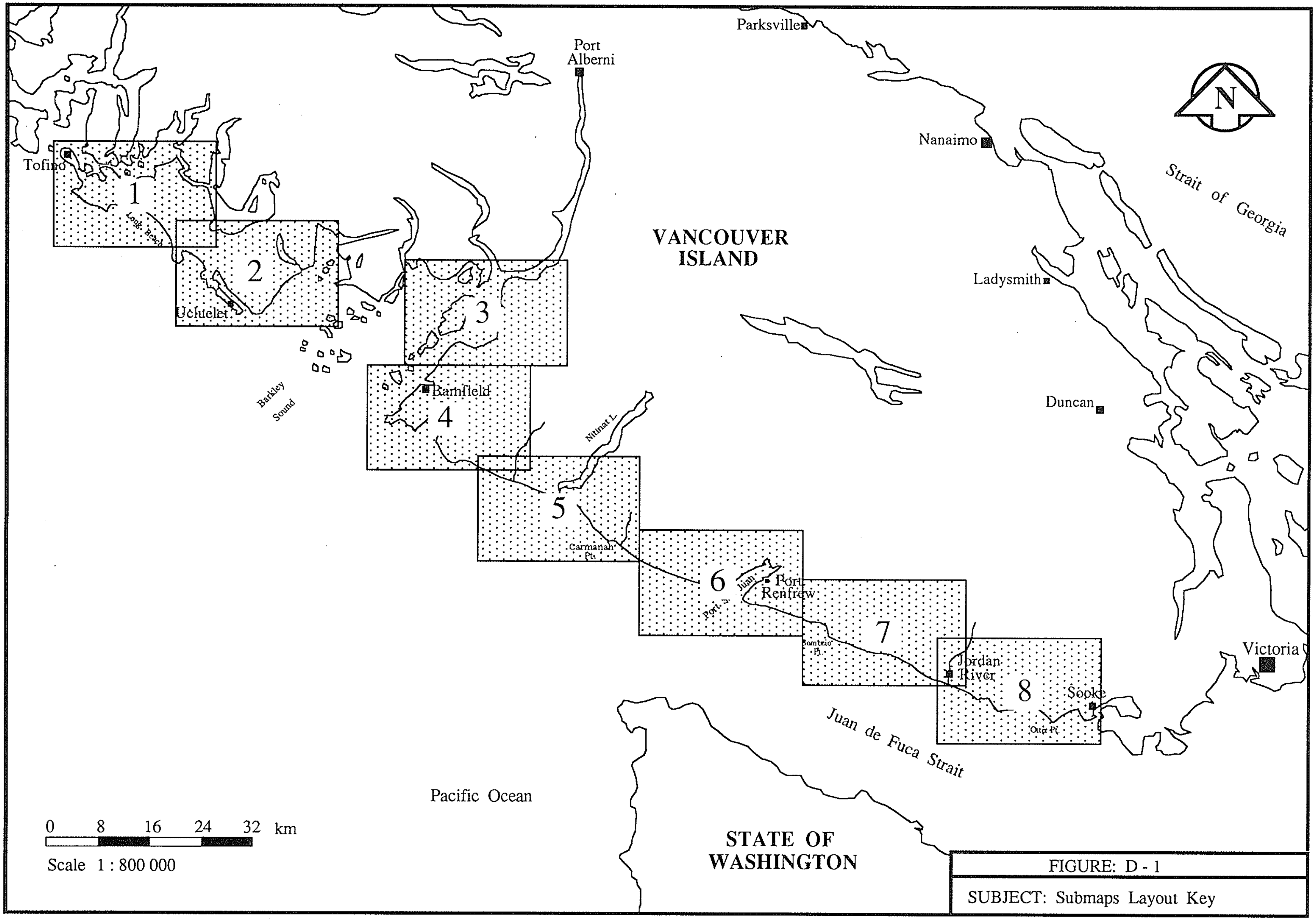

FIGURE: D - 1

SUBJECT: Submaps Layout Key

number of potential oiled debris management sites have been selected. To illustrate these locations more effectively, eight submaps of the study area were prepared at a scale of 1:100,000. Figure D-1 consists of the submap layout key to illustrate the effective coastal area covered by each submap, with Figures D-2 to D-9 corresponding to Submaps #1 to #8, respectively. A more detailed description and rationale for the sites selected is best done by reviewing each submap as follows:

Submap #1

Most of the coastal area in this region is comprised of the Pacific Rim National Park, containing the renowned Long Beach recreational area. All of the major beaches in this area were found to have good vehicle access for oil spill clean-up efforts, with direct access onto the beach blocked only by moveable blockades or locked gates. The land area north of the park's boundaries is largely developed by the Village of Tofino, cottage subdivisions, and tourist resort camps, with many other areas already in the process of development. Aside from the environmental sensitivity of this coastline, the coastal real estate was found to be very expensive, with the resort areas depending heavily on the beaches as offering the primary attraction for the tourists, such that a major oil spill on these beaches would elicit a fierce local call for an urgent clean-up campaign.

A solid waste disposal site, locally called the "six-mile dump", which used to serve this developed area is shown just west of the junction of HWY #4 and the park boundary. This site was closed for environmental reasons and is no longer in active use. Most of the garbage and debris has been covered with a flat soil cap, but the site has a small surface area. In consideration of its closure and small size, this site was dismissed as a potential oiled debris management site. However, with better access security provisions, it could be used to store certain bulky emergency response equipment. The solid waste disposal site currently being used by Tofino, Ucluelet

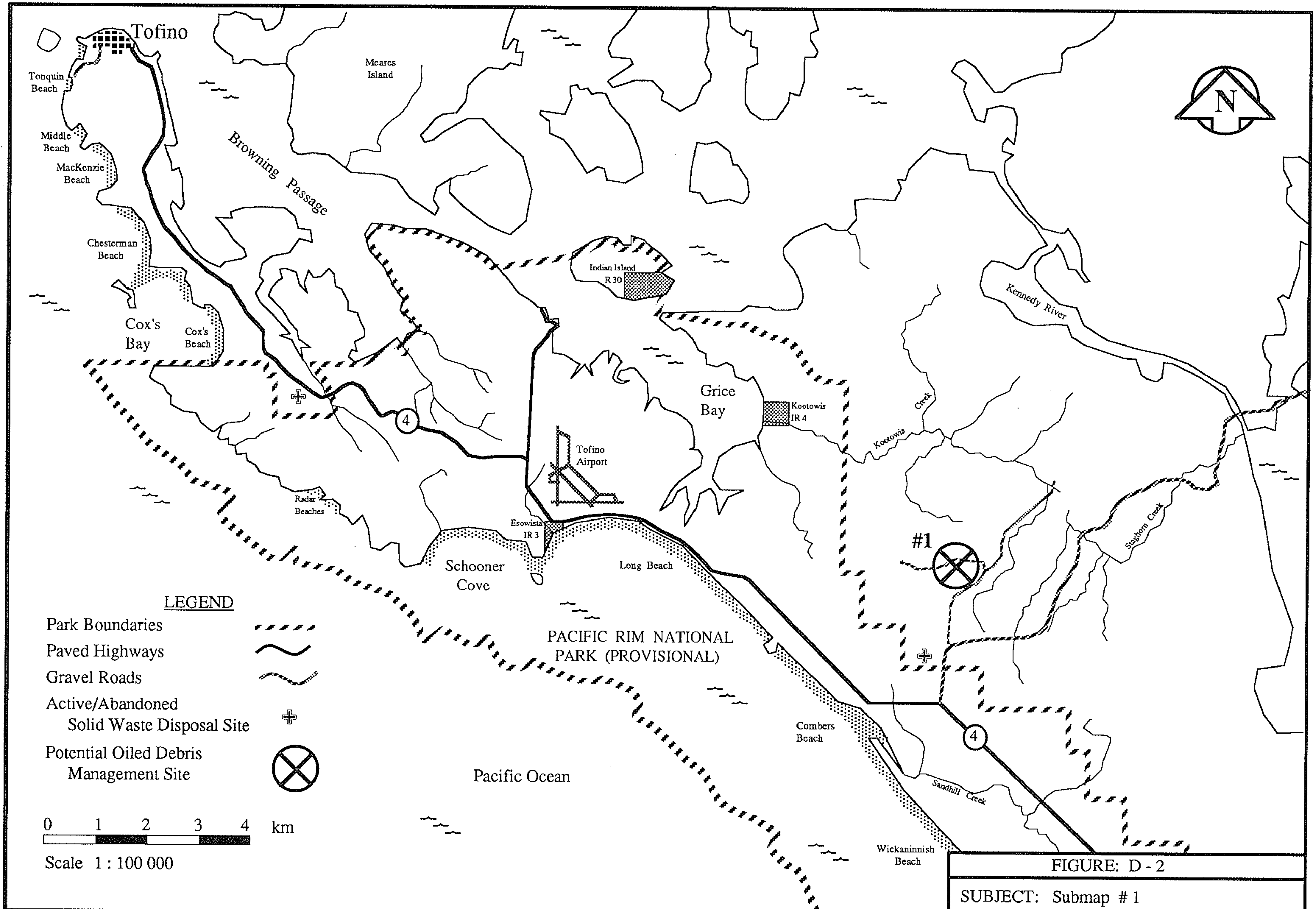

FIGURE: D - 2

SUBJECT: Submap # 1

TABLE D-2

POTENTIAL SITE #1 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [ ]	regrown clear-cut timberland [X]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [X] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [ ]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [X]	2 to 9 % [ ]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [X] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [ ] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [X]	northeast [ ] south [ ]	north [ ] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

and the park, is located north of HWY #4 and north-east of Combers Beach. It was learned that this site, as well, is controversial due to the potential for leachates and contaminated run-off to migrate into Sandhill Creek which drains into Combers Beach. Were it not for the lack of a better immediate solution, this solid waste disposal site would probably also have been forced to close by now.

Despite this local setting and environment, and recognizing that significant amounts of oiled debris would be generated along this coast in the event of a major marine oil spill affecting these beaches, a potential oiled debris management site (Site #1) was found about 2 kilometres north of the existing active solid waste disposal site. This site was previously clear-cut, but is in the process of regrowth. The area is quite flat, and on-site soil testing determined the presence of excellent consolidated clay soils. On the basis of the presence of very saturated clays within some lower lying areas, the water table would appear to be high, but likely quite stationary. Therefore, precipitation in this area would be lost through surface runoff rather than through losses to the groundwater. Ideally, the active area of the oiled debris management site should be built up, if necessary, and well drained to maintain its unhindered accessibility during high precipitation periods.

Appendix 'E' describes the physical data pertaining to Site #1, and Table D-2 reflects the status of Site #1 relative to the site selection criteria.

Submap #2

The coastal area in this region, as in the case of Submap #1, contains a significant portion of beaches, and is spotted with three Indian Reserves. The beaches of Florencia Bay are not accessible by vehicle from the road. Likewise, much of the beach shoreline along Loudon Channel is not readily accessible until further east towards David Channel. Here the beach is accessed by an active logging road which takes off from Highway #4, passes Maggie Lake and ends at a logging

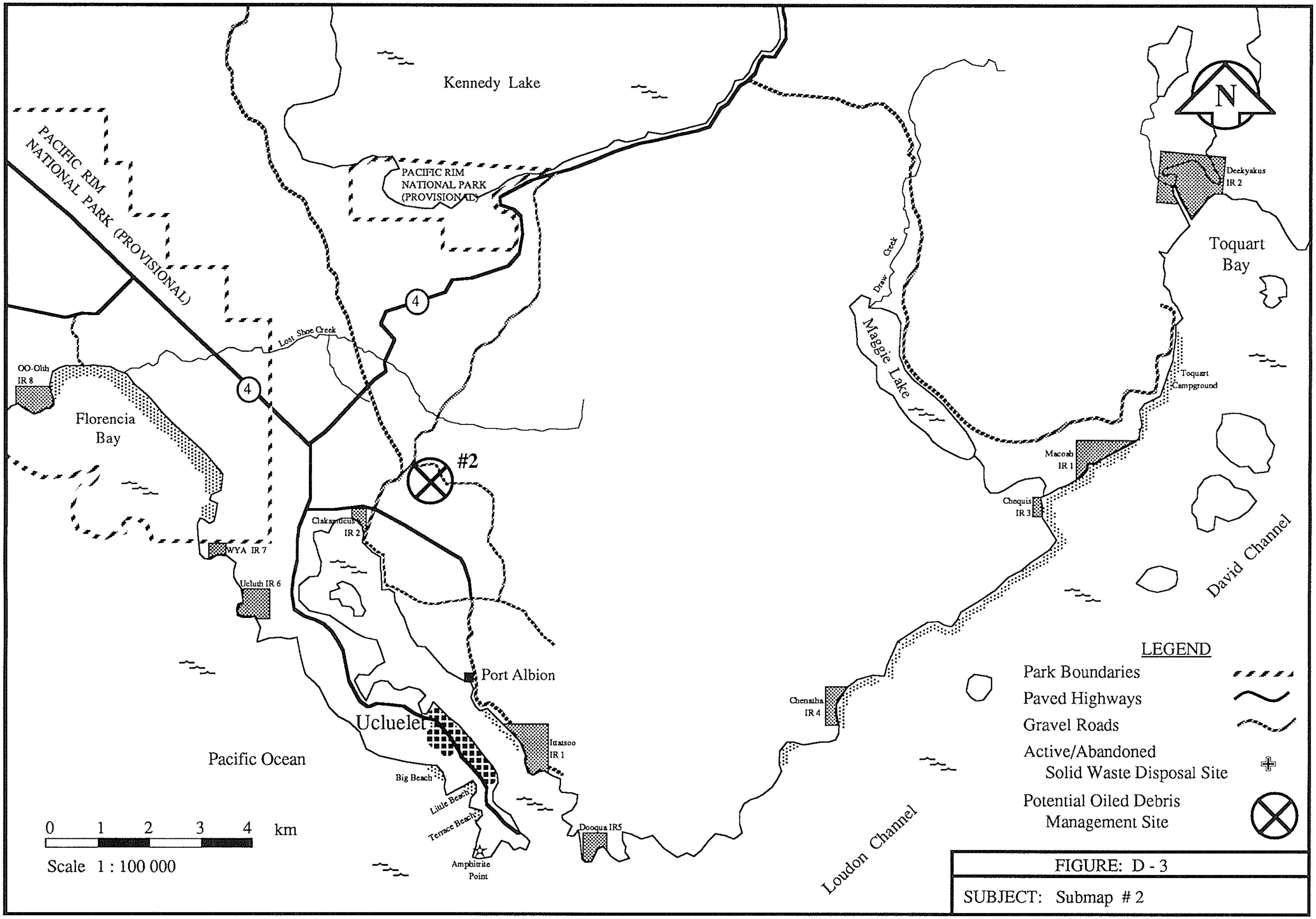

FIGURE: D - 3

SUBJECT: Submap # 2

TABLE D-3

POTENTIAL SITE #2 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road ☐	all-weather gravel road ☐	logging road ☒	no access ☐
Land Tenure	vacant prov. Crown land ☐	leased prov. Crown land ☒	privately owned ☐ federal Crown land ☐	Indian Reserves ☐ under land claim ☐
Land Use	clear-cut timberland ☒	regrown clear-cut timberland ☐	uncut timberland ☐ agricultural land ☐	residential land ☐ ecological reserves ☐ wildlife sanctuaries ☐ wildlife management areas ☐ designated parks ☐ historical sites ☐
Soil Cover	clay ☐ silty clay ☐ glacial till ☐	sandy clay ☐ loam ☐ silt ☐	sandy loam ☐ loamy sand ☒ gravelly loam ☐	sand ☐ gravel ☐ bedrock ☐
Soil Cover Thickness	10 to 5 metres ☐	5 to 2 metres ☐	2 to 1 metres ☐	< 1 metres ☐ bedrock ☐
Surficial Gradient	0 to 2 % ☒	2 to 9 % ☐	9 to 20 % ☐	> 20 % ☐
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres ☐ ≥ 5 kilometres ☐ ≥ 500 metres ☐ ≥ 3 kilometres ☒ ≥ 250 metres ☐ ≥ 100 metres ☐ ≥ 100 metres ☐	 500 to 400 metres ☒ 5 to 4 kilometres ☐ 500 to 400 metres ☐ 3 to 2 kilometres ☐ 250 to 200 metres ☐ 100 metres ☐ 100 metres ☐	 400 to 300 metres ☐ 4 to 3 kilometres ☐ 400 to 300 metres ☐ 2 to 1 kilometres ☐ 200 to 150 metres ☐	 < 300 metres ☐ < 3 kilometres ☐ < 300 metres ☐ < 1 kilometres ☐ < 150 metres ☐ < 100 metres ☐ < 100 metres ☐
General Location Considerations				in wetland areas ☐ in a 100 yr floodplain ☐ areas subject to tsunamis ☐
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast ☐	northeast ☐ south ☐	north ☒ southwest ☐ west to northwest ☐ (and > 5 km away)	west to northwest ☐ (and < 5 km away)
Available Working Area	> 5 hectares ☒	5 to 4 hectrares ☐	4 to 3 hectares ☐	< 3 hectares ☐
Public Visibility	secluded ☒			visible from highway ☐
Public Acceptability		public endorsement ☐		public opposition ☐

transfer depot at Toquart Bay. No practical site could be found for the area between Port Albion and Toquart Bay. However, north of Ucluelet and Port Albion a potential oiled debris management site (Site #2) was accessed by a logging road on land that had been clear-cut by MacMillan-Bloedel.

Appendix 'F' describes the physical data pertaining to Site #2, and Table D-3 reflects the status of this site relative to the site selection criteria.

Submap #3

In this area, vehicle access to the coast is offered only at Sarita, a logging transfer depot. No potential oiled debris management site was found during the ground survey, and nothing promising could be seen in available maps of the area. A site in this location is not regarded as critical in that this coastline may be the least likely to be affected after a marine oil spill in the Juan de Fuca Strait.

Submap #4

Much of the coast in this area comprises the Pacific Rim National Park, and about eleven Indian Reserves are scattered throughout this area. Only two locations, Bamfield and Pachena Beach in Pachena Bay offer access to the coast by road. However, Cape Beale offers a helicopter landing pad such that helicopter assistance could be readily accommodated to airlift oiled debris from inaccessible beaches to some convenient waste management site, were it available.

The search for potential oiled debris management sites during the ground survey, revealed only one suitable area (Site #3) about 2 kilometres south of Bamfield. The site had been previously clear-cut with no regrowth having yet occurred. Although slightly sloped, some fairly large level areas could be seen. The soil consisted of the typical glacial till found throughout much of the region, with significant clayey content as evidenced by soil sampling and the ponding of water in dugout areas despite the high elevation of the land. The suitability of this site was

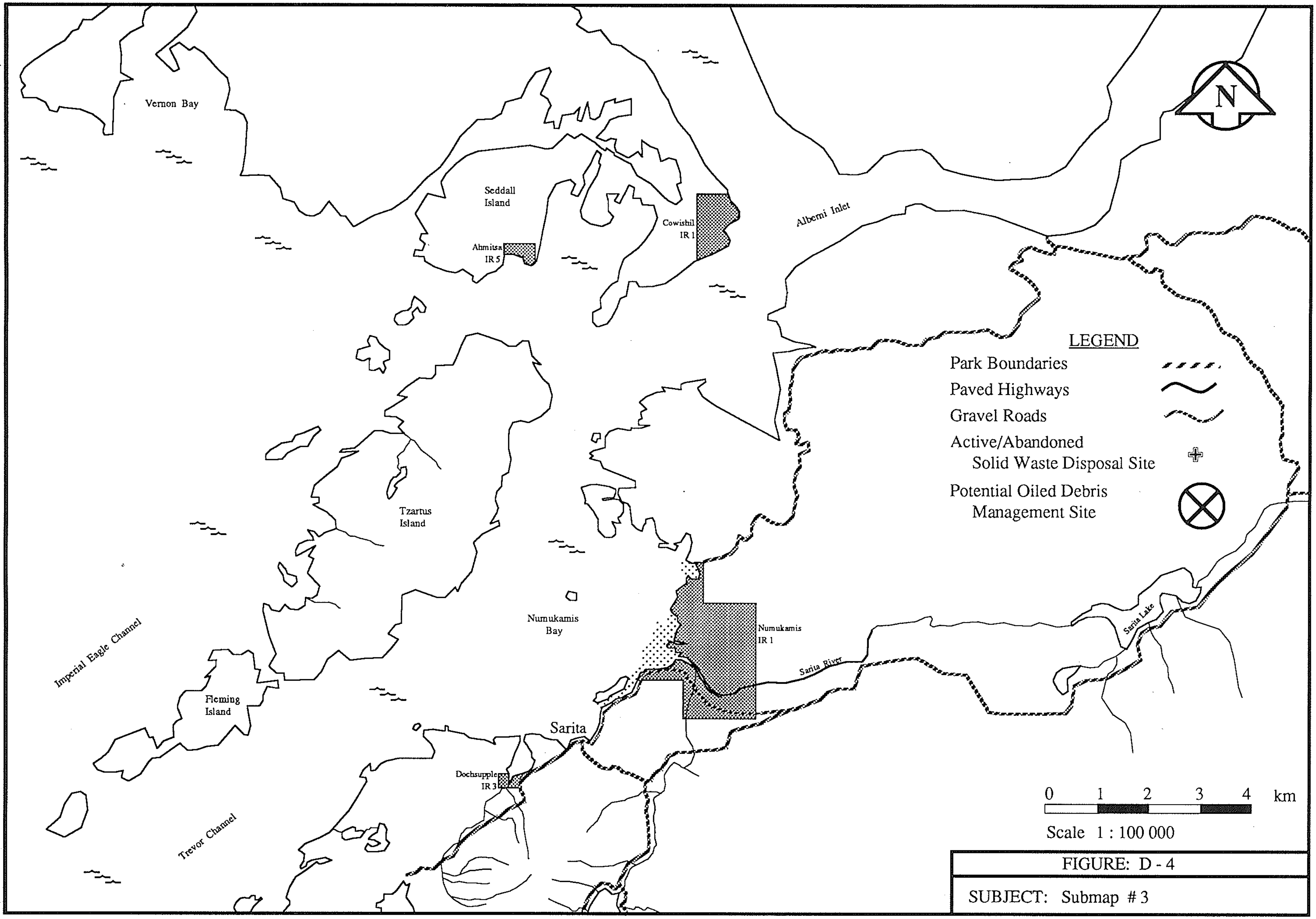

FIGURE: D - 4

SUBJECT: Submap # 3

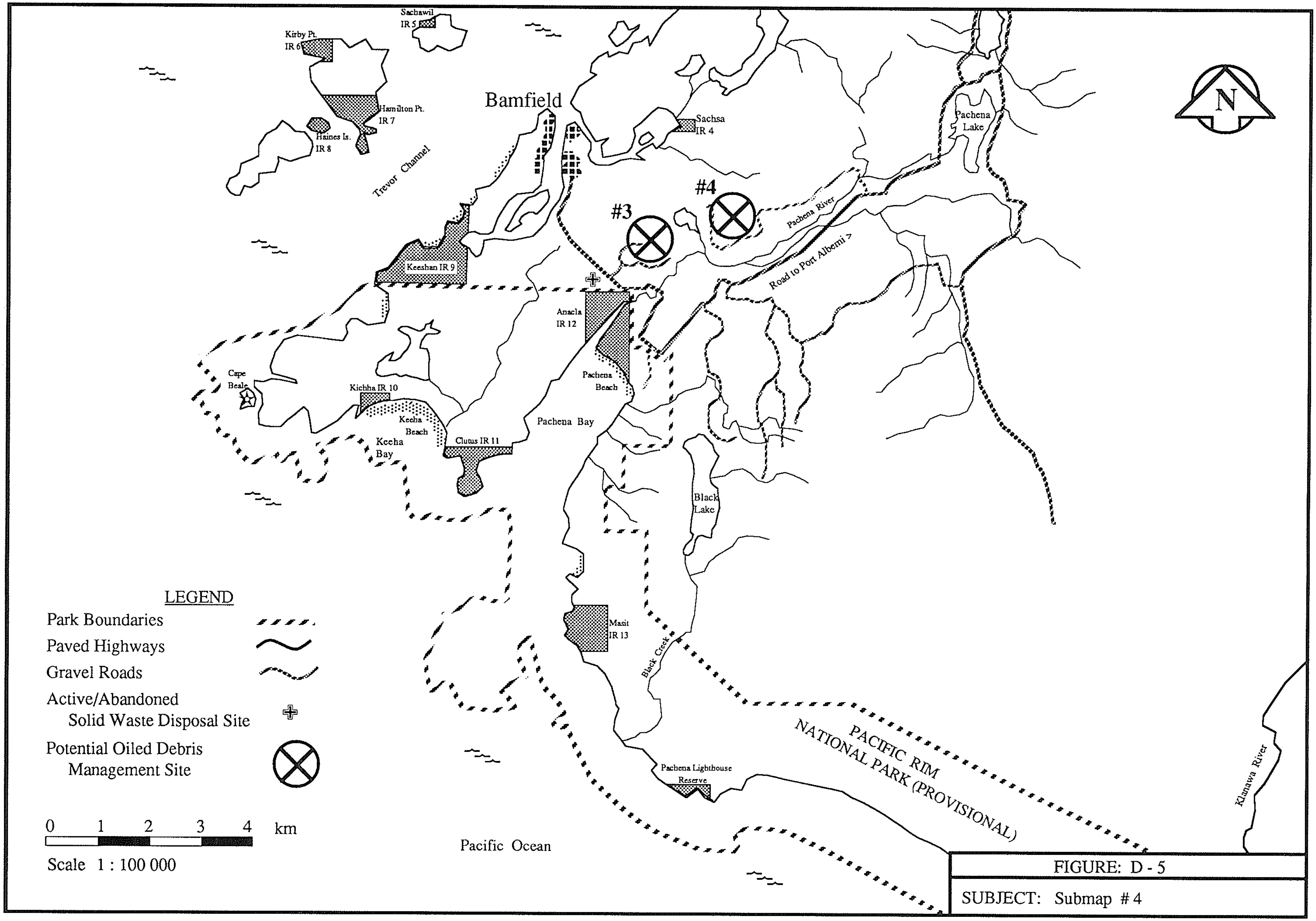

FIGURE: D - 5

SUBJECT: Submap # 4

TABLE D-4

POTENTIAL SITE #3 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [X]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [X] gravelly loam [ ]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [X]	2 to 9 % [ ]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [ ] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [X] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [ ] south [ ]	north [X] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

TABLE D-5

POTENTIAL SITE #4 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [X]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [X] loamy sand [ ] gravelly loam [ ]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [X]	2 to 9 % [ ]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [X] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [X] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [ ] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [ ] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [X] south [ ]	north [ ] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

also verified by information obtained from topographical, soil and landform maps. The second potential site (Site #4) shown as about 2 kilometres to the east of the aforementioned site could not be accessed by the logging road during the ground survey due to the low profile of the vehicle. However, information from the maps would imply that this site could also serve as a suitable alternative or complementary site, and may in fact offer a much larger available waste management area.

Appendices 'G' and 'H' describe the physical data pertaining to Sites #3 and #4, and Tables D-4 and D-5 reflect the status of these sites relative to the site selection criteria.

Submap #5

The Pacific Rim National Park makes up all of the coastal land within this area, with the exception of about seven Indian Reserves. This coastline was observed to contains some of the most beautiful beaches and natural habitat seen throughout the entire study area. No road access is available to any location within this stretch of the study area. Access is achieved only by foot, by boat, or by helicopter. No potential oiled debris management sites can be proposed in this area.

A possibility exists that logging activity in the "Tree Farm Licence 27 BK 2" area to the east of the park boundaries near Nitinat Lake, which has brought some logging roads close to the park boundary, as evidenced by the federal topographical maps, may offer a potential site, but all the oiled debris would have to be airlifted to such sites and vehicle access to such a site for construction and maintenance purposes may be poor at best to such an isolated and potentially very moist area. Therefore, it may be just as well that any barged or airlifted oiled debris be taken to the identified potential waste management sites outside of Bamfield since they offer

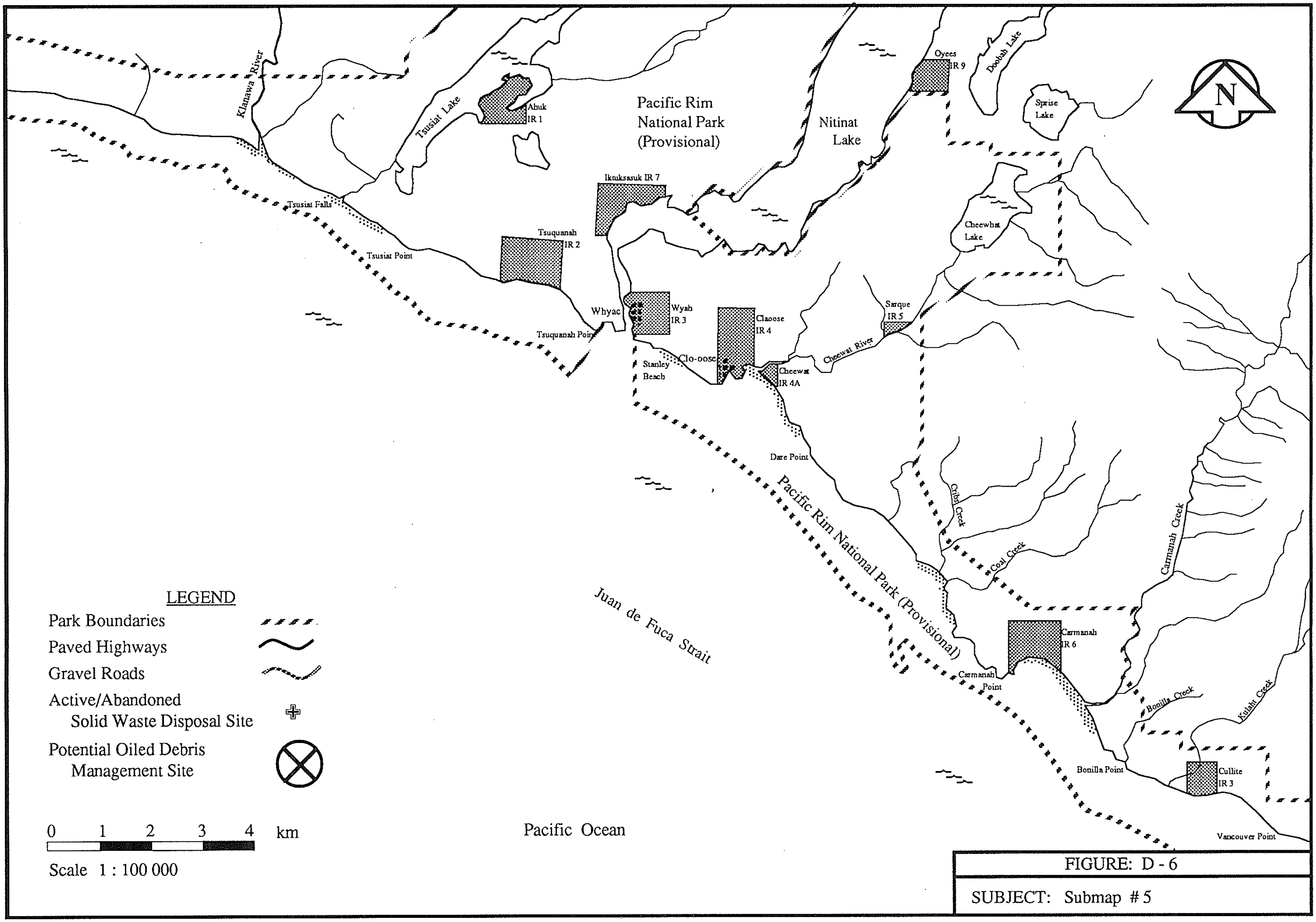

FIGURE: D - 6

SUBJECT: Submap # 5

much better vehicle access and the community has the labour resource to properly maintain the sites.

Submap #6

As in the case of Submap #5, the Pacific Rim National Park makes up the majority of the coastal area, and likewise offers very limited access other than logging roads from the interior. For much the same reasons as cited above no potential oiled debris management site was selected for the coast north-west of Port San Juan. Furthermore, given the much more rugged nature of the coast along this stretch of the park, oiled debris may not be possible to collect, such that wave energy may have to play the dominant role in breaking down any beached oil.

Port San Juan offers a beautiful beach at its north-east end, which can be accessed by vehicle through the Pacific Rim National Park. The community of Port Renfrew is well accessed by HWY #14, and noteworthy is that San Juan Point offers a helicopter landing pad which can serve some strategic purpose during an oil spill event. This area was searched extensively but no ideal location could be found for an oiled debris management site. In fact the solid waste disposal site shown as located just north of the Gordon River Indian Reserve had apparently been ordered closed by B.C. Environment. The search during the ground survey then extended farther east along HWY #14, but the land appeared mostly quite steep. Considerable clear-cut logging activity has taken place south of HWY #14 and east of Providence Cove but the logging roads were either too poor to travel or they were deliberately blocked, such that close visual examination of potential sites was not practical, and subsequent soils information for areas of interest between Providence Cove and Sombrio Point did not support the appropriateness of those areas given their close proximity to the coast.

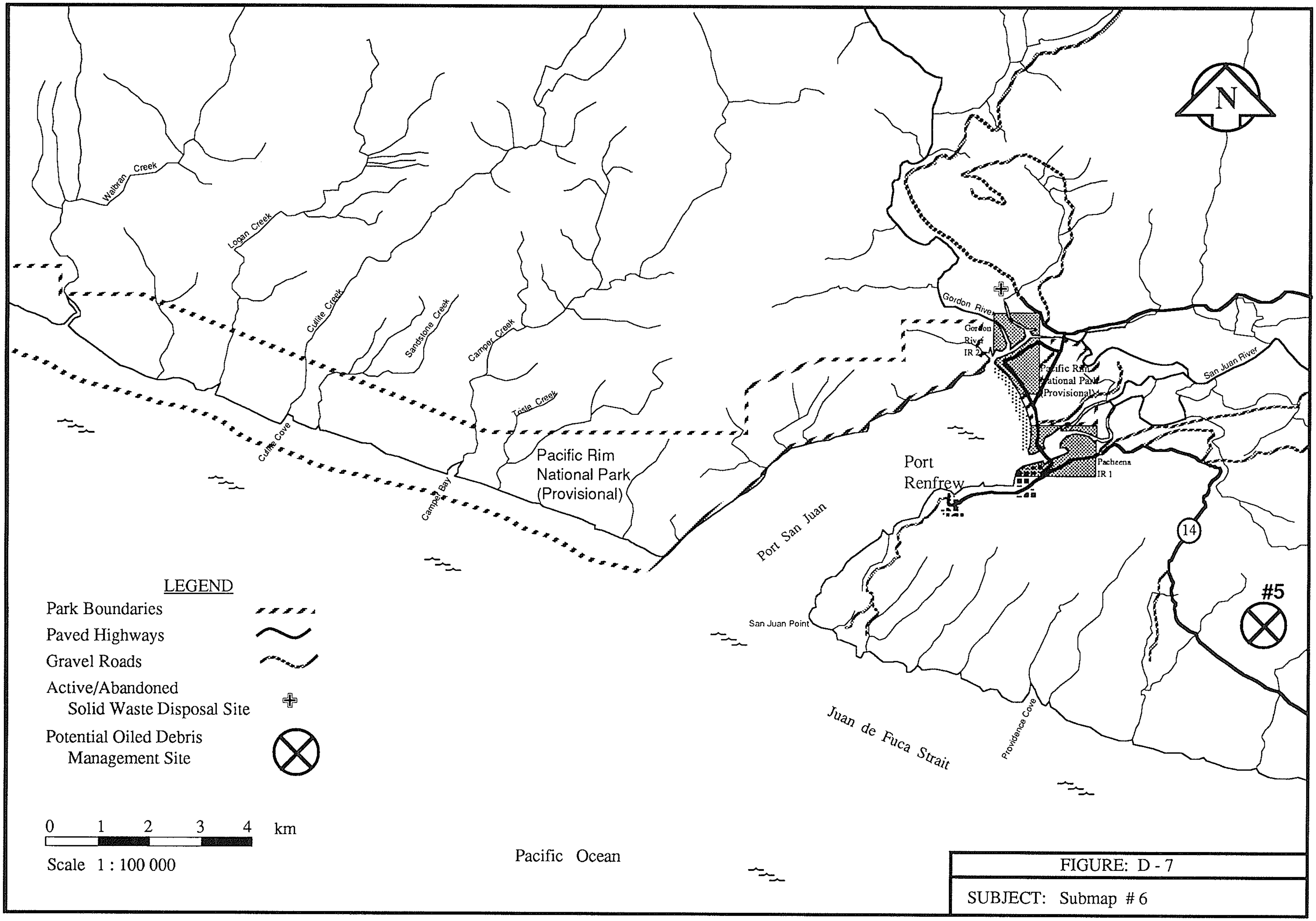

FIGURE: D - 7

SUBJECT: Submap # 6

TABLE D-6

POTENTIAL SITE #5 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [ ]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [ ]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [X]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [ ]	2 to 9 % [X]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [X] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [ ] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [X]	northeast [ ] south [ ]	north [ ] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

The potential oiled debris management site (Site # 5) shown on Submap #6 was ultimately selected on the basis of information derived from topographical maps, and soils and landform maps, but was not physically investigated at the time of the ground survey because the search was focused to the south of HWY #14. The site was selected for its relative shallow slope, soil matrix, reasonably distanced between Port San Juan and Sombrio Beach, and close to a highway. Unknown is whether this location has been clear-cut yet and whether any logging road might already exist right to the site.

Appendix 'I' describes the physical data pertaining to Site #5, and Table D-6 reflects the status of this site relative to the site selection criteria.

Submap #7

Submap #7 covers a coastal area which is spotted with beaches. Some of these beaches, such as Sombrio Beach, Mystique Beach and China Beach in China Beach Provincial Park, are accessible but only by foot paths from the highway. Only at the community of River Jordan is the coastal beach fully accessible by vehicle. Therefore, any oiled debris requiring removal would have to be removed by barge (assuming marine landing is possible) or airlifted out by helicopter to a barge, to a truck on the highway or directly to an available waste management site.

One potential site located almost half way between River Jordan and Sombrio Point, was investigated on the south side of HWY #14 at what the federal topographical maps call a former correctional camp. This site is accessible by a short road off the main highway, and yet is well obscured from view off the highway. The attraction of the site is that it is quite flat with an exposed cleared area which is situated about 90 metres above sea level and separated from the sea by a belt of timber. The surficial soil conditions, however, are not ideal in that they are a sandy gravel, although soils maps indicate that the surficial soil is underlain

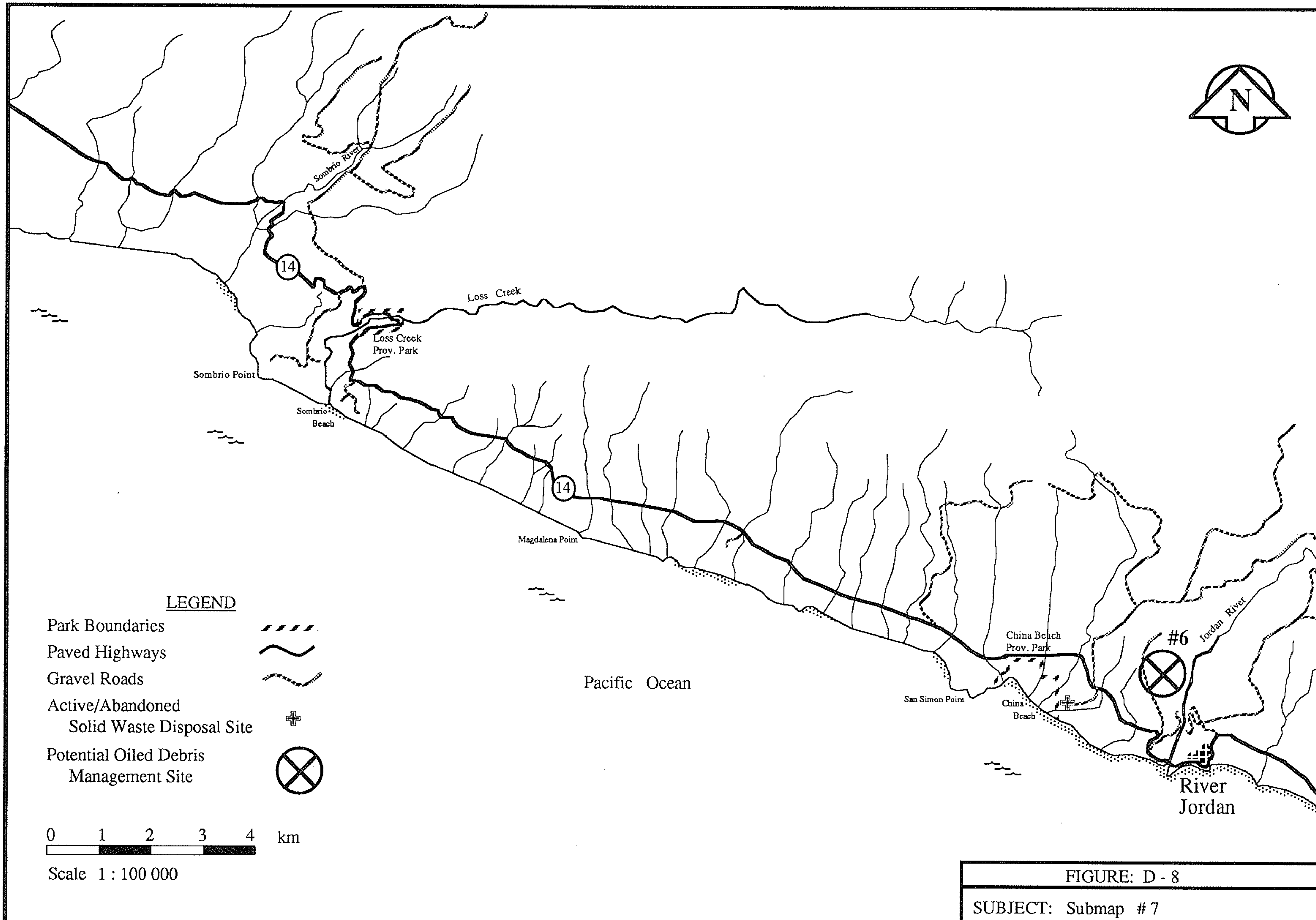
N
Sombrio River
14
Loss Creek
Loss Creek Prov. Park
Sombrio Point
Sombrio Beach
Magdalena Point
Pacific Ocean
San Simon Point
China Beach Prov. Park
China Beach
#6
Jordan River
River Jordan
LEGEND
Park Boundaries
Paved Highways
Gravel Roads
Active/Abandoned Solid Waste Disposal Site
Potential Oiled Debris Management Site
0 1 2 3 4 km
Scale 1 : 100 000
FIGURE: D - 8
SUBJECT: Submap # 7

TABLE D-7

POTENTIAL SITE #6 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [X]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [X]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [ ]	2 to 9 % [ ]	9 to 20 % [X]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [ ] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [X] 200 to 150 metres [ ]	< 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [ ] south [ ]	north [X] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

with moraine deposits. Also, the area is limited in size compared to other selected potential sites, but it may serve some strategical purpose for equipment storage in view of the long coastline between River Jordan and Port Renfrew. Reportedly, however, the provincial Department of Highways has applied for the site.

Since the majority of the exposed beach area in this region is at River Jordan, it would make strategic sense to locate an oiled debris waste management site near River Jordan. Such a site (Site 6) was found about 2 kilometres north of River Jordan. This site is located between Jordan River and a logging road which ends at a quarry. This site has been clear-cut, is sloped to the south-west, and is separated from the Jordan River by a high ridge.

Appendix 'J' describes the physical data pertaining to Site #6, and Table D-7 reflects the status of this site relative to the site selection criteria.

<u>Submap #8</u>

Submap #8 includes the entire coastal area between River Jordan and Sooke and identifies three potential oiled debris management sites. This coastal area is featured by the popular French Beach Provincial Park, with the coastline along Orveas Bay and Sooke Bay marked with numerous residential or cabin sites, increasing in density towards Sooke. French Beach is directly accessible by vehicles for beach clean-up purposes. The only other suitable vehicle access to the beach is at the mouth of Muir Creek. On the west side of the mouth of Muir Creek is a trailer campsite, but on the east side is the site of a former logging transfer station, reportedly owned by the CPR. No other direct public vehicle access to the shores could be found between Muir Creek and Sooke Bay, although municipal maps showed the locations of numerous road allowances between the highway and the shoreline which obviously were never developed.

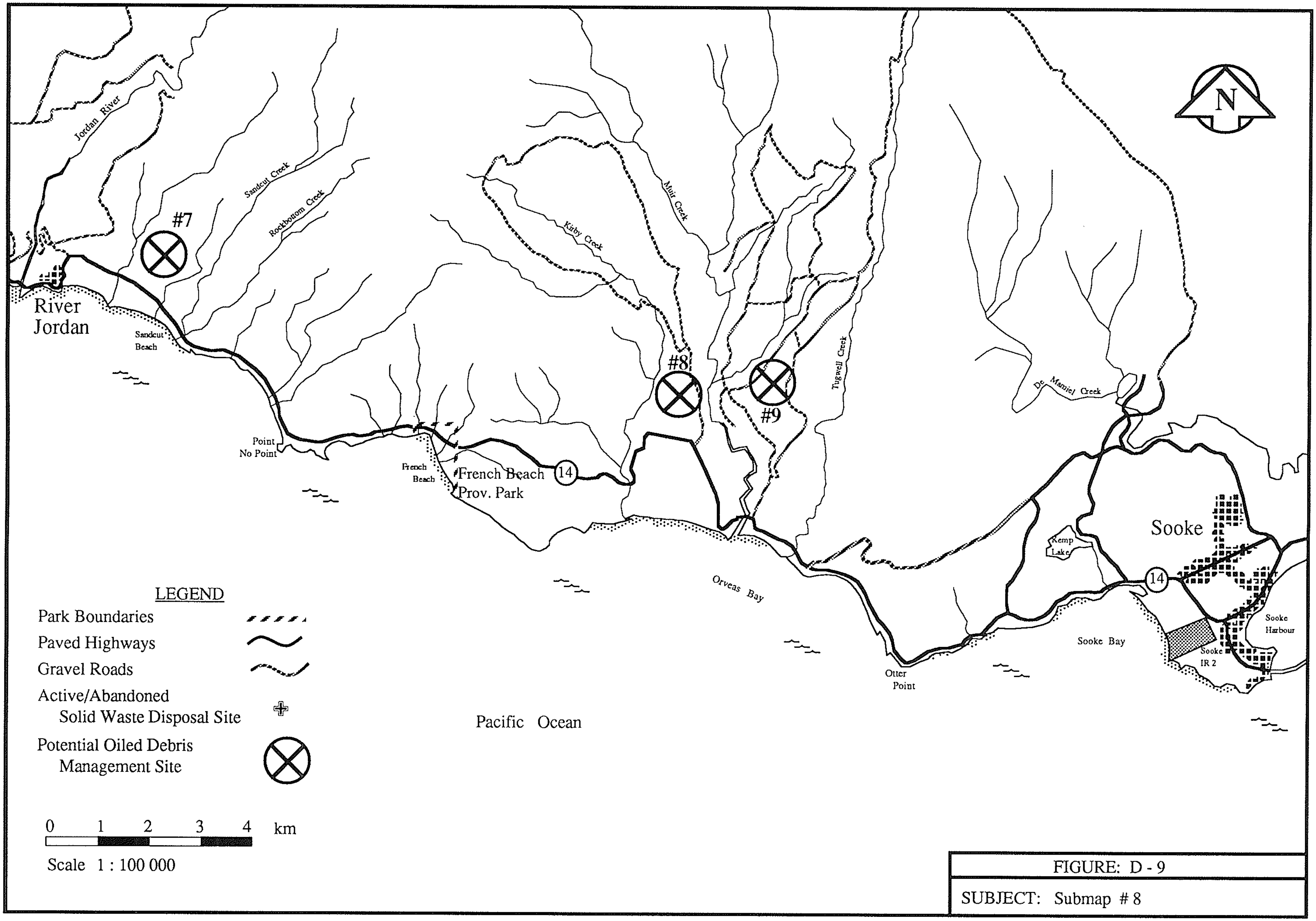

FIGURE: D - 9

SUBJECT: Submap # 8

TABLE D-8

POTENTIAL SITE #7 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [ ]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [X]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [ ]	2 to 9 % [X]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [ ] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [X] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [X] south [ ]	north [ ] southwest [ ] west to northwest [ ] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

TABLE D-9

POTENTIAL SITE #8 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [ ]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [X]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [ ]	2 to 9 % [X]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [X] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [X] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [ ] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [ ] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [ ] south [ ]	north [ ] southwest [ ] west to northwest [X] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

TABLE D-10

POTENTIAL SITE #9 SELECTION CRITERIA STATUS

CATEGORY	PREFERABLE	ACCEPTABLE	MARGINAL	UNACCEPTABLE
Accessibility	all-weather paved road [ ]	all-weather gravel road [ ]	logging road [X]	no access [ ]
Land Tenure	vacant prov. Crown land [ ]	leased prov. Crown land [ ]	privately owned [ ] federal Crown land [ ]	Indian Reserves [ ] under land claim [ ]
Land Use	clear-cut timberland [ ]	regrown clear-cut timberland [ ]	uncut timberland [ ] agricultural land [ ]	residential land [ ] ecological reserves [ ] wildlife sanctuaries [ ] wildlife management areas [ ] designated parks [ ] historical sites [ ]
Soil Cover	clay [ ] silty clay [ ] glacial till [ ]	sandy clay [ ] loam [ ] silt [ ]	sandy loam [ ] loamy sand [ ] gravelly loam [X]	sand [ ] gravel [ ] bedrock [ ]
Soil Cover Thickness	10 to 5 metres [ ]	5 to 2 metres [ ]	2 to 1 metres [X]	< 1 metres [ ] bedrock [ ]
Surficial Gradient	0 to 2 % [ ]	2 to 9 % [X]	9 to 20 % [ ]	> 20 % [ ]
Distance Considerations from: surface waters wells (upstream) wells (downstream) nearest settlement nearest dwelling land subject to slope failure Holocene fault	 ≥ 500 metres [ ] ≥ 5 kilometres [ ] ≥ 500 metres [ ] ≥ 3 kilometres [X] ≥ 250 metres [ ] ≥ 100 metres [ ] ≥ 100 metres [ ]	 500 to 400 metres [ ] 5 to 4 kilometres [ ] 500 to 400 metres [ ] 3 to 2 kilometres [ ] 250 to 200 metres [ ] 100 metres [ ] 100 metres [ ]	 400 to 300 metres [X] 4 to 3 kilometres [ ] 400 to 300 metres [ ] 2 to 1 kilometres [ ] 200 to 150 metres [ ]	 < 300 metres [ ] < 3 kilometres [ ] < 300 metres [ ] < 1 kilometres [ ] < 150 metres [ ] < 100 metres [ ] < 100 metres [ ]
General Location Considerations				in wetland areas [ ] in a 100 yr floodplain [ ] areas subject to tsunamis [ ]
Prevailing Wind Considerations: (location w.r.t. nearest settlement under summer prevailing winds)	east to southeast [ ]	northeast [ ] south [ ]	north [ ] southwest [ ] west to northwest [X] (and > 5 km away)	west to northwest [ ] (and < 5 km away)
Available Working Area	> 5 hectares [X]	5 to 4 hectrares [ ]	4 to 3 hectares [ ]	< 3 hectares [ ]
Public Visibility	secluded [X]			visible from highway [ ]
Public Acceptability		public endorsement [ ]		public opposition [ ]

The potential oiled debris management site (Site #7) shown about 2 kilometres east of River Jordan can serve to complement the site selected north of River Jordan or to serve as an alternative location to this site. The site is accessible by a logging road off HWY #14 and is an active clear-cut area, separated from view off the highway by a wide belt of regrown timber. Stumps and waste timber proliferate the site, and the site is sloped towards the highway with no apparent streams intersecting the site.

Two other potential sites (Sites #8 and #9) are shown to be located east and west of Muir Creek. Neither of these sites could be physically inspected because the access route was locked to vehicle traffic. An attempt was made to walk in along the logging roads towards both sites but the distance was significant and the initial survey was disappointing due to the abundance of very sandy surficial deposits. However, upon review of soils maps which were obtained at a latter date, it was revealed that clayey soils with fairly flat topography are available farther inland at the indicated sites. It is uncertain whether the indicated sites have formerly been clear-cut, but the evidence presented by the foot survey towards these sites, and the network of logging roads and trails available in this region, would raise the probability that the selected sites have been disturbed in the past through logging activities.

Appendices 'K' , 'L' and 'M' describe the physical data pertaining to Sites #7, #8 and #9, and Tables D-8, D-9 and D-10 reflect the status of these sites relative to the site selection criteria.

D.5.2 Discussion

The objective of identifying potential oiled debris management sites has been achieved through the identification of nine potential sites throughout the study area. The sites have been distributed as much as possible, although in at least three locations, two

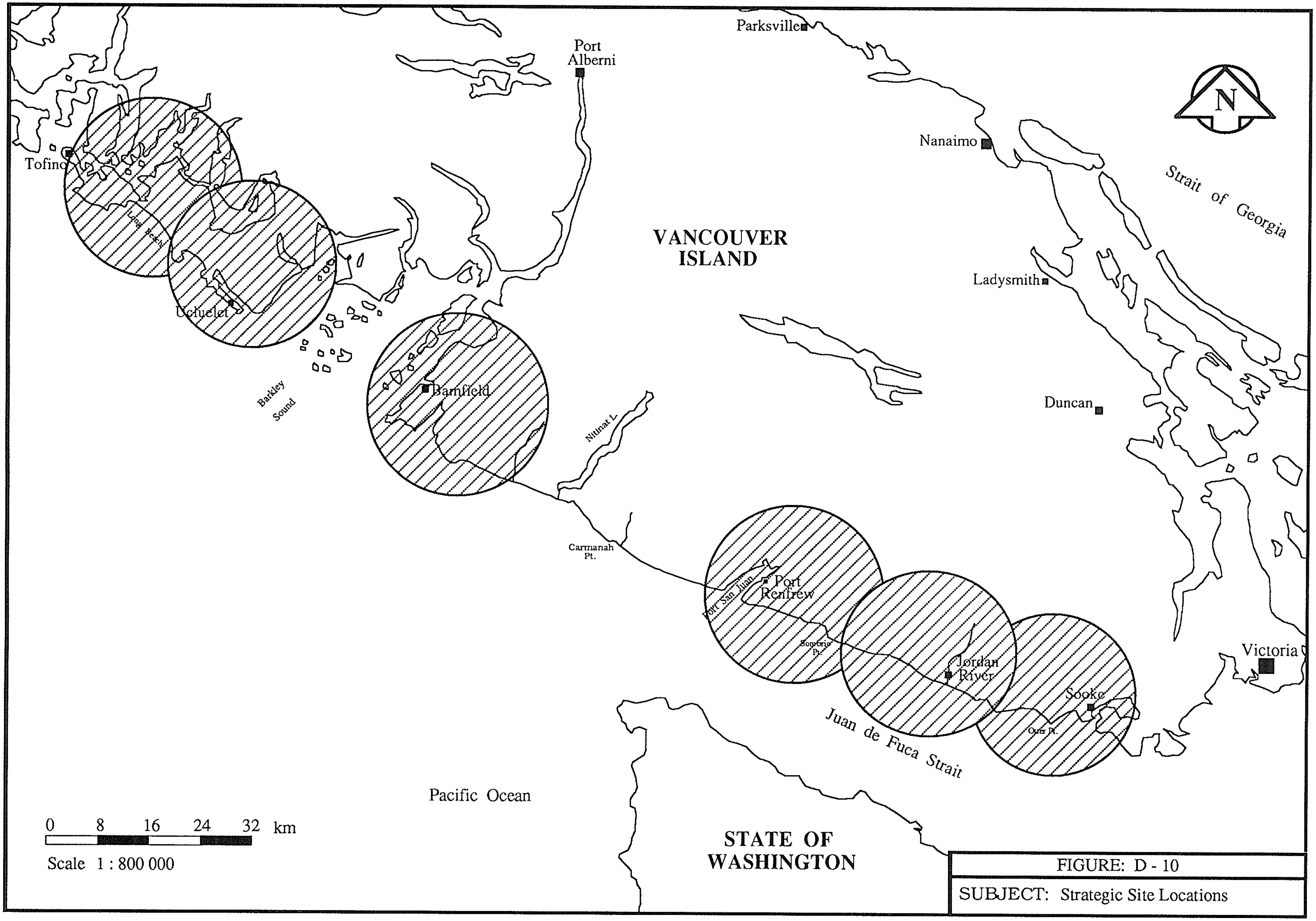

FIGURE: D - 10

SUBJECT: Strategic Site Locations

sites have been identified relatively close to each other so as to offer a choice between the two or to provide a second complementary site. Figure D-10 depicts the strategic coastal areas which could be served if at least six of the nine potential sites were selected. The only area of concern for which a readily accessible emergency waste management site could not be identified is that stretch along the West Coast Trail between Port Renfrew and Bamfield. Generally, the objective has been achieved, with all the sites supported by available data relative to the developed site selection criteria.

Section E

CONCLUSIONS AND RECOMMENDATIONS

E.1 CONCLUSIONS

1) The current absence of approved predesignated oiled debris management sites poses a logistical gap in B.C.'s oil spill response strategy for Juan de Fuca Strait as was demonstrated by the waste management problems which emerged during the Nestucca oil spill event.

2) The establishment of approved predesignated temporary oiled debris management sites within the study area has been recommended in four recent investigative reports prepared in response to oil spill incidents on the west coast.

3) The public opinion is that any predesignated oiled debris management sites should be used only as temporary waste management sites, that is, not be used to permanently dispose of the oiled debris.

4) Native groups want to play an active role in the establishment and operation of oiled debris management sites.

5) The environmental setting of the study area, with its abundant streams and estuaries, steep slopes, limited access, and extensive parks and Indian reserves offers a very limited choice of suitable potential oiled debris management sites.

6) The high amounts of precipitation characteristic to the study area would preclude the use of landfilling of oiled debris as a practical and environmentally acceptable waste management option. Landfilling of oiled debris, where alternatives are available, is also not supported by the Canadian Public Review Panel.

7) On the basis of preliminary investigations and site selection criteria, nine potential oiled debris management sites for the temporary storage and treatment of oiled debris are identified .

8) Oiled debris management sites in themselves will not constitute a solution to the problems posed by oiled debris, but rather will serve as a part of the solution provided that an overall infrastructure is made available for the treatment and ultimate disposal of the oiled debris.

E.2 RECOMMENDATIONS

1) To minimize the environmental damage to marine life, and the adverse impact on livelihoods, tourism and property value along coastlines affected by oil spills, a minimum of six strategically placed oiled debris management sites should be selected and established along the coast of the study area, even if the most ideal site conditions cannot be found.
2) The selected oiled debris management sites should have a minimum available working area of about three hectares.
3) More detailed mapping and site specific environmental impact assessments on the selected potential oiled debris management sites should be carried out.
4) Selected oiled debris management sites should be screened through a public participation process consisting of information meetings, or public hearings, in order to confirm their acceptability before they are formally approved and designated for this purpose.
5) Where applicable, local native bands should be involved in the establishment and operation of oiled debris management sites.
6) Covered bulk containers or equivalent containment options should be used to store the oiled debris at the waste management sites.
7) The specific role and functional purpose of predesignated oiled debris waste management sites, within the infrastructure of B.C.'s Marine Oil Spill Contingency

Plan, should be clearly spelled out with emphasis placed on how the stored oiled debris would be further handled, treated and/or disposed.

Section F

EPILOGUE

The scope of this study focused primarily on the subject matter of oiled debris management sites which, when placed into perspective relative to marine oil spill response measures, constitute only a part of the overall problems which need to be addressed by the B.C. Ministry of Environment in arriving at a comprehensive Marine Oil Spill Contingency Plan. Therefore, to complete the response strategy, such a contingency plan needs to define the intended role of the temporary oiled debris management sites, and to lend credence to the term "temporary" by outlining the intended strategy for treating and ultimately disposing of the oiled debris.

The recommendations presented in this report have been made upon the assumption that the B.C. Ministry of Environment is committed to the implementation of the recommendations of the States/B.C. Oil Spill Task Force and other Task Force reports regarding the establishment of oiled debris management sites. The possibility of other alternative solutions to oiled debris management sites was not examined.

Future work which needs to be carried out by the B.C. Ministry of Environment with respect to oiled debris management sites should focus on examining: the practicality of operating these sites; how the oiled debris will be transported from the beaches; how many covered containers will be required; how long the oiled debris will be stored; how the oiled debris will be treated; and where the oiled debris will ultimately be disposed. As well, the optimum number of sites will have to be established and site specific environmental assessments will have to be undertaken on each candidate site.

Section G

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Section H

APPENDIX 'A'

LIST OF REFERENCED COASTAL B&W AERIAL PHOTOS

Study Area	Code	Numbers
Sooke - Port Renfrew	BC 80083	64-67/ 153-159/ 162-166/ 172-173/ 175-178
		225-226/ 228-230/ 231-236/ 241-243
	BC 84031	117-123
	BC 84028	122-129
Port Renfrew - Bamfield	BC 7238	168-171/ 174/ 176/ 288-289/ 297-299
	BC 7239	2-3/ 7-17/ 43-48/ 50-52/ 91-92
	BC 7261	68-70/ 73-76
Bamfield - Port Alberni	BC 81073	186-199
Port Alberni - Ucluelet	BC 81074	83-85/ 213-226
Ucluelet - Tofino	BC 7238	54-55/ 69-70/ 145-146/ 196-197
	BC 81073	114-120
	BC 81074	63-71/ 203/ 223-227/ 231-240/ 248-249
	BC 81075	26-34/ 40-50

APPENDIX 'B'

LIST OF REFERENCED MAPS

Maps Obtained from Maps B.C. in Victoria

-Biogeoclimatic Units of the Vancouver Forest Region (1:500 000)

-British Columbia Relief Map (1:2 000 000)

-Coastal Marine Parks of British Columbia (1:800 000)

-Provincial Parks of Vancouver Island (1:800 000)

-Soils & Landform Maps (1: 50 000) :

Identification	
Sooke	92B/5
River Jordan	92C/8
San Juan	92C/9
Carmanah Creek	92C/10
Pachena Point	92C/11
Ucluelet	92C/13
Barkley Sound	92C/14
Effingham River	92F/3
Tofino	92F/4

-Topographical Maps (1:125 000) :

Identification	
Nitinat Lake	92C/NE
Kennedy Lake	92F/SW
Victoria	92B/NW

Maps Obtained from Geological Survey of Canada in Vancouver

-Geology of Vancouver Island (East Half), O.F. 463

-Geology of Nitinat Lake Map Area, O.F. 821 (1:125 000)

-Topographical Maps (1: 50 000) :

Identification	
Sooke	92B/5
River Jordan	92C/8
Port Renfrew	92C/9
Carmanah Creek	92C/10
Pachena Point	92C/11
Ucluelet	92C/13
Barkley Sound	92C/14
Little Nitinat River	92C/15

APPENDIX 'B' (Continued)

-Topographical Maps (1: 50 000) :

	Identification	
	Alberni Inlet	92F/2
	Effingham River	92F/3
	Tofino	92F/4

<u>Maps Obtained from Parks Canada</u>

- Guide to Forest Land of Southern Vancouver Island (1:175 000)

-Pacific Rim National Park - West Coast Trail (1:50 000)

-Pacific Rim National Park - Long Beach Unit

<u>Maps Obtained from the Capital Regional District</u>

- 3 Subdivision and Zoning Maps covering Sooke to China Beach.

<u>Maps Obtained from MacMillan Bloedel Limited</u>

- T.F.L . 44 East Map - Recreation and Logging Road Guide (1:125 000)

- T.F.L. 44 West Map - Recreation and Logging Road Guide (1:125 000)

APPENDIX 'C '

REFERENCED ENVIRONMENT CANADA WEATHER DATA

COURTESY
OF
THE VICTORIA ENVIRONMENT CANADA
WEATHER OFFICE

APPENDIX 'D'

AVAILABLE WELL LOG DATA

COURTESY
OF
MINISTRY OF ENVIRONMENT
WATER MANAGEMENT BRANCH
GROUNDWATER SECTION

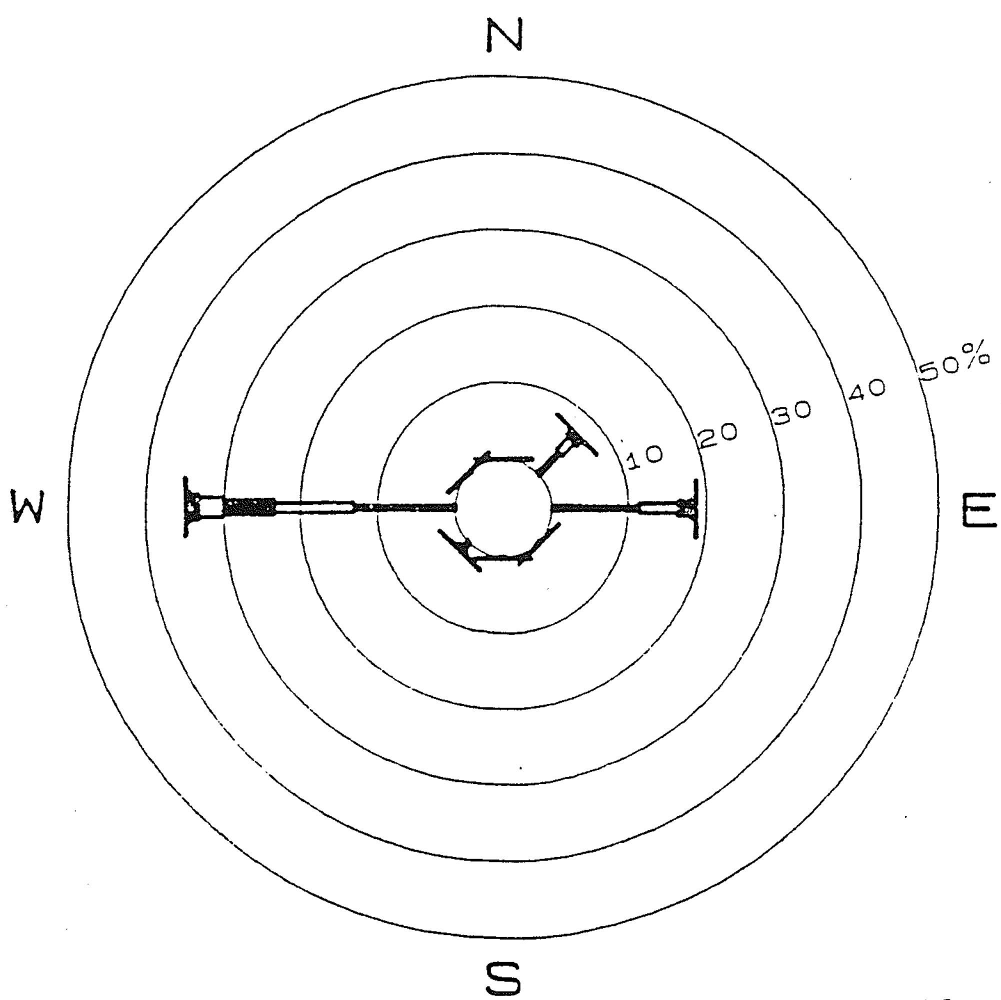
ENVIRONMENT
CANADA

ATMOSPHERIC ENVIRONMENT SERVICE
PACIFIC REGION

FREQUENCY OF WIND SPEED BY DIRECTION

VICTORIA MARINE

1967 - 1982



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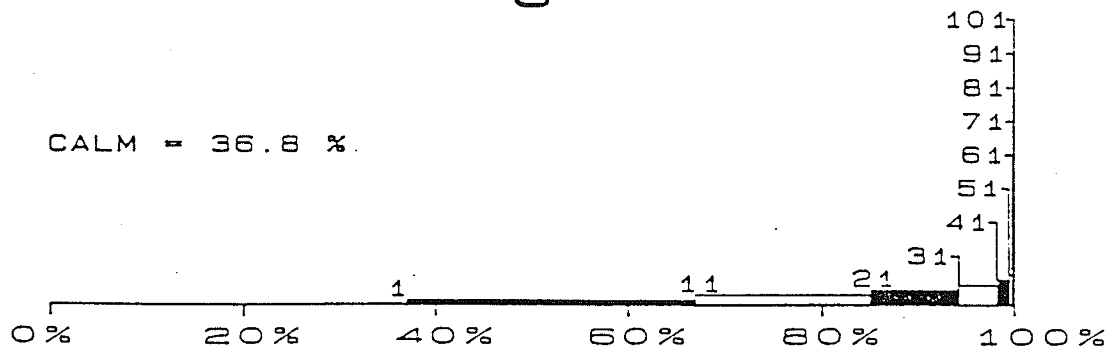


DISTRIBUTION OF WIND SPEED (KM/H)

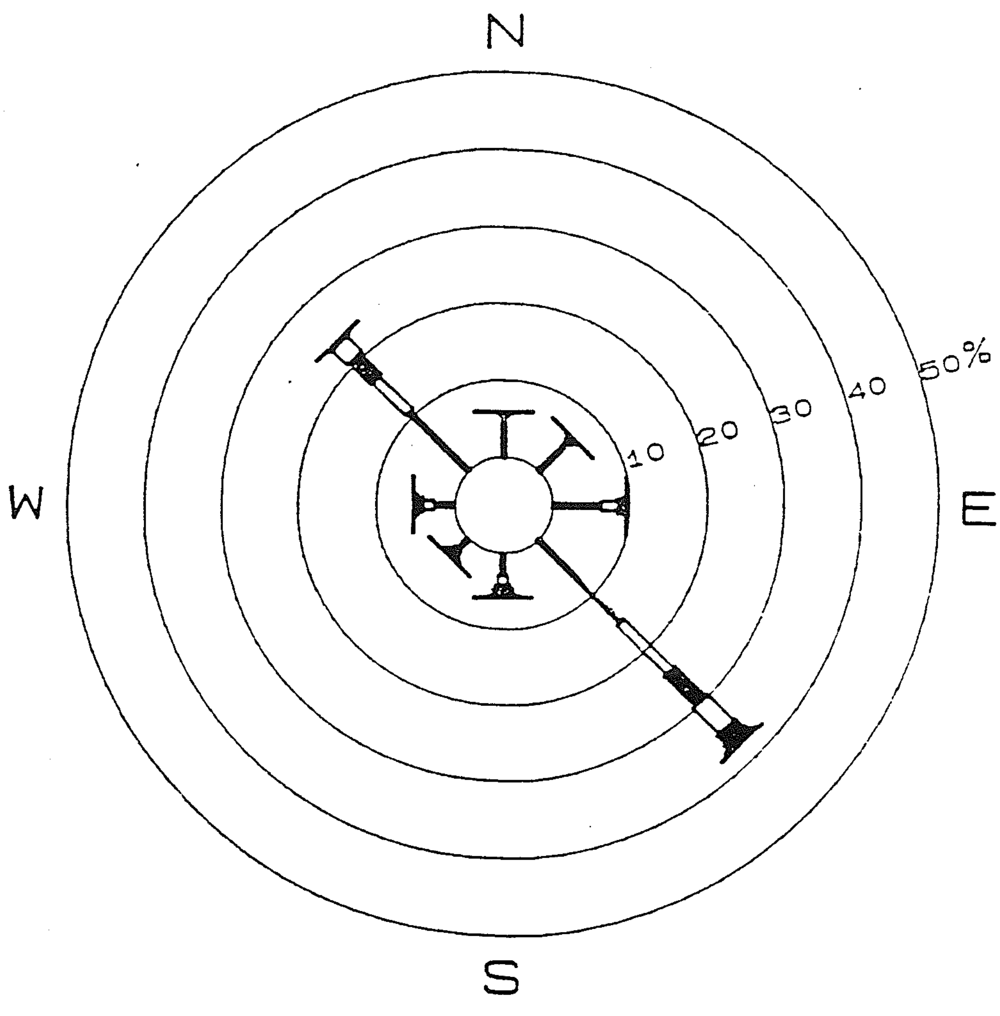
ENVIRONMENT CANADA

ATMOSPHERIC ENVIRONMENT SERVICE
PACIFIC REGION

FREQUENCY OF WIND SPEED BY DIRECTION

PACHENA POINT

1953 - 1958



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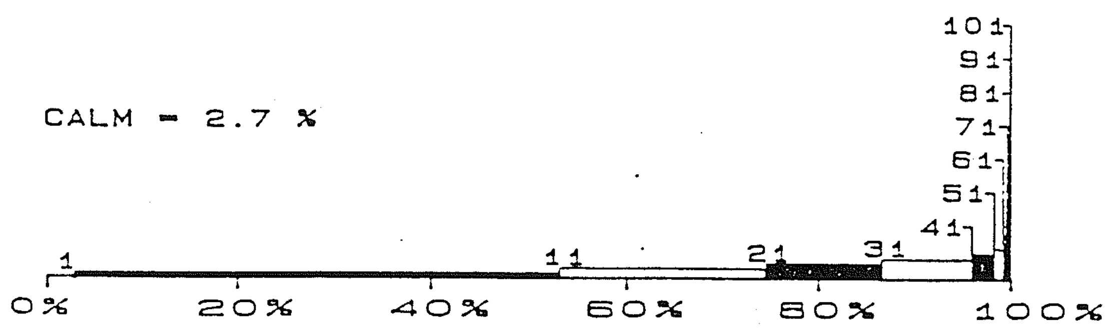


DISTRIBUTION OF WIND SPEED (KM/H)

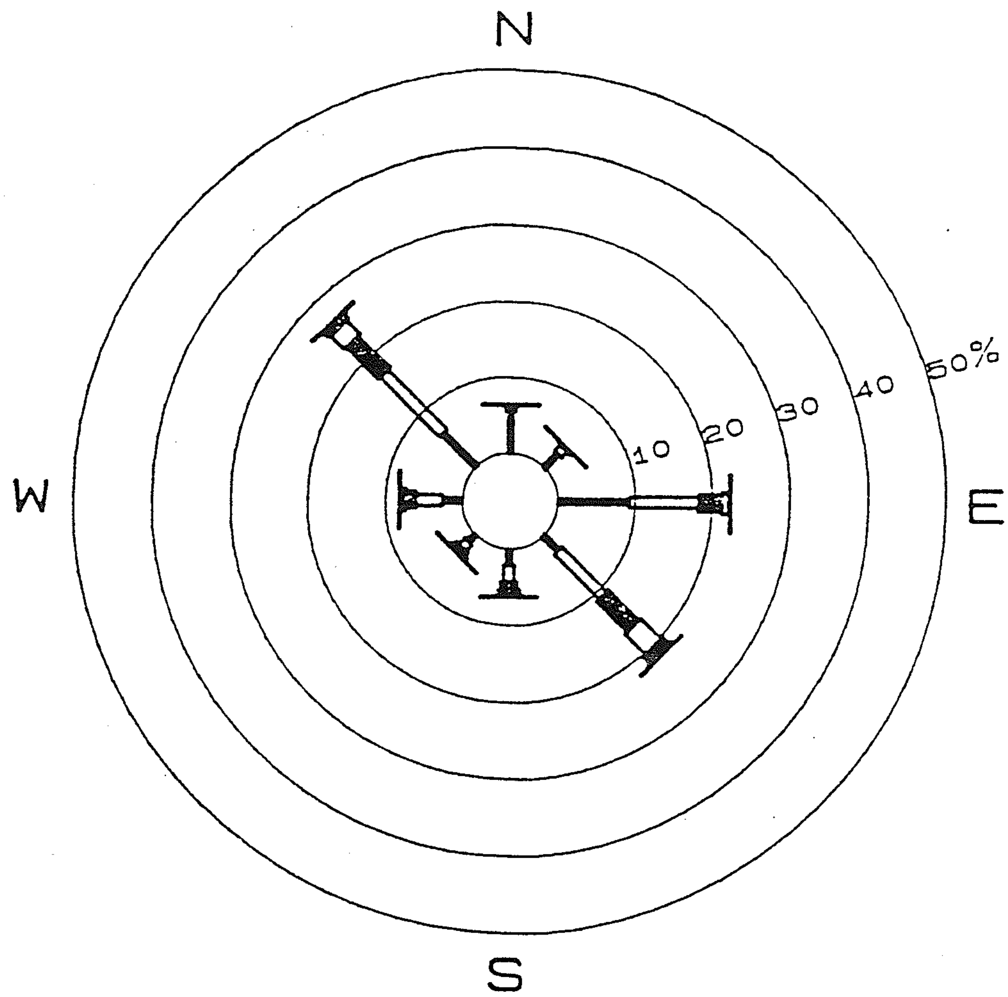
ENVIRONMENT
CANADA

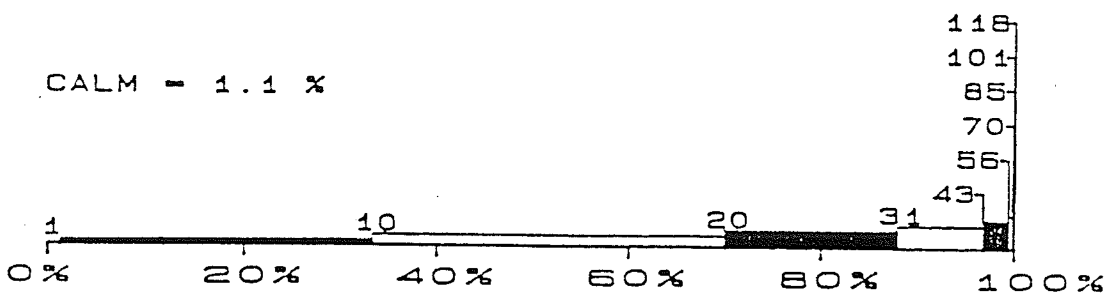
ATMOSPHERIC ENVIRONMENT SERVICE
PACIFIC REGION

FREQUENCY OF WIND SPEED BY DIRECTION

AMPHITRITE POINT

1970 - 1977





DISTRIBUTION OF WIND SPEED (KM/H)

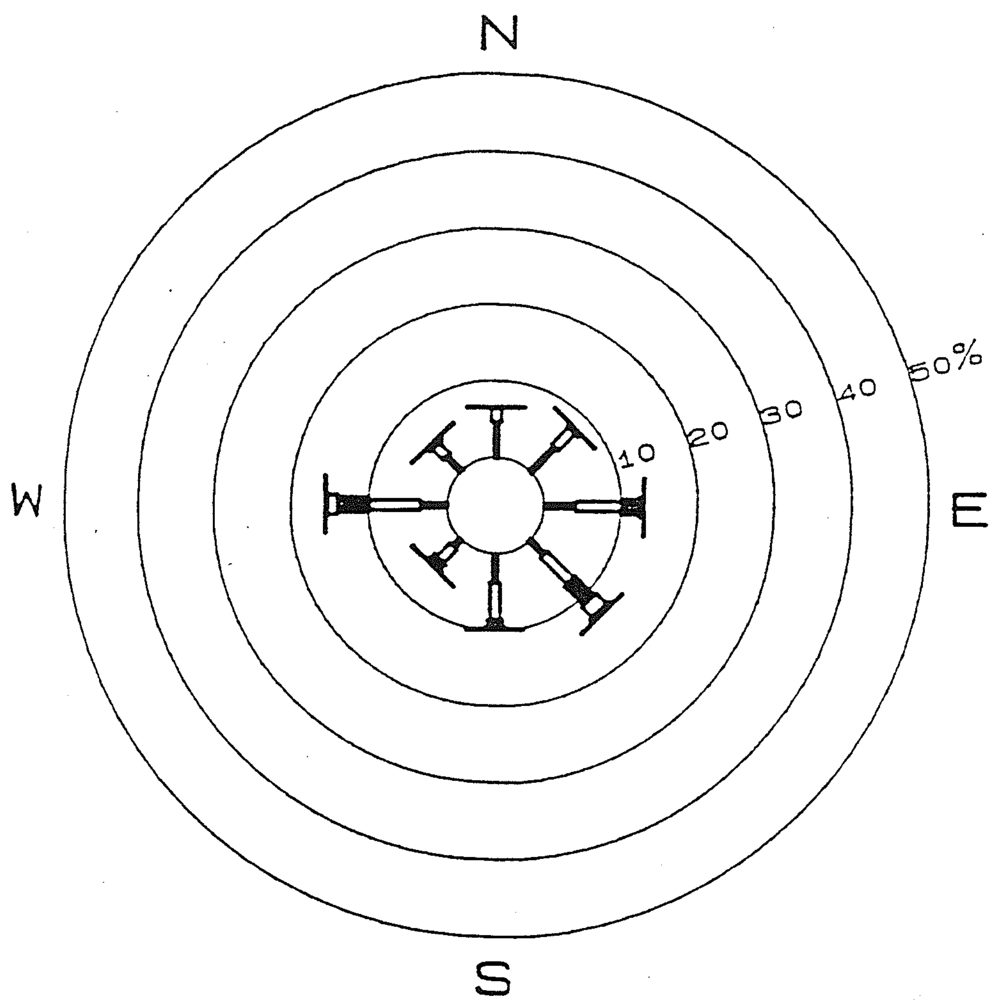
ENVIRONMENT CANADA

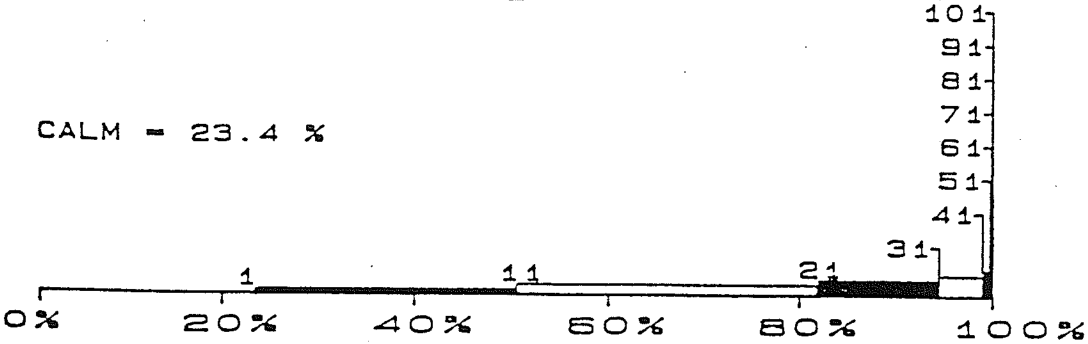
ATMOSPHERIC ENVIRONMENT SERVICE
PACIFIC REGION

FREQUENCY OF WIND SPEED BY DIRECTION

TOFINO A

1960 – 1982





DISTRIBUTION OF WIND SPEED (KM/H)

VICTORIA MARINE B.C.

PERIOD 1967-80 PERIODE

Lat. 48°22'N Long. 123°45'W

Elevation 32 m Altitude

PERCENTAGE FREQUENCY / FRÉQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	N
NNE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NNE
NE	17.2	12.7	6.4	3.4	1.7	1.0	0.7	0.8	2.3	4.7	13.2	14.1	6.5	NE
ENE	0.5	0.6	0.8	0.7	0.2	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	ENE
E	32.2	28.8	29.1	22.7	5.8	3.4	2.6	3.1	13.6	22.2	32.9	32.0	19.1	E
ESE	0.2	0.5	0.1	0.1	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.1	ESE
SE	0.0	0.3	0.2	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	SE
SSE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	SSE
S	0.0	0.1	0.2	0.5	0.4	0.4	0.4	0.5	0.8	0.2	0.1	0.1	0.3	S
SSW	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	SSW
SW	0.5	0.9	1.5	1.3	1.4	2.0	1.9	2.4	2.0	1.1	0.9	0.7	1.4	SW
WSW	0.0	0.1	0.0	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	WSW
W	18.6	19.5	28.5	38.7	51.0	60.1	54.6	50.4	25.8	19.0	15.5	21.1	33.6	W
WNW	0.7	0.7	0.4	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.2	WNW
NW	0.3	0.2	0.4	0.6	0.2	0.1	0.1	0.1	0.0	0.1	0.2	0.2	0.2	NW
NNW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	NNW
Calm	29.7	35.5	32.3	31.3	38.9	32.7	39.2	42.5	55.0	52.2	36.8	31.2	38.1	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	12.0	6.0	8.1	11.2	9.6	6.0	0.0	0.0	3.8	6.7	8.6	15.8	7.3	N
NNE	0.0	5.0	0.0	0.0	0.0	4.0	0.0	6.0	0.0	0.0	0.0	0.0	1.3	NNE
NE	13.7	14.9	12.4	10.4	9.4	10.4	8.4	8.2	10.7	10.6	13.1	12.7	11.2	NE
ENE	11.9	12.0	23.1	24.9	7.9	9.3	10.5	0.0	7.7	9.5	13.6	8.9	11.6	ENE
E	14.6	12.1	13.1	13.4	8.4	8.1	7.9	9.0	10.5	10.1	12.3	12.4	11.0	E
ESE	15.1	8.3	6.6	9.1	5.0	6.0	3.0	6.0	9.4	13.6	0.0	9.3	7.6	ESE
SE	23.7	9.8	6.4	10.8	12.0	7.3	5.9	7.9	6.9	12.1	7.9	8.9	10.0	SE
SSE	0.0	0.0	0.0	0.0	3.0	0.0	2.0	0.0	0.0	0.0	10.0	0.0	1.3	SSE
S	10.0	6.6	5.9	6.3	6.8	8.0	7.1	6.6	7.0	4.6	15.6	7.8	7.7	S
SSW	0.0	0.0	0.0	6.0	5.0	8.0	9.7	22.0	4.6	0.0	8.0	0.0	5.3	SSW
SW	19.3	17.3	12.7	10.8	11.9	11.6	10.2	9.3	8.7	12.6	16.0	24.1	13.7	SW
WSW	21.4	17.1	10.8	8.3	13.4	9.3	12.7	10.1	4.3	13.3	0.0	36.0	13.1	WSW
W	20.1	18.4	18.9	16.9	17.2	17.7	17.6	15.5	13.2	14.7	18.8	21.1	17.5	W
WNW	21.2	25.1	16.1	12.1	9.0	14.0	9.7	9.0	5.3	16.0	3.0	10.3	12.6	WNW
NW	16.0	13.5	9.6	12.9	10.6	9.3	12.3	9.3	10.6	12.0	14.2	11.4	11.8	NW
NNW	0.0	5.0	3.0	9.5	0.0	0.0	0.0	0.0	0.0	13.0	0.0	0.0	2.5	NNW
All Directions / Toutes directions	11.2	9.5	10.5	10.5	9.7	11.3	10.1	8.4	5.4	5.8	8.9	10.5	9.3	
Maximum Hourly Speed / Vitesse horaire maximale	64 W	74 W	111 W	71 W	74 W	74 W	65 W	65 W	59 W	60 W	74 W	102 W	111 W	
Maximum Gust Speed / Vitesse maximale des rafales	M M	64 NE	M M	M M	M M	M M	M M	M M	M M	M M	M M	M M	64 NE	

Height of anemometer 10.0 m hauteur de l'anemomètre

STATION INFORMATION

Poor but best available site at this location. Station is located on the SE end of Vancouver Island on a point of land on the North side of Sooke Harbour. Site is surrounded on all sides by a dense forest of trees to 25 m high. The clearing is 90 x 800 m in size with the thickest part of the forest in the south to west quad blocking the prevailing winds from Juan de Fuca Strait.

DONNÉES RELATIVES A LA STATION

L exposition est assez mauvaise mais il s agit du meilleur emplacement disponsible dans cette region. La station se trouve a l extremite sud-est de l'île de Vancouver sur une pointe de terre du côte nord de Sooke Harbour. L emplacement est entouré de toutes parts par une forêt epaise composée d'arbres de 25 m de haut. La clairire mesure 90 x 800 m; la forêt la plus épaisse se trouve dans le sud-ouest et bloque les vents dominants du detroit de Juan de Fuca.

WILLIAMS LAKE A B.C.

PERIOD 1961-80 PERIODE

Lat. 52°11'N Long. 122°04'W

Elevation 940 m Altitude

PERCENTAGE FREQUENCY / FRÉQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	5.4	4.0	3.9	5.7	6.9	6.9	8.3	7.8	5.0	2.7	3.4	4.2	5.4	N
NNE	0.9	0.9	1.0	1.5	2.1	2.3	2.8	2.3	1.6	0.7	0.7	0.5	1.4	NNE
NE	0.4	0.4	0.4	0.9	1.3	1.7	1.7	1.7	0.9	0.5	0.3	0.4	0.9	NE
ENE	0.2	0.4	0.5	0.9	1.2	1.4	1.5	1.5	0.9	0.5	0.3	0.3	0.8	ENE
E	0.7	0.6	1.3	1.7	2.3	2.1	2.5	2.3	1.9	1.5	0.8	0.6	1.5	E
ESE	1.9	3.2	3.7	3.8	3.3	3.0	3.3	3.4	4.0	3.8	3.4	2.3	3.3	ESE
SE	21.2	24.3	20.8	16.8	11.4	9.5	8.9	10.0	17.2	28.5	30.0	27.0	18.8	SE
SSE	16.8	16.0	14.5	11.7	8.1	6.4	5.5	5.9	10.4	19.4	19.1	18.9	12.7	SSE
S	4.9	5.4	6.2	5.6	5.5	4.8	4.6	3.9	4.4	4.9	5.0	5.2	5.0	S
SSW	1.1	1.1	1.6	2.2	3.0	2.6	2.6	2.3	1.7	1.3	1.2	1.0	1.8	SSW
SW	1.1	1.5	1.9	2.9	3.4	3.6	3.3	2.6	1.9	1.4	1.1	0.9	2.1	SW
WSW	1.0	1.4	2.0	3.0	3.5	3.6	3.2	2.9	1.8	1.4	0.9	0.8	2.1	WSW
W	1.8	2.0	3.0	4.6	5.4	5.6	4.6	4.2	2.8	2.3	1.7	1.6	3.3	W
WNW	2.1	2.1	3.1	3.5	4.2	4.4	3.1	3.2	2.8	1.9	1.8	2.0	2.9	WNW
NW	6.9	5.4	7.8	8.3	8.3	8.8	6.5	6.3	6.9	4.0	4.7	5.7	6.6	NW
NNW	8.6	6.3	6.5	7.8	8.1	9.1	9.5	8.8	7.6	4.2	5.5	6.4	7.4	NNW
Calm	25.0	25.0	21.8	19.1	22.0	24.2	28.1	30.9	28.2	21.0	20.1	22.2	24.0	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMÈTRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	9.5	10.8	11.8	11.9	11.9	12.0	11.2	10.8	10.0	10.8	10.0	11.0	11.0	N
NNE	7.4	8.9	9.4	10.9	11.2	9.7	10.1	8.9	8.9	8.3	7.4	8.4	9.1	NNE
NE	6.6	7.1	8.3	10.4	10.2	9.5	9.1	8.6	7.2	6.9	6.1	6.5	8.0	NE
ENE	6.2	7.9	8.2	8.4	10.5	8.8	9.4	8.1	7.4	7.6	7.2	6.5	8.0	ENE
E	9.1	8.8	9.1	10.9	10.6	9.3	9.8	8.8	9.1	8.4	8.4	8.6	9.2	E
ESE	10.6	11.6	12.1	13.5	13.3	11.2	11.5	10.2	11.3	10.8	11.4	12.0	11.6	ESE
SE	16.2	17.3	17.8	16.6	15.4	13.8	12.8	12.0	13.3	15.9	16.6	18.1	15.5	SE
SSE	15.8	17.2	17.3	16.1	15.9	13.4	13.1	11.9	14.3	17.3	17.7	17.5	15.6	SSE
S	11.5	14.5	15.0	12.9	13.5	11.0	10.5	9.6	10.8	11.4	12.1	13.4	12.2	S
SSW	8.3	8.7	10.1	11.9	11.8	10.1	9.8	8.1	8.5	9.3	8.2	8.5	9.4	SSW
SW	6.5	7.8	9.7	11.0	10.1	9.2	9.1	8.4	7.6	8.0	7.5	6.8	8.5	SW
WSW	7.4	8.6	9.3	10.4	10.4	9.7	9.4	8.8	8.5	8.8	8.8	7.2	8.9	WSW
W	9.6	11.7	10.9	11.7	11.0	11.3	10.0	9.6	10.1	11.0	10.7	10.3	10.7	W
WNW	11.7	13.6	13.6	13.4	12.1	12.3	10.9	10.3	11.5	11.8	12.5	12.0	12.1	WNW
NW	14.0	13.3	15.5	15.0	14.1	13.5	11.4	12.4	13.3	13.6	13.8	13.4	13.6	NW
NNW	11.7	12.2	14.5	13.5	13.3	13.1	12.0	12.5	12.4	12.9	13.1	11.8	12.8	NNW
All Directions / Toutes directions	10.1	11.1	11.8	11.3	10.2	9.1	8.0	7.4	8.5	11.3	11.9	11.9	10.2	
Maximum Hourly Speed / Vitesse horaire maximale	60 SSE	72 SE	72 SE	61 ESE	56 SVL	56 NW	56 SE	64 SSE	53 SE	55 SVL	64 SVL	68 SE	72 SE	
Maximum Gust Speed / Vitesse maximale des rafales	90 SE	90 SE	92 SE	81 SSW	74 S	83 W	97 WNW	74 W	84 SE	100 WNW	93 SSE	89 SE	100 WNW	

Height of anemometer 10.1 m hauteur de l'anemomètre

STATION INFORMATION

The surrounding country is hilly with airport located on the top of one of the hills. The winds are unaffected except some local effect caused by dense stands of tall trees surrounding the airport.

DONNEES RELATIVES A LA STATION

La région environnante est accidentée. L'aéroport se trouve au sommet d'une colline. Les vents ne sont pas affectés sauf de façon locale par d'épais bouquets de trs hauts arbres entourant l aeroport

TERRACE A B.C.

PERIOD 1955-80 PERIODE

Lat. 54°28'N Long. 128°35'W

Elevation 217 m Altitude

PERCENTAGE FREQUENCY / FRÉQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	33.8	26.5	17.4	10.8	8.5	4.9	4.7	7.3	12.8	13.3	24.4	26.5	15.9	N
NNE	15.4	10.1	6.5	4.0	3.0	1.7	1.7	2.7	6.1	6.5	9.9	12.5	6.7	NNE
NE	2.9	2.7	2.6	1.9	1.3	0.7	0.8	1.0	1.8	2.3	2.7	3.6	2.0	NE
ENE	1.1	1.3	1.2	1.1	0.6	0.4	0.4	0.4	0.7	0.9	1.1	1.1	0.8	ENE
E	1.1	1.6	1.9	1.6	1.3	0.9	0.9	1.0	1.4	1.9	2.0	2.0	1.5	E
ESE	0.8	1.2	1.8	1.8	1.7	1.5	1.5	1.5	1.6	2.2	1.9	1.5	1.6	ESE
SE	2.2	3.2	5.1	6.1	6.1	6.3	5.0	5.0	4.8	5.6	4.1	3.2	4.7	SE
SSE	4.2	6.7	8.4	14.1	14.9	15.7	14.1	14.2	10.6	10.9	6.0	4.9	10.4	SSE
S	9.5	13.5	16.6	21.8	23.2	26.7	26.7	25.6	18.3	18.5	13.1	11.0	18.7	S
SSW	2.6	3.1	3.6	4.5	4.6	5.3	5.6	5.7	4.9	5.5	3.9	3.4	4.4	SSW
SW	1.4	1.6	1.9	3.0	3.3	3.6	3.4	2.8	2.6	2.4	1.7	1.8	2.4	SW
WSW	0.7	0.8	1.5	2.3	3.4	3.4	2.9	2.4	1.8	1.7	0.9	0.9	1.9	WSW
W	0.8	0.9	2.3	3.6	5.2	6.3	6.5	5.0	3.2	2.2	1.1	1.0	3.2	W
WNW	0.3	0.5	1.2	1.5	2.0	2.7	3.0	2.6	1.6	1.0	0.5	0.5	1.4	WNW
NW	1.1	1.4	2.0	2.6	2.8	3.1	3.0	2.3	2.5	1.4	1.5	1.1	2.1	NW
NNW	3.8	3.4	3.5	2.6	2.8	2.2	2.2	2.5	2.8	2.5	3.7	2.4	2.9	NNW
Calm	18.3	21.5	22.5	16.7	15.3	14.6	17.6	18.0	22.5	21.2	21.5	22.6	19.4	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMETRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	26.4	23.6	17.7	15.4	14.2	13.0	12.1	13.4	15.2	17.7	21.4	24.3	17.9	N
NNE	25.2	20.5	16.5	14.6	13.1	12.1	11.9	12.5	13.8	16.3	20.4	21.5	16.5	NNE
NE	16.0	13.6	13.7	11.8	9.9	8.4	9.1	8.3	9.7	11.1	10.9	13.1	11.3	NE
ENE	13.1	11.2	10.6	10.8	8.5	8.6	7.0	7.5	7.7	8.6	9.6	10.4	9.5	ENE
E	9.6	9.2	9.0	9.6	8.8	8.1	8.0	7.7	7.3	8.3	7.6	7.9	8.4	E
ESE	9.5	9.7	11.8	12.0	13.2	12.4	11.4	11.8	9.6	9.4	9.9	10.0	10.9	ESE
SE	14.3	16.2	16.7	17.4	17.5	17.9	17.5	16.0	14.1	14.9	13.6	15.8	16.0	SE
SSE	23.9	22.8	21.3	22.2	21.5	21.3	20.8	19.9	19.6	21.8	20.2	22.8	21.5	SSE
S	22.0	23.6	20.4	20.8	20.7	20.0	19.7	19.5	19.3	21.0	21.8	21.7	20.9	S
SSW	16.4	17.1	15.6	15.5	15.0	15.0	15.3	15.9	15.5	16.6	17.2	17.1	16.0	SSW
SW	13.0	14.5	13.8	14.7	14.0	13.4	12.6	11.8	13.9	13.1	13.1	14.3	13.5	SW
WSW	11.0	13.4	13.0	14.5	16.2	16.0	14.3	13.0	13.1	12.6	12.6	13.3	13.6	WSW
W	8.8	9.5	10.6	12.1	12.9	13.4	12.0	11.2	9.5	9.2	8.4	9.2	10.6	W
WNW	8.0	7.4	9.2	10.0	10.4	11.0	9.6	9.4	8.2	7.9	7.6	7.9	8.9	WNW
NW	15.3	13.9	10.6	11.1	10.3	9.2	8.7	9.0	10.2	10.0	12.8	10.2	10.9	NW
NNW	21.0	18.3	14.4	12.6	12.0	10.2	9.8	10.7	11.1	13.1	16.8	16.1	13.8	NNW
All Directions / Toutes directions	18.7	16.1	13.1	14.3	14.4	14.5	13.4	13.1	11.9	13.4	14.5	15.6	14.4	
Maximum Hourly Speed / Vitesse horaire maximale	72 SVL	80 S	89 SSE	64 SVL	68 S	80 S	64 SVL	61 S	68 S	68 SVL	80 S	80 SSE	89 SSE	
Maximum Gust Speed / Vitesse maximale des rafales	113 SE	92 N	98 SSE	97 SSE	105 SSE	116 WSW	89 SVL	89 SSE	92 SSE	113 SSE	121 SE	121 SSE	121 SVL	

Height of anemometer 10.1 m hauteur de l'anémomètre

STATION INFORMATION

Situated on a large ledge of flat land 150 m above Skeena River, completely surrounded by hills and mountains. Valley to the south, ending in Douglas Channel, causes a funnelling effect, giving strong south winds from storms in Gulf of Alaska and strong north winds from Arctic outbreaks. Wind rarely blows from east or west.

DONNÉES RELATIVES À LA STATION

La station est située sur une vaste corniche plate, s'élevant à 150 m au-dessus de la rivire Skeena, compltement entourée de collines et de montagnes. La vallee, au sud, débouchant dans le Chenal Douglas, provoque un effet d'entonnoir qui donne naissance à de violents vents de sud causés par des tempetes dans le golfe d'Alaska et à desvionlents vents du nord dus aux invasions d'air froid de l'Arctique. Le vent souffle rarement de l'est ou de l'ouest.

TOFINO A B.C.

PERIOD 1960-80 PERIODE

Lat. 49°05'N Long. 125°46'W

Elevation 20 m Altitude

PERCENTAGE FREQUENCY / FREQUENCE EN %

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	4.8	4.9	5.4	4.4	3.1	1.3	1.1	1.7	5.0	4.5	5.2	5.1	3.9	N
NNE	4.7	4.2	4.7	3.1	2.1	0.7	0.6	1.0	2.3	3.8	5.2	5.0	3.1	NNE
NE	7.7	5.7	4.9	3.2	2.4	0.9	0.6	0.8	1.6	3.6	7.5	7.0	3.8	NE
ENE	9.1	7.4	5.6	4.6	2.3	1.2	0.7	1.2	1.8	4.8	8.6	9.3	4.7	ENE
E	14.0	12.9	11.0	7.8	5.0	3.0	2.3	2.9	4.1	9.3	13.9	15.4	8.5	E
ESE	5.0	6.0	5.5	4.5	3.1	2.4	2.7	2.6	3.7	7.0	6.3	6.0	4.6	ESE
SE	7.0	9.7	8.6	8.3	6.4	7.4	6.9	8.8	9.6	14.0	8.8	7.6	8.6	SE
SSE	3.1	4.7	4.5	5.6	5.3	6.6	6.5	7.5	5.9	5.0	3.6	3.2	5.1	SSE
S	3.3	4.6	6.4	8.1	10.0	10.3	12.1	11.6	9.3	6.0	2.9	3.0	7.3	S
SSW	0.9	1.3	2.0	2.4	3.2	3.1	2.9	2.5	2.6	1.3	0.9	1.0	2.0	SSW
SW	3.0	2.8	3.7	3.7	4.2	3.7	3.6	2.6	2.3	2.0	2.0	3.0	3.1	SW
WSW	1.4	1.5	2.0	2.7	3.0	3.1	2.3	2.1	1.3	1.4	1.1	1.3	1.9	WSW
W	4.1	4.3	6.6	9.4	12.5	15.0	13.2	10.1	7.0	4.9	3.6	3.3	7.8	W
WNW	3.8	4.9	5.8	8.4	11.1	13.3	12.8	10.2	7.1	4.7	3.8	3.8	7.5	WNW
NW	3.3	2.9	3.9	3.7	4.9	5.9	5.7	5.3	4.6	3.4	3.2	3.1	4.2	NW
NNW	1.1	1.3	1.6	1.4	1.2	1.0	0.8	1.0	1.3	1.2	1.4	1.5	1.2	NNW
Calm	23.7	20.9	17.8	18.7	20.2	21.1	25.2	28.1	30.5	23.1	22.0	21.4	22.7	Calme

MEAN WIND SPEED IN KILOMETRES PER HOUR
VITESSE MOYENNE DES VENTS EN KILOMETRES PAR HEURE

	JAN JANV	FEB FEV	MAR MARS	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOUT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNUEL	
N	9.0	9.5	9.3	9.4	8.7	7.1	8.4	7.8	8.0	8.5	9.5	9.4	8.7	N
NNE	9.7	10.0	9.9	9.7	8.8	7.7	7.8	8.4	8.6	9.5	9.4	10.1	9.1	NNE
NE	10.8	11.5	10.6	9.3	8.5	7.4	7.6	7.7	7.9	9.3	10.7	10.5	9.3	NE
ENE	12.1	11.9	12.6	11.2	10.0	8.6	8.1	8.4	9.2	11.7	12.5	12.7	10.8	ENE
E	14.0	14.3	15.8	13.7	12.0	11.2	9.3	9.5	11.1	14.0	15.3	15.5	13.0	E
ESE	18.7	19.3	21.0	19.5	16.7	15.6	15.6	13.8	15.9	20.4	21.2	21.6	18.3	ESE
SE	24.6	24.4	25.5	23.1	19.7	18.1	16.3	16.2	19.2	24.4	26.8	27.8	22.2	SE
SSE	23.6	21.7	22.7	20.9	18.3	16.7	14.2	14.2	14.6	19.5	22.5	25.9	19.6	SSE
S	20.9	16.1	17.2	16.2	14.4	12.8	12.0	11.6	11.5	13.1	18.0	21.8	15.5	S
SSW	18.5	16.5	14.8	14.1	14.1	13.7	12.9	11.9	11.8	12.2	17.6	18.9	14.8	SSW
SW	20.9	18.8	16.8	17.2	15.0	14.7	13.5	12.4	11.5	15.1	21.3	21.6	16.6	SW
WSW	21.3	18.9	17.5	17.6	17.1	16.0	14.9	14.0	13.3	17.6	18.1	19.6	17.2	WSW
W	20.4	20.1	19.3	20.2	19.2	18.8	17.1	15.6	16.0	16.7	18.5	20.4	18.5	W
WNW	19.7	21.9	20.4	21.5	20.0	19.0	17.3	16.4	17.9	18.2	19.2	19.0	19.2	WNW
NW	14.2	15.6	15.7	13.8	12.4	12.0	11.3	11.4	11.4	12.4	13.7	14.1	13.2	NW
NNW	10.0	10.1	9.5	9.2	8.8	8.3	8.0	8.4	8.4	9.3	9.2	9.7	9.1	NNW
All Directions / Toutes directions	12.1	13.1	13.9	13.7	12.6	12.4	10.8	9.7	9.5	12.5	12.8	13.3	12.2	
Maximum Hourly Speed / Vitesse horaire maximale	74 WSW	77 SE	72 SSE	64 SVL	64 SVL	64 SE	50 SVL	56 SSE	80 SE	77 SSE	100 SSE	80 SE	100 SSE	
Maximum Gust Speed / Vitesse maximale des rafales	129 W	111 SE	108 ESE	95 SE	90 SE	80 SE	80 SE	74 WNW	113 SE	113 SSE	117 SSE	130 SE	130 SE	

Height of anemometer 18.9 m hauteur de l'anemometre

STATION INFORMATION

The site is located on the Estowista Peninsula on the west coast of Vancouver Island. Immediate airport surroundings are heavily wooded and anemometer is 20 m above ground for improved exposure. Site is open to the sea southeast to west, partly sheltered with inlets and islands west through north to northeast and sheltered northeast to southeast by hills and higher ground.

DONNEES RELATIVES A LA STATION

L'emplacement se trouve dans la Peninsule d'Eastowista, sur la cote ouest de l'île de Vancouver. Les abords de l'aeroport etant trs boises, on a place l'anemometre a 20 m au-dessus du sol pour en ameliorer l'exposition. Le lieu est expose a la mer du sud-est a l'ouest. Il est en partie abrite par des petits bras de mer et des îles de l'ouest au nord-est en passant le nord, et abrite du nord-est au sud-est par des collines et un terrain plus eleve.

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

VICTORIA LANSDOWNE
48° 26'N 123° 19'W 29 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature	6.2	8.2	9.7	12.9	16.5	19.1	21.8	21.5	18.7	13.9	9.3	7.3	13.8	8	Température Maximale Quotidienne
Daily Minimum Temperature	1.4	2.3	2.5	4.4	6.9	9.4	10.6	10.5	8.5	6.3	4.0	2.5	5.8	8	Température Minimale Quotidienne
Daily Temperature	3.8	5.2	6.1	8.6	11.7	14.3	16.2	16.0	13.6	10.1	6.7	5.0	9.6	8	**Température Quotidienne**
Standard Deviation, Daily Temperature	1.9	1.8	1.1	1.0	1.4	1.3	1.5	1.0	0.9	0.5	1.5	1.0	0.8	6	Écart Type de la Temperature Quotidienne
Extreme Maximum Temperature	13.3	13.9	16.7	21.1	27.8	30.0	35.0	32.2	27.3	21.1	16.7	13.9	35.0		Température Maximale Extrême
Years of Record	9	9	9	9	9	9	8	8	8	6	8	7			Années de Relèves
Extreme Minimum Temperature	−12.2	−10.0	−7.8	−1.7	−1.7	3.3	6.1	5.6	2.2	−0.6	−13.3	−8.3	−13.3		Température Minimale Extrême
Years of Record	9	9	9	9	9	9	8	9	8	6	8	7			Années de Relèves
Rainfall	100.2	73.2	45.2	27.3	18.7	21.7	13.5	18.1	33.1	60.9	91.3	110.3	613.5	8	Chutes de Pluie
Snowfall	8.8	2.9	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	5.0	19.7	8	Chutes de Neige
Total Precipitation	109.4	77.4	46.1	27.6	18.7	21.7	13.5	18.1	33.1	60.9	93.1	116.2	635.8	8	**Précipitations Totales**
Standard Deviation, Total Precipitation	47.5	41.6	26.1	19.1	9.6	19.5	11.6	15.1	25.1	31.3	58.2	46.8	99.4	6	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	38.1	51.1	23.9	23.6	10.2	26.7	15.2	23.4	16.0	38.4	81.8	66.0	81.8		Chute de Pluie Record en 24 heures
Years of Record	9	8	9	9	7	9	8	8	7	8	8	6			Années de Relèves
Greatest Snowfall in 24 hours	22.9	15.2	14.7	8.4	0.0	0.0	0.0	0.0	0.0	0.0	12.7	15.0	22.9		Chute de Neige Record en 24 heures
Years of Record	9	9	9	9	9	9	8	8	8	9	8	8			Années de Relèves
Greatest Precipitation in 24 hours	38.1	51.1	23.9	23.6	10.2	26.7	15.2	23.4	16.0	38.4	81.8	66.0	81.8		Précipitation Record en 24 heures
Years of Record	9	9	9	9	7	9	8	8	7	8	8	6			Années de Relèves
Days with Rain	16	14	12	9	7	7	5	6	8	13	16	18	131	8	Jours de Pluie
Days with Snow	2	1	1	0	0	0	0	0	0	0	0	1	5	8	Jours de Neige
Days with Precipitation	17	14	13	9	7	7	5	6	8	13	16	19	134	8	Jours de Précipitation

VICTORIA MARINE
48° 22'N 123° 45'W 32 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature	6.1	8.3	9.4	11.8	14.3	16.3	18.2	18.3	16.9	13.3	9.3	7.2	12.5	8	Température Maximale Quotidienne
Daily Minimum Temperature	1.3	2.4	2.4	4.2	6.6	8.8	9.8	10.1	9.0	6.5	3.9	2.5	5.6	8	Température Minimale Quotidienne
Daily Temperature	3.8	5.4	5.9	8.0	10.4	12.5	14.0	14.2	13.0	9.9	6.6	4.9	9.1	8	**Température Quotidienne**
Standard Deviation, Daily Temperature	1.7	1.2	0.9	0.8	0.8	0.9	0.6	0.8	0.9	0.7	0.9	1.6	0.3	5	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	13.3	15.0	15.6	22.2	23.9	29.3	29.4	28.6	27.2	20.9	19.4	15.9	29.4		Température Maximale Extrême
Years of Record	13	13	13	13	13	14	14	14	14	14	14	14			Années de Relèves
Extreme Minimum Temperature	−10.6	−4.4	−4.4	−2.2	0.0	3.3	5.0	4.4	1.7	−2.8	−3.9	−13.9	−13.9		Température Minimale Extrême
Years of Record	13	13	13	13	13	14	14	14	14	14	14	14			Années de Relèves
Rainfall	212.1	150.1	106.8	69.4	39.1	26.3	22.7	26.5	62.0	132.1	185.1	219.6	1251.8	8	Chutes de Pluie
Snowfall	11.1	3.9	8.3	0.9	0.0	0.0	0.0	0.0	0.0	0.0	1.4	7.9	33.5	8	Chutes de Neige
Total Precipitation	225.0	155.5	114.4	70.7	39.1	26.3	22.7	26.5	62.0	132.1	186.1	227.0	1287.4	8	**Précipitations Totales**
Standard Deviation, Total Precipitation	78.3	62.9	45.6	36.7	18.8	14.6	21.6	34.1	38.6	97.0	81.8	81.3	222.6	5	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	61.0	59.4	106.7	38.9	18.5	25.9	42.7	23.1	39.4	44.7	84.6	100.8	106.7		Chute de Pluie Record en 24 heures
Years of Record	13	13	13	13	13	14	14	13	13	13	14	14			Années de Relèves
Greatest Snowfall in 24 hours	21.6	8.4	7.9	2.8	0.0	0.0	0.0	0.0	0.0	0.0	6.1	16.5	21.6		Chute de Neige Record en 24 heures
Years of Record	13	13	12	13	13	14	14	13	13	13	13	14			Années de Relèves
Greatest Precipitation in 24 hours	61.0	59.4	106.7	38.9	18.5	25.9	42.7	23.1	39.4	44.7	84.6	100.8	106.7		Précipitation Record en 24 heures
Years of Record	13	13	13	13	13	14	14	13	13	13	14	14			Années de Relèves
Days with Rain	20	16	16	14	10	8	5	7	11	16	21	21	165	8	Jours de Pluie
Days with Snow	4	1	3	1	0	0	0	0	0	0	0	3	12	8	Jours de Neige
Days with Precipitation	21	16	18	14	10	8	5	7	11	16	21	22	169	8	Jours de Précipitation

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

ALTA LAKE 2
50° 9'N 122° 59'W 640 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature															Température Maximale Quotidienne
Daily Minimum Temperature															Température Minimale Quotidienne
Daily Temperature															**Température Quotidienne**
Standard Deviation, Daily Temperature															Écart Type de la Température Quotidienne
Extreme Maximum Temperature															Température Maximale Extrême
Years of Record															Années de Relèves
Extreme Minimum Temperature															Température Minimale Extrême
Years of Record															Années de Relèves
Rainfall	58.2	44.2	48.0	55.4	45.1	55.1	39.8	51.3	83.1	158.3	113.3	85.1	836.9	8	Chutes de Pluie
Snowfall	176.1	104.9	70.9	18.2	1.0	0.0	0.0	0.0	0.2	10.4	79.8	147.1	608.6	8	Chutes de Neige
Total Precipitation	**221.0**	**142.2**	**116.0**	**76.4**	**46.0**	**55.1**	**39.8**	**51.3**	**83.3**	**176.6**	**189.2**	**223.4**	**1420.3**	**8**	**Précipitations Totales**
Standard Deviation, Total Precipitation	84.3	60.8	42.9	40.1	24.6	34.7	28.6	27.6	40.3	74.6	70.7	62.5	190.9	4	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	61.0	55.9	48.0	56.4	39.9	40.1	38.6	45.7	48.0	78.0	60.7	75.4	78.0		Chute de Pluie Record en 24 heures
Years of Record	36	38	37	37	38	38	38	38	38	37	37	38			Années de Relèves
Greatest Snowfall in 24 hours	101.6	55.9	31.0	27.9	13.5	0.0	0.0	0.0	5.1	27.9	64.8	100.8	101.6		Chute de Neige Record en 24 heures
Years of Record	36	38	36	37	38	38	38	38	38	37	37	38			Années de Relèves
Greatest Precipitation in 24 hours	101.6	58.4	48.0	56.4	39.9	40.1	38.6	45.7	48.0	78.0	72.9	100.8	101.6		Précipitation Record en 24 heures
Years of Record	36	38	36	37	38	38	38	38	38	37	37	38			Années de Relèves
Days with Rain	7	8	9	10	10	11	8	10	11	16	13	10	123	8	Jours de Pluie
Days with Snow	16	11	11	4	0	0	0	0	0	2	9	16	69	8	Jours de Neige
Days with Precipitation	19	15	17	13	11	11	8	10	11	17	19	22	173	8	Jours de Précipitation

AMPHITRITE POINT
48° 55'N 125° 32'W 11 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature	6.9	8.5	9.3	11.2	13.5	15.4	17.0	17.2	16.4	13.3	9.9	7.7	12.2	8	Température Maximale Quotidienne
Daily Minimum Temperature	2.3	3.5	3.2	4.8	7.1	9.3	10.9	11.4	10.3	8.0	4.8	3.3	6.6	8	Temperature Minimale Quotidienne
Daily Temperature	**4.7**	**6.1**	**6.2**	**8.0**	**10.4**	**12.4**	**13.9**	**14.3**	**13.4**	**10.6**	**7.4**	**5.5**	**9.4**	**8**	**Température Quotidienne**
Standard Deviation, Daily Temperature	1.4	1.3	0.9	0.8	0.8	0.9	0.7	0.7	1.0	0.8	1.1	1.5	0.5	3	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	12.8	17.2	16.1	20.6	23.3	25.0	28.9	27.2	24.4	20.6	20.6	15.0	28.9		Température Maximale Extrême
Years of Record	20	20	21	21	20	20	20	20	20	20	20	20			Années de Relèves
Extreme Minimum Temperature	−7.2	−4.4	−2.8	−0.6	1.1	3.9	6.1	7.2	2.8	−0.6	−3.3	−11.7	−11.7		Température Minimale Extrême
Years of Record	20	20	21	21	20	20	20	20	20	20	20	20			Années de Relèves
Rainfall	393.1	344.2	338.1	203.5	130.0	92.1	72.6	113.1	161.0	359.1	393.6	440.3	3040.7	3	Chutes de Pluie
Snowfall	14.5	3.1	4.5	0.8	0.0	0.0	0.0	0.0	0.0	0.0	2.2	11.4	36.5	3	Chutes de Neige
Total Precipitation	**407.5**	**347.3**	**342.8**	**204.3**	**130.0**	**92.1**	**72.6**	**113.1**	**161.0**	**359.1**	**395.8**	**451.7**	**3077.3**	**3**	**Précipitations Totales**
Standard Deviation, Total Precipitation	169.0	154.0	131.6	79.2	63.3	46.6	70.4	79.2	78.4	188.1	128.0	125.3	402.8	3	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	138.2	118.9	117.6	65.5	67.3	38.4	109.5	85.9	75.9	121.9	110.2	155.4	155.4		Chute de Pluie Record en 24 heures
Years of Record	23	23	23	23	21	22	22	22	22	22	21	22			Années de Relèves
Greatest Snowfall in 24 hours	20.3	12.7	19.1	8.1	T	0.0	0.0	0.0	0.0	T	10.9	22.9	22.9		Chute de Neige Record en 24 heures
Years of Record	23	23	23	23	22	22	22	22	22	22	21	21			Années de Relèves
Greatest Precipitation in 24 hours	138.2	118.9	117.6	65.5	67.3	38.4	109.5	85.9	75.9	121.9	110.2	155.4	155.4		Précipitation Record en 24 heures
Years of Record	23	23	23	23	21	22	22	22	22	22	21	22			Années de Relèves
Days with Rain	20	19	19	17	14	11	9	12	12	19	21	22	195	3	Jours de Pluie
Days with Snow	2	1	1	*	0	0	0	0	0	0	*	2	6	3	Jours de Neige
Days with Precipitation	21	19	19	17	14	11	9	12	12	19	21	23	197	3	Jours de Precipitation

BRITISH COLUMBIA/COLOMBIE-BRITANNIQUE

TODAGIN RANCH

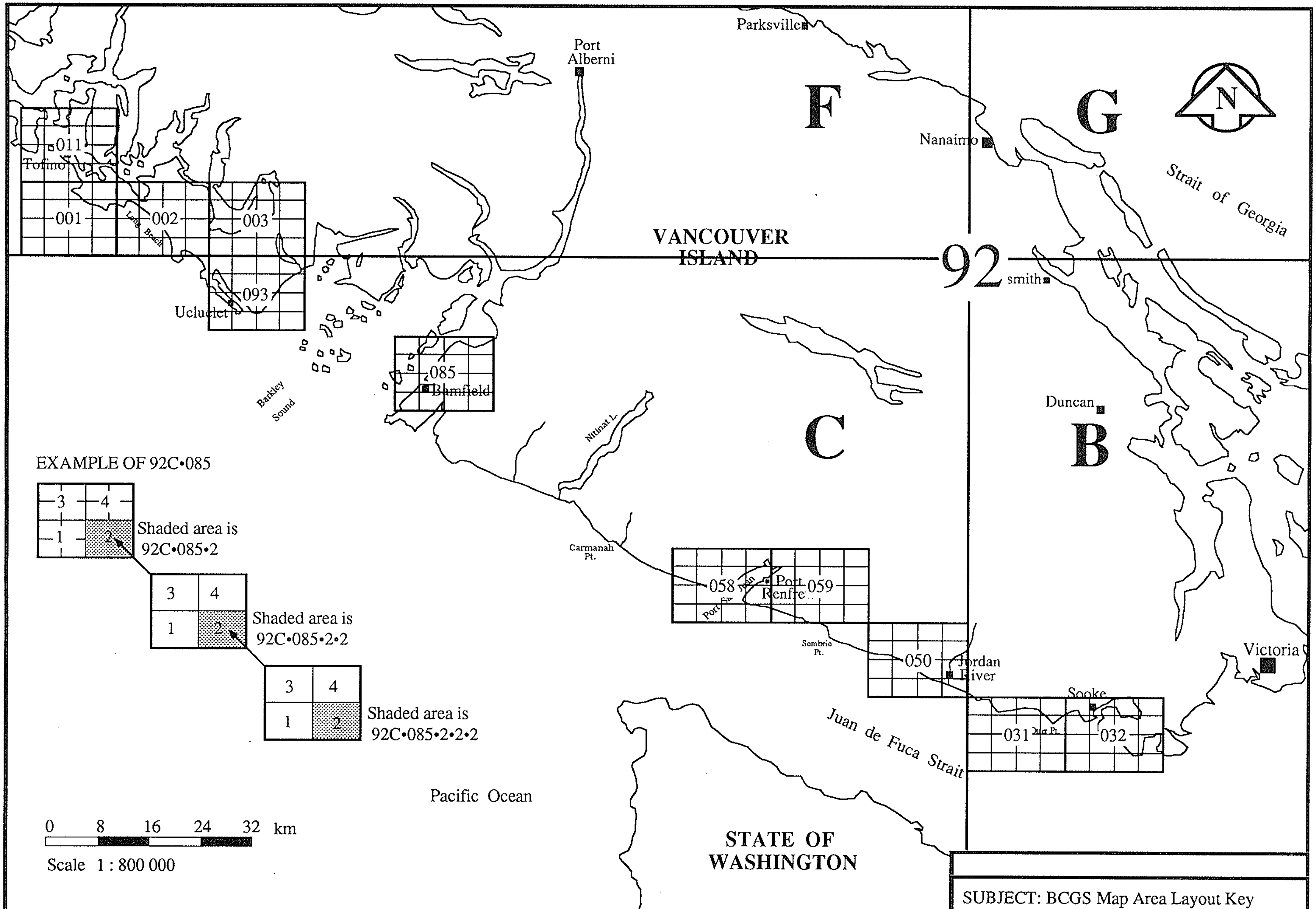
57° 36'N 130° 4'W 899 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature	−13.0	−3.5	0.3	6.4	12.0	16.8	18.6	17.9	12.3	5.4	−3.2	−8.4	5.1	8	Température Maximale Quotidienne
Daily Minimum Temperature	−24.2	−17.6	−13.9	−6.6	−2.3	1.2	3.9	3.1	0.0	−3.8	−13.2	−18.6	−7.7	8	Température Minimale Quotidienne
Daily Temperature	**−18.7**	**−10.6**	**−6.9**	**−0.1**	**4.9**	**9.0**	**11.2**	**10.5**	**6.2**	**0.8**	**−8.2**	**−13.5**	**−1.3**	**8**	**Température Quotidienne**
Standard Deviation, Daily Temperature	4.4	6.0	2.3	0.7	0.7	1.4	1.3	1.3	0.9	1.2	4.4	4.4	0.3	6	Ecart Type de la Température Quotidienne
Extreme Maximum Temperature	3.9	7.8	12.0	20.5	22.2	26.5	29.0	31.7	27.2	17.2	9.0	7.8	31.7		Température Maximale Extrême
Years of Record	7	7	7	5	7	7	7	7	8	8	8	8			Années de Relèves
Extreme Minimum Temperature	−46.1	−45.0	−39.4	−22.0	−8.9	−3.9	−3.3	−5.0	−9.5	−12.8	−38.3	−45.6	−46.1		Température Minimale Extrême
Years of Record	7	7	7	6	7	7	7	8	8	8	8	8			Années de Relèves
Rainfall	0.2	1.9	0.5	44.6	16.3	25.2	36.6	50.8	54.7	33.5	4.9	0.0	269.2	8	Chutes de Pluie
Snowfall	30.8	13.2	21.6	7.4	2.8	0.0	0.0	0.0	0.3	17.0	25.9	38.1	157.1	8	Chutes de Neige
Total Precipitation	**31.0**	**14.1**	**22.1**	**21.4**	**17.8**	**25.2**	**36.6**	**50.8**	**54.2**	**46.3**	**30.6**	**38.5**	**388.6**	**8**	**Précipitations Totales**
Standard Deviation, Total Precipitation	15.0	8.2	10.1	9.5	9.5	14.3	14.5	16.1	21.8	24.6	24.2	31.9	39.2	6	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	0.0	3.8	2.0	12.2	10.4	22.9	20.3	32.0	14.7	21.4	14.7	T	32.0		Chute de Pluie Record en 24 heures
Years of Record	6	7	7	5	7	7	6	8	8	8	8	8			Années de Relèves
Greatest Snowfall in 24 hours	14.2	13.7	17.0	6.1	1.8	0.0	0.0	0.0	1.3	10.4	38.8	35.0	38.8		Chute de Neige Record en 24 heures
Years of Record	7	7	7	5	7	7	7	8	8	8	8	8			Années de Relèves
Greatest Precipitation in 24 hours	14.2	13.7	17.0	12.2	10.4	22.9	20.3	32.0	14.7	21.4	44.6	35.0	44.6		Précipitation Record en 24 heures
Years of Record	7	7	7	5	7	7	6	8	8	8	8	8			Années de Relèves
Days with Rain	0	0	1	7	9	10	13	14	17	8	1	0	80	8	Jours de Pluie
Days with Snow	10	7	7	3	2	0	0	0	1	8	10	11	59	8	Jours de Neige
Days with Precipitation	10	7	7	9	10	10	13	14	18	13	10	11	132	8	Jours de Précipitation

TOFINO A

49° 5'N 125° 46'W 20 m

	JAN JAN	FEB FEV	MAR MAR	APR AVR	MAY MAI	JUN JUIN	JUL JUIL	AUG AOÛT	SEP SEPT	OCT OCT	NOV NOV	DEC DEC	YEAR ANNEE	CODE CODE	
Daily Maximum Temperature	6.7	8.5	9.0	10.9	13.7	16.1	18.3	18.1	17.2	13.4	9.8	7.7	12.5	3	Température Maximale Quotidienne
Daily Minimum Temperature	0.8	2.0	1.9	3.5	5.9	8.5	10.2	10.7	9.0	6.4	3.4	2.1	5.4	3	Température Minimale Quotidienne
Daily Temperature	**3.8**	**5.3**	**5.5**	**7.2**	**9.9**	**12.4**	**14.2**	**14.4**	**13.1**	**9.9**	**6.6**	**4.9**	**8.9**	**3**	**Température Quotidienne**
Standard Deviation, Daily Temperature	1.5	1.3	0.9	0.8	0.8	1.0	0.7	0.9	1.1	0.9	1.1	1.7	0.5	3	Écart Type de la Température Quotidienne
Extreme Maximum Temperature	14.4	18.9	18.3	21.7	25.6	32.2	32.8	31.3	29.4	23.9	21.1	15.6	32.8		Température Maximale Extrême
Years of Record	25	24	25	24	25	25	26	26	26	25	25	26			Années de Relèves
Extreme Minimum Temperature	−15.0	−7.2	−5.0	−1.7	0.0	2.2	3.9	4.4	−0.6	−2.2	−7.0	−12.2	−15.0		Température Minimale Extrême
Years of Record	25	25	25	24	24	25	26	26	25	25	25	26			Années de Relèves
Rainfall	382.7	357.3	361.2	231.4	143.0	101.7	86.1	114.1	163.2	391.8	429.3	464.2	3226.0	3	Chutes de Pluie
Snowfall	20.5	6.0	8.6	2.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	13.2	53.0	3	Chutes de Neige
Total Precipitation	**404.3**	**366.4**	**372.4**	**233.8**	**143.0**	**101.7**	**86.1**	**114.1**	**163.2**	**391.8**	**432.3**	**479.2**	**3288.3**	**3**	**Précipitations Totales**
Standard Deviation, Total Precipitation	159.2	170.0	148.0	94.0	73.0	49.4	71.2	89.2	77.4	204.3	143.9	145.7	412.5	3	Écart Type des Précipitations Totales
Greatest Rainfall in 24 hours	174.2	128.5	169.7	106.2	95.5	51.3	98.3	131.3	105.9	154.2	155.4	166.4	174.2		Chute de Pluie Record en 24 heures
Years of Record	26	26	26	26	26	26	26	26	26	25	26	27			Années de Relèves
Greatest Snowfall in 24 hours	31.2	10.7	20.3	14.2	T	0.0	0.0	0.0	0.0	0.0	22.6	15.5	31.2		Chute de Neige Record en 24 heures
Years of Record	26	26	26	25	25	26	25	26	26	26	25	27			Années de Relèves
Greatest Precipitation in 24 hours	174.2	128.5	169.7	106.2	95.5	51.3	98.3	131.3	105.9	154.2	155.4	166.4	174.2		Précipitation Record en 24 heures
Years of Record	26	26	26	26	26	25	26	26	26	25	26	27			Années de Relèves
Days with Rain	20	18	19	18	13	11	9	11	13	19	22	22	195	3	Jours de Pluie
Days with Snow	4	2	2	1	0	0	0	0	0	0	1	3	13	3	Jours de Neige
Days with Precipitation	21	19	20	18	13	11	9	11	13	19	22	23	199	3	Jours de Précipitation



SUBJECT: BCGS Map Area Layout Key

Ministry of Environment – Water Management Branch – Groundwater Section
Groundwater Database System
Data Summary – with Legal Descriptions and Old Coordinates

BCGS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (dmy)	Well Depth (ft.)	Well Diam. (in.)	Drill Contr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092B.031.3.4.2	001	2	29513			55			00	00	00	000	46	PAUL B JOHNSON	SHERINGHAM PT RD	01-01-81	565.0	6.0	033	DRI	0.5	GPM	UNK	12	BED					
092B.031.3.4.2	002	1	31710			55			00	00	00	000	46	GORDON HOBERT	SUNNY BRAE	01-11-79	225.0	0.0	135	DRI			UNK	2	BED					
092B.031.3.4.2	003	B	30175			55			00	00	00	000	46	PAUL BEAUCHER	SHERINGHAM PT RD	23-03-81	500.0	6.0	033	DRI	0.5	GPM	UNK	1	BED					
092B.031.4.2.2	001					10			00	00	00	001	41	R ELROSE		14-11-68	297.0	0.0	076	DRI	2.0	GPM	UNK	11	BED					
092B.031.4.2.2	002	1	9773			9			00	00	00	017	41	EDWARD P KENNEY	WEST COAST ROAD	17-12-83	300.0	6.0	072	DRI	1.0	GPM	UNK	21	BED					
092B.031.4.2.2	003	3	25153			10			00	00	00	002	41	JUMBO N DAVIES	SOOKE RD	31-07-74	325.0	0.0	076		0.5	GPM	UNK	2	BED					
092B.031.4.2.2	004		25417			10			00	00	00	003	41	ROSALIA ELROSE	GOV'T RD & H W	07-06-73	315.0	0.0	135		1.0	GPM	UNK	38	BED					
092B.031.4.2.2	005	5	25153			10			00	00	00	004	41	GERRY VANDEERS	WEST COAST ROAD	11-03-74	100.0	0.0	076		0.5	GPM	UNK	9	BED					
092B.031.4.2.2	006	7	25153			10			00	00	00	005	41	ROBERT SAVILLE	WEST COAST ROAD	05-03-74	100.0	0.0	135		8.0	GPH	UNK	7	BED					
092B.031.4.2.2	007	4	25417			10			00	00	00	006	41	R ELROSE		16-06-73	325.0	0.0	135				UNK	55	BED					
092B.031.4.2.2	008	1	24917			10			00	00	00	007	41	MELVIN ELROSE	WEST COAST ROAD	01-06-75	295.0	0.0	135	DRI	2.0	GPM	UNK	16	BED					
092B.031.4.2.2	009	8	25153			10			00	00	00	008	41	WILLIAM LANG	WEST COAST ROAD	01-04-78	325.0	6.0	076	DRI	1.5	GPM	UNK	17	BED					
092B.031.4.2.2	010	C	14072			9			00	00	00	008	41	PETER WOYCE	WEST COAST ROAD	01-07-78	350.0	6.0	076	DRI			UNK	7	BED					
092B.031.4.2.2	011	4	25153			10			00	00	00	009	41	ROY HUTCHINS	WEST COAST ROAD	20-06-84	250.0	0.0	135		1.0	GPM	UNK	12	BED					
092B.031.4.2.2	012	C	14072			9			00	00	00	009	41	PETER WOYCE	WEST COAST ROAD	01-08-78	300.0	6.0	076	DRI			UNK	13	UNC					
092B.031.4.2.2	013	1	12535			9			00	00	00	010	41	JOHN PHILLIPS	WEST COAST ROAD	15-07-80	50.0	6.0	076	DRI	65.0	GPM	UNK	0	BED					
092B.031.4.2.2	014	A	12535			9			00	00	00	013	41	KEN PUNGENTE	WEST COAST ROAD	20-08-80	510.0	6.0	033	DRI	1.0	GPM	UNK	5	BED					
092B.031.4.2.3	001	10	15583			9			00	00	00	001	41	C R UNDERWOOD	SOOKE RD	10-02-70	270.0	0.0	076	DRI	1.0	GPM	UNK	4	BED					
092B.031.4.2.3	002	7	15583			9			00	00	00	002	41	J W SINCLAIR	WEST COAST ROAD	02-01-74	272.0	0.0	076		1.0	GPM	UNK	11	BED					
092B.031.4.2.3	003	2	15583			9			00	00	00	003	41	V E HODSON		01-09-72	150.0	0.0	135		2.5	GPM	UNK	29	BED					
092B.031.4.2.3	004	2	22721			7			00	00	00	003	41	JOHN W NICOL	CAVERS BAY ESTATES W	13-06-80	39.0	6.0	076	DRI	12.0	GPM	UNK	UNK	UNC	25-29				
092B.031.4.2.3	005	3	22721			7			00	00	00	004	41	J E NYBERG	WEST COAST RD	16-08-79	36.0	6.0	076	DRI	10.0	GPM	UNK	UNK	UNC					
092B.031.4.2.3	006	9	12871			7			00	00	00	005	41	ARCHIE MCCUAIG	OTTER PT RD	24-11-82	25.0	0.0	135		8.0	GPM	UNK	UNK	UNC					
092B.031.4.2.3	007	3	15583			9			00	00	00	004	41	JAMES W BELL	WEST COAST RD	01-11-74	37.0	0.0	135		5.0	GPM	UNK	UNK	UNC					
092B.031.4.2.3	008	12	15583			9			00	00	00	005	41	HENRY BLAKEWAY	WEST COAST RD	30-05-74	465.0	0.0	076		1.5	GPM	UNK	5	BED					
092B.031.4.2.3	009	13	15583			9			00	00	00	006	41	S D WILLIAMSON	EAST OTTER POINT	21-11-74	498.0	6.0	076		1.5	GPM	UNK	16	BED					
092B.031.4.2.3	010	2	9514			9			00	00	00	007	41	DAVID WALLIS	WEST COAST ROAD	05-11-73	175.0	0.0	076				UNK	6	BED					
092B.031.4.2.3	011	5	15583			9			00	00	00	011	41	E HARMAN	WEST COAST ROAD	15-08-79	105.0	6.0	076	DRI	1.5	GPM	UNK	16	BED					
092B.031.4.2.3	012	8	15583			9			00	00	00	012	41	BOB PANIER	WEST COAST ROAD		97.0	8.0	076		2.5	GPM	UNK	UNK	UNC					
092B.031.4.2.3	013	4	15583			9			00	00	00	014	41	K WINDLEY	WEST COAST ROAD	14-07-86	410.0	0.0	135		15.0	GPM	UNK	52	BED					
092B.031.4.2.3	014	7	15583			9			00	00	00	015	41	JENS HOVE	WEST COAST ROAD	23-08-85	460.0	0.0	033	DRI	2.0	GPM	UNK	4	BED					
092B.031.4.2.3	015	7	15583			9			00	00	00	016	41	JIM HOVE	WEST COAST ROAD	30-06-84	640.0	0.0	033	DRI	1.0	GPM	UNK	4	BED					
092B.031.4.3.1	001								00	00	00	000	46	R DEWITT	INVERMUIR RD	02-10-75	280.0	6.5	076		6.0	GPM	UNK	150	BED					
092B.031.4.3.2	001	2	25212			8			00	00	00	001	41	S PARKINS		24-08-73	157.0	6.0	076		5.0	GPM	UNK	UNK	UNC					
092B.031.4.3.2	002	A	23093			8			00	00	00	002	41	J D ECKERSON	WEST COAST RD	02-12-74	58.0	0.0	076				UNK	UNK	UNC					
092B.031.4.3.2	003	A	23093			8			00	00	00	003	41	J D ECKERSON	WEST COAST RD	06-12-74	29.0	6.0	076		15.0	GPM	UNK	UNK	UNC					
092B.031.4.3.2	004	3	25212			8			00	00	00	004	41	JOHN STOKE	WEST COAST ROAD	01-01-74	148.0	6.0	076		4.0	GPM	UNK	UNK	UNC					
092B.031.4.3.2	005	1	25212			8			00	00	00	006	41	ALAN PARKIN	WEST COAST RD	01-04-76	133.0	6.3	076	DRI	1.8	GPM	UNK	UNK	UNC					
092B.031.4.3.2	006	8	23864			8			00	00	00	005	41	F FROST		01-05-73	130.0	6.0	076		5.0	GPM	UNK	UNK	UNC					
092B.031.4.3.2	007	6	23864			8			00	00	00	007	41	M A MERKE	WEST COAST RD	07-12-81	150.0	0.0	032	DRI	10.0	GPM	88	UNK	UNC					
092B.031.4.3.2	008	3	23864			8			00	00	00	008	41	DALE AARON LOG HAULI	WEST COAST RD	02-05-81	160.0	6.0	032	DRI	12.0	GPM	60	129	BED					
092B.031.4.3.2	009	A	31036			8			00	00	00	009	41	J ECKERSON	WEST COAST RD	28-04-77	154.0	6.0	076	DRI	3.0	GPM	UNK	98	BED					
092B.031.4.4.1	001	1	12028			7			00	00	00	001	41	A MOOD		01-01-50	40.0	0.0	137		150.0	GPH	UNK	UNK	UNC					
092B.031.4.4.1	002	1	12871			7			00	00	00	002	41	GOVENLOCK	OTTER POINT RD	16-12-80	123.0	5.0	076	DRI	5.0	USGPM	UNK	UNK	UNC					
092B.031.4.4.2	001	A	30432			51			00	00	00	001	41	JOHN TREGEAR	OTTER PT ROAD	11-08-81	495.0	6.0	072	DRI	2.0	GPM	UNK	6	BED					
092B.031.4.4.2	002	A	33095			11			00	00	00	001	41	WAYNE DIXON	OTTER PT ROAD	28-10-80	125.0	0.0	076	DRI	0.5	GPM	UNK	UNK	UNC					
092B.031.4.4.2	003	6	34588			11			00	00	00	002	41	STEVE HAWKS	AMANDA PLCE	28-06-82	300.0	6.0	072	DRI	2.0	GPM	UNK	21	BED					
092B.031.4.4.2	004	2	34588			11			00	00	00	003	41	TOM HAWKINS	AMANDA PL	28-06-82	225.0	6.0	072	DRI	3.0	GPM	195	11	BED					

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BCGS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (dmy)	Well Depth (ft.)	Well Diam. (in.)	Drill Contr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092B.032.2.3.4	001	12	33328			151			00	00	00	002	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	16-10-78	500.0	6.0	076				UNK	15	BED					
092B.032.2.3.4	002	9	33328			151			00	00	00	003	54	DIAMOND DEVELOPMENTS	PARK HEIGHTS	30-11-83	510.0	6.0	076	DRI			60	6	BED					
092B.032.2.3.4	003	9	33328			151			00	00	00	004	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	13-10-78	500.0	6.0	076		0.5	GPM	UNK	7	BED					
092B.032.2.3.4	004	7	33328			151			00	00	00	005	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	10-10-78	325.0	6.0	076		15.0	GPM	UNK	15	BED					
092B.032.2.3.4	005	7	40040			151			00	00	00	006	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	09-11-78	525.0	6.0	076		1.0	GPM	UNK	8	BED					
092B.032.2.4.1	001	5	9493			86			00	00	00	001	54	PERCY BROWN		16-08-74	150.0	0.0	076		6.0	GPM	UNK	26	BED					
092B.032.2.4.1	002					85			00	00	00	001	54	R F GREEN	E SOOKE RD	01-01-50	22.0	0.0	UNK	DUG			4	UNK	UNC					
092B.032.2.4.1	003	1				86			00	00	00	002	54	PACIFIC LIONS MARINA	BECHER BAY RD	01-02-74	370.0	0.0	076		1.5	GPM	UNK	40	BED					
092B.032.2.4.1	004					85			00	00	00	002	54	R F GREEN	E SOOKE RD	01-01-54	60.0	6.0	034	DRI	60.0	GPH	UNK	48	BED					
092B.032.2.4.1	005		865571			86			00	00	00	003	54	WILLIAM FIFE		16-09-75	230.0	6.0	076				UNK	21	BED					
092B.032.2.4.1	006					85			00	00	00	003	54	R F GREEN	E SOOKE RD	01-01-50	20.0	0.0	UNK	DUG			UNK	UNK	UNC					
092B.032.2.4.1	007	A				86			00	00	00	004	54	D HICKMAN		01-10-76	75.0	0.0	135	DRI	2.0	GPM	UNK	29	BED					
092B.032.2.4.1	008					85			00	00	00	004	54	ROBERT GREEN	BECHER BAY & EAST SO	01-05-74	280.0	0.0	135		1.0	GPM	UNK	3	BED					
092B.032.2.4.1	009	2	9493			86			00	00	00	002	54	GEORGE E BROWN	BECHER BAY	17-11-81	230.0	6.0	072	DRI	3.0	GPM	UNK	5	BED					
092B.032.2.4.1	010					86			00	00	00	006	54	WILLIAM FIFE	BECHER BAY ROAD	07-04-79	400.0	6.0	076		1.5	GPM	UNK	15	BED					
092B.032.2.4.1	011	1	28937			86			00	00	00	007	54	T HUDEC	BECHER BAY RD	04-04-81	200.0	6.0	072	DRI	5.5	GPM	UNK	10	BED					
092B.032.2.4.1	012	1	9493			86			00	00	00	008	54	G E BROWN	BECHER BAY	14-07-82	165.0	0.0	UNK				UNK	0	UNC					
092B.032.2.4.1	013	6	9493			86			00	00	00	009	54	RICHARD A HUMPHRIES	BECHER BAY RD	23-08-84	200.0	6.0	072	DRI	12.0	GPM	UNK	0	BED					
092B.032.2.4.4	001					49			00	00	00	001	31	CHEANUH DEVELOPMENTS	BEECHER BAY INDIAN R	16-08-74	235.0	0.0	076		6.3	GPH	UNK	18	BED					
092B.032.2.4.4	002					49	1		00	00	00	002	31	CHEANUH DEVELOPMENTS	BECHER BAY	01-03-78	300.0	0.0	135	DRI			UNK	50	BED					
092B.032.2.4.4	003					49	1		00	00	00	003	31	CHEANUH DEVELOPMENTS	BECHER BAY	01-03-78	680.0	0.0	135	DRI	0.1	GPM	UNK	2	BED					
092B.032.2.4.4	004					49	1		00	00	00	004	31	CHEANUH DEVELOPMENTS	BECHER BAY	01-01-78	300.0	0.0	135	DRI	0.5	GPM	UNK	22	BED					
092B.032.3.1.3	001					29			00	00	00	001	41	ANNE FENNER		01-10-74	190.0	0.0	135				UNK	18	UNC					
092B.032.3.1.3	002	1	7179			31			00	00	00	001	41	L M FRENCH	WEST COAST ROAD	30-10-74	197.0	0.0	076		0.5	GPM	UNK	30	BED					
092B.032.3.1.4	001	1	7938			18			00	00	00	001	54	C L BUTLER		11-05-70	596.0	0.0	076	DRI			UNK	0	BED					
092B.032.3.1.4	002	1	12532			1			00	00	00	001	54	G W LAKE		01-04-61	102.0	6.0	108	DRI	1.0	GPM	60	UNK	UNC					
092B.032.3.1.4	003					1			00	00	00	002	54	MAY REDIGER		01-01-62	195.0	0.0	108	DRI	1.5	GPM	13	50	BED					
092B.032.3.1.4	004	A	25416			1			00	00	00	003	54	RUDIGER	7370 ELLA RD	27-11-72	112.0	6.0	076	DRI	4.0	GPM	UNK	UNK	UNC					
092B.032.3.1.4	005	1	28024			1			00	00	00	004	54	JOHN L ROCKWELL		01-03-76	125.0	0.0	135	DRI	5.0	GPM	UNK	UNK	UNC					
092B.032.3.1.4	006	2	28024			1			00	00	00	005	54	ED BLUMENTHAL	ELLA RD	17-01-77	87.0	6.0	076	DRI	2.0	GPM	UNK	UNK	UNC					
092B.032.3.2.2	001	7	5313			89			00	00	00	001	54	H M COKE		01-10-70	130.0	0.0	137	DRI			UNK	UNK	UNC					
092B.032.3.2.2	002	3	26576			89			00	00	00	002	54	DAVE KORMAN	EAST SOOKE RD	18-10-75	450.0	6.0	076				UNK	16	BED					
092B.032.3.2.2	003	2	26576			89			00	00	00	003	54	G W BARNARD	EAST SOOKE RD	29-11-74	275.0	6.0	076				UNK	8	BED					
092B.032.3.2.4	001					132			00	00	00	001	54	G J WESTON	EAST SOOKE RD	01-01-40	100.0	0.0	034	DRI			UNK	22	UNC					
092B.032.3.2.4	002	A	21139			9			00	00	00	001	54	RENSHAW-BEAUCHAMP	TIDEVIEW RD	01-07-79	200.0	6.0	033		0.5	GPM	UNK	7	BED					
092B.032.3.2.4	003	4				12			00	00	00	001	54	R BAECHLER	TIDE VIEW RD	03-06-68	225.0	0.0	076	DRI	10.0	GPH	UNK	15	BED					
092B.032.3.2.4	004	A	12818			132			00	00	00	002	54	N B BEGG	EAST SOOKE RD	07-10-72	200.0	6.0	076	DRI	2.0	GPM	UNK	12	BED					
092B.032.3.2.4	005					12			00	00	00	002	54	J VESTERGAARD		01-01-50	280.0	0.0	076	DRI			UNK	12	BED					
092B.032.3.2.4	006	2	20423			12			00	00	00	003	54	SHOLDE		23-01-73	400.0	0.0	076		6.0	GPH	UNK	5	BED					
092B.032.3.2.4	007	1	3992			132			00	00	00	003	54	G J WESTON		01-01-40	50.0	0.0	034	DRI	5.0	GPH	UNK	23	BED					
092B.032.3.2.4	008	1	4579			132			00	00	00	004	54	LARRY BEAKER	6790 EAST SOOKE RD	01-12-78	240.0	0.0	033	DRI	0.5	GPM	10	11	BED					
092B.032.3.2.4	009		19599			133			00	00	00	001	54	ED COURT & SONS LTD	1805 ELIZA POINT RD	31-03-83	680.0	0.0	033	DRI			UNK	2	BED					
092B.032.3.2.4	010	4	13981			12			00	00	12	004	54	R BAECHLER	TIDEVIEW ROAD	01-10-76	450.0	6.0	076	DRI	0.3	GPM	UNK	11	BED					
092B.032.3.3.1	001	4	19985			28			00	00	00	001	41	D SELL	KEMP LAKE RD	19-11-73	445.0	0.0	076		0.5	GPM	UNK	93	BED					
092B.032.3.3.1	002	4	23503			52			00	00	00	001	41	DAVID BAILLIE		08-12-70	385.0	0.0	076	DRI			UNK	6	BED					
092B.032.3.3.1	003	7	15795			44			00	00	44	001	54	HANS VAN BEERS	BROOM HILL ROAD	01-10-76	155.0	6.0	076		1.5	GPM	UNK	UNK	UNC					
092B.032.3.3.1	004	5	15795			44			00	00	00	002	54	DALE HOFFMAN	BROOM HILL ROAD	01-09-76	131.0	6.0	076	DRI	1.0	GPM	UNK	UNK	UNC					
092B.032.3.3.1	005	2	23503			52			00	00	00	002	41	M FROBEEN		01-11-74	250.0	0.0	135		2.0	GPM	UNK	56	BED					

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092B.032.3.3.1	006	1	23503			52			00	00	00	003	41	BRUCE HELGESEN	4860 TOWNE RD	30-06-75	375.0	6.0	076				UNK	15	BED					
092B.032.3.3.1	007	4	15795			44			00	00	00	003	54	BARNHART	BROOMHILL RD	01-01-77	88.0	0.0	135	DRI			UNK	UNK	UNC					
092B.032.3.3.1	008	3	23583			44			00	00	00	004	54	G FITZ-PATRICK	BROOMHILL RD	01-04-76	80.0	0.0	136		10.0	GPM	UNK	UNK	UNC					
092B.032.3.3.1	009	7	1910			52			00	00	00	004	54	HAWES	7906 OTTER PT RD	01-08-75	430.0	0.0	136		9.0	GPM	UNK	7	BED					
092B.032.3.3.1	010	7	1910			52			00	00	00	005	41	J A HAWES	7906 OTTER POINT RD	01-01-80	552.0	0.0	136	DRI			UNK	UNK	BED					
092B.032.3.3.1	011	6	15797			44			00	00	00	005	54	JIM MCGREGOR	7747 BROOMHILL RD	22-05-81	127.0	6.0	076	DRI	5.0	UGPM	UNK	UNK	UNC					
092B.032.3.3.1	012	5	23583			44			00	00	00	006	54	PETER SOLGA	7746 BROOMHILL RD	11-05-81	100.0	6.0	UNK	DRI			UNK	UNK	UNC					
092B.032.3.3.1	013	A	28894			52			00	00	00	006	41	RICHARD FYFE	3745 OTTER PT RD	01-09-74	286.0	0.0	135		1.0	GPM	UNK	5	BED					
092B.032.3.3.1	014	2	15795			44			00	00	00	007	54	BROMAN	7779 BROOMHILL RD	09-05-81	250.0	6.0	032	DRI			UNK	125	BED					
092B.032.3.3.1	015	6	23583			44			00	00	00	008	54	JOHNSTON JOHN	7736 BROOMHILL RD	09-05-81	75.0	6.0	032	DRI	5.0	GPM	50	UNK	UNC					
092B.032.3.3.1	016	6	23583			44			00	00	00	009	54	J M JOHNSON	7736 BROOMHILL	28-07-84	107.0	0.0	032	DRI	5.0	GPM	85	UNK	UNC					
092B.032.3.3.1	017	5	23583			44			00	00	00	010	54	PETER SOLGA	7746 BROOMHILL RD	21-02-85	140.0	0.0	032	DRI	2.0	GPM	35	UNK	UNC					
092B.032.3.3.1	018	4	15795			44			00	00	00	011	54	AL TALBOT	7775 BROOMHILL RD	31-01-84	125.0	6.0	076	DRI	1.5	GPM	UNK	UNK	UNC					
092B.032.3.3.3	001	1	2662			17			00	00	00	001	41	MURRAY MCNULTY	KEMP LAKE	01-05-74	325.0	0.0	135		0.5	GPM	UNK	21	BED					
092B.032.3.3.3	002	10	31125			46			00	00	00	001	41	L W KING	3025 MICHELSON RD	01-01-81	640.0	6.0	033	DRI			UNK	2	BED					
092B.032.3.3.3	003	2	31125			46			00	00	00	002	41	BRAND/WASILODOWSKI	3034 MICHELSON RD	01-01-80	260.0	6.0	UNK	DRI	1.0	UGPM	UNK	15	BED					
092B.032.3.3.3	004	3	21528			17			00	00	00	002	41	R L ROLLS	OTTER POINT ROAD	01-10-76	400.0	6.0	076	DRI	1.5	GPM	UNK	19	BED					
092B.032.3.3.3	005	5	21528			17			00	00	00	003	41	E A WRIGHT J SAVER	3475 OTTER POINT RD	13-08-80	450.0	6.0	072	DRI	2.0	GPM	UNK	62	BED					
092B.032.3.3.3	006	7	31125			46			00	00	00	003	41	PAUL ALBERTSON	MICHELSON ROAD/OTTER	01-02-80	600.0	0.0	033	DRI			UNK	16	UNC					
092B.032.3.3.3	007	8	31125			46			00	00	00	004	41	WALLY VOWLES	2949 MICHLESON RD	06-09-80	505.0	6.0	033	DRI	2.0	GPM	UNK	10	BED					
092B.032.3.3.3	008								00	00	00	000	41	LLOYD THOMAS	3450A OTTER POINT RD	10-05-83	77.0	0.0	076	DRI			57	45	BED					
092B.032.3.3.4	001	5	8525			15			00	00	00	002	41	DALLAS HANSON	2947 ROBINSON RD	24-06-80	504.0	6.0	076	DRI			UNK	20	BED					
092B.032.3.3.4	002	2	8525			15			00	00	00	003	41	G F HOWARD	3025 ROBINSON	31-08-82	375.0	0.0	135	DRI	0.5	GPM	UNK	23	BED					
092B.032.3.4.1	001	39	1525			36			00	00	00	001	54	H E HARRIS	OTTER PT & BLANCHARD	01-10-74	280.0	0.0	135				UNK	10	BED					
092B.032.3.4.3	001	7	1525			35			00	00	00	001	54	D M PAYNE		16-09-74	225.0	0.0	076				UNK	50	UNC					
092B.032.3.4.3	002	4	26066			37			00	00	00	000	54	BOB GUDMUNSON		01-01-74	109.0	6.0	076				UNK	26	UNC					
092B.032.3.4.3	003	4	26066			37			00	00	00	000	54	BOB GUDMUNSON		09-09-74	250.0	0.0	076				UNK	25	UNC					
092B.032.3.4.3	004	6	1525			35			00	00	00	002	54	PETER R BURR	OTTER POINT RD	17-09-74	150.0	0.0	076				UNK	55	UNC					
092B.032.3.4.3	005	17	1525			35			00	00	00	000	54	MARY CAIN	OTTER POINT RD	01-05-78	475.0	0.0	076	DRI	3.5	GPM	UNK	10	BED					
092B.032.3.4.3	006	10	26066			37			00	00	00	002	54	THOMAS J ELLIS	SELLARS RD OFF OTTER	30-10-78	550.0	0.0	033	DRI	0.5	GPM	UNK	110	BED					
092B.032.3.4.3	007	8	26066			37			00	00	00	003	54	HOLLY BURT	SELLARS RD	12-06-81	570.0	6.0	033	DRI			UNK	125	UNC					
092B.032.3.4.3	008	2	26066			37			00	00	00	004	54	R L SIMON	SELLARS DR	01-03-79	60.0	8.0	033	DRI	6.0	GPM	5	10	BED					
092B.032.3.4.3	009	7	26066			37			00	00	00	005	54	ROLAND MILKERT	SELLARS RD	01-09-81	800.0	6.0	076	DRI	0.1	GPM	700	55	BED					
092B.032.3.4.4	001					27			00	00	00	001	54	PAULHORN	PHILLIPS RD	12-12-78	65.0	6.0	076		3.0	GPM	UNK	UNK	UNC					
092B.032.3.4.4	002	1	9958			27			00	00	00	002	54	HANS PAETEN	PHILLIPS RD	09-09-85	25.0	0.0	033	DRI	12.0	GPM	UNK	UNK	UNC					
092B.032.3.4.4	003	1	9958			27			00	00	00	003	54	HANS PAETEN	PHILLIPS RD	09-09-85	20.0	0.0	033	DRI	20.0	GPM	8	UNK	UNC					
092B.032.4.1.2	001	18	33328			95			00	00	00	001	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	06-10-78	410.0	0.0	076		30.0	GPM	UNK	12	BED					
092B.032.4.1.2	002	5	36257			95			00	00	00	002	54	DIAMOND DEVELOPMENT	PARK HEIGHTS	10-07-80	500.0	6.0	076	DRI	0.2	GPM	UNK	2	BED					
092B.032.4.1.2	003	1	1999			84			00	00	00	002	54	C A BENNET	EAST SOOKE RD	22-11-73	270.0	0.0	076		0.5	GPM	UNK	8	BED					
092B.032.4.1.2	004	1	20602			84			00	00	00	003	54	ELWOOD J SMITH	AMBASSADOR AVE	17-03-69	235.0	0.0	076	DRI	1.0	GPM	UNK	115	BED					
092B.032.4.1.2	005	4	36256			95			00	00	00	003	54	DIAMOND DEVELOP	PARK HEIGHTS	17-07-80	345.0	6.0	076	DRI	4.0	GPM	UNK	2	BED					
092B.032.4.1.2	006	A	24094			95			00	00	00	004	54	G A MAY	E SOOKE RD	01-10-74	250.0	0.0	136	DRI	0.5	GPM	UNK	86	BED					
092B.032.4.1.2	007	2	1999			84			00	00	00	005	54	ERIC JOA	E SOOKE RD	16-06-82	223.0	0.0	136		1.5	GPM	UNK	24	BED					
092B.032.4.1.2	008	1	23589			92			00	00	00	004	54	J HOMER	SOOKE RD	09-04-73	300.0	6.5	076				UNK	15	BED					
092B.032.4.1.2	009	3	36256			95			00	00	00	000	54	GARTH MCKAY	5949 JUPITER PL.	19-07-88	350.0	0.0	136	DRI	2.0	GPM		2	BED					
092B.032.4.1.3	001	4	3466			134			00	00	00	001	54	D G DIXIE		05-08-68	220.0	0.0	076	DRI	12.0	GPH	UNK	14	BED					
092B.032.4.1.3	002	2	14990			98			00	00	00	001	54	J C COOK	WOODCOCK LANE	01-06-68	80.0	0.0	137	DRI	4.0	GPH	40	10	BED					
092B.032.4.1.3	003	2	146446			98			00	00	00	002	54	G W GREGORY	WOODCOCK RD	22-11-74	400.0	6.5	076				UNK	26	UNC					

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BCGS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (dmy)	Well Depth (ft.)	Well Diam. (in.)	Drill Contr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092B.032.4.1.3	004	2	3466			134			00	00	00	002	54	STEPHEN LUSH	EAST SOOKE ROAD	15-10-79	540.0	6.5	076	DRI	0.5	GPM	UNK	58	BED					
092B.032.4.1.3	005	2	3466			134			00	00	00	003	54	PAUL RIDOUT	EAST SOOKE RD	14-10-83	505.0	6.0	076	DRI	1.5	GPM	UNK	8	BED					
092B.032.4.1.3	006	4	21888			98			00	00	00	003	54	AL BLANIDEN	EAST SOOKE RD	01-01-75	260.0	8.0	076				UNK	15	BED					
092B.032.4.1.3	007	4	21888			98			00	00	98	004	54	A D BLANIDEN	EAST SOOKE	01-03-75	350.0	6.5	076	DRI			UNK	45	BED					
092B.032.4.1.3	008	1	21888			98			00	00	00	006	54	BRIAN ROWBOTTOM	TIMBERDOODLE RD	25-01-77	200.0	6.5	076	DRI			UNK	17	BED					
092B.032.4.1.4	001	1	23589			92			00	00	00	001	54	JOHN HOMER		06-03-73	250.0	6.5	076		0.5	GPM	UNK	57	BED					
092B.032.4.1.4	002	1	24649			110			00	00	00	001	54	REV D LEHANE	COVINA DR	04-10-73	400.0	0.0	076				UNK	21	BED					
092B.032.4.1.4	003					110			00	00	00	002	54	SISTERS OF ST ANNE	EAST SOOKE RD	01-07-78	500.0	6.5	076	DRI	2.0	GPM	UNK	19	BED					
092B.032.4.1.4	004	23	23589			92			00	00	00	002	54	DONALD B THOMSON		31-10-72	0.0	0.0	135				UNK	UNK	UNC					
092B.032.4.1.4	005	3	23589			92			00	00	00	003	54	FRED P HOMER		01-10-71	64.0	6.5	076	DRI	4.0	GPM	UNK	60	UNC					
092B.032.4.1.4	006	1	27428			92			00	00	00	005	54	T RIGBY		13-12-72	37.0	0.0	135		3.0	GPM	UNK	UNK	UNC					
092B.032.4.1.4	007	1	22602			98			00	00	00	005	54	GRAHAM FIELD	EAST SOOKE RD	01-06-77	370.0	6.0	032	DRI	1.5	GPM	60	16	BED					
092B.032.4.1.4	008	11	23589			92			00	00	00	006	54	VICTORIA MORTGAGE CO		25-09-70	540.0	0.0	076	DRI	1.0	GPM	UNK	18	BED					
092B.032.4.1.4	009	2	25389			92			00	00	92	008	54	R MACALISTER	ANDERSON COVE RD	01-01-76	125.0	8.0	076	DRI			UNK	32	BED					
092B.032.4.1.4	010	23	23589			92			00	00	00	009	54	DON THOMSON	PIM HEAD RD	26-04-83	710.0	6.0	076	DRI			UNK	6	BED					
092B.032.4.1.4	011	23	23589			92			00	00	00	010	54		PIM HEAD RD	31-03-83	430.0	6.0	076	DRI			220	3	BED					
092B.032.4.1.4	012	22	23589			92			00	00	00	007	54	D A KERR	PIM HEAD	04-12-74	175.0	6.5	076				UNK	0	UNC					
092B.032.4.2.1	001	6	38149			88			00	00	00	001	54	DIAMOND DEVELOP	PARK HEIGHTS RD	23-06-80	520.0	6.0	076	DRI	1.5	GPM	UNK	0	BED					
092B.032.4.2.1	002	2				84			00	00	00	001	54	W E FARMER	EAST SOOKE RD	01-06-68	128.0	0.0	137	DRI	50.0	GPH	UNK	47	BED					
092B.032.4.2.1	003		1191			101			00	00	00	001	54	PAUL MCGARRY	GILLESPIE RD	01-04-47	150.0	6.0	108	DRI			UNK	0	BED					
092B.032.4.2.1	004					101			00	00	00	002	54	DAVID WAMAN	GILLESPIE RD	01-01-83	455.0	0.0	076	DRI			150	9	BED					
092B.032.4.2.1	005	5	1999			84			00	00	00	004	54	HANS STOPE	SOOKE RD	30-04-73	225.0	0.0	136		15.0	GPH	UNK	15	BED					
092B.032.4.2.3	001	2	25018			101			00	00	00	003	54	G SCHUETZ	GILLESPIE RD	01-01-76	330.0	0.0	137	DRI			8	UNK	BED					
092B.032.4.2.3	002					101			00	00	00	004	54	B & R LEND LEASE LTD	GILLESPIE RD	18-01-79	400.0	6.5	076		2.5	GPM	UNK	6	BED					
092B.032.4.2.3	003	3	1999			84			00	00	00	001	54	H B BOLLS	EAST SOOKE RD	01-07-70	90.0	0.0	137	DRI	90.0	GPH	36	0	BED					
092B.032.4.3.1	001	3	2434	3		7			00	00	00	000	54	OCEAN CITY REALTY	2011 IDLEMORE ROAD	20-07-89	40.0	0.0	403	DRI	60.0	GPM			UNC					
092B.032.4.3.4	001	9	2434			51			00	00	00	001	54	JOHN BEIRIE	WOODLANDS RD	22-11-80	200.0	6.0	033	DRI	4.0	GPM	15	15	BED					
092B.032.4.3.4	002	2	24761			64			00	00	00	001	54	EMERSON (WENDELL)?		01-07-73	220.0	6.5	076		1.5	GPM	UNK	11	BED					
092B.032.4.3.4	003	1	2434	15		65			00	00	65	001	54	S LALART	HARBOUR VIEW RD	07-08-67	85.0	0.0	076	DRI	10.0	GPM	UNK	0	BED					
092B.032.4.3.4	004	A				54			00	00	00	002	54	J ALDMAN	SOOKE RD	01-11-79	320.0	6.0	033	DRI			40	50	BED					
092B.032.4.4.1	001					115			00	00	00	001	54	JAMES KROCK	GILLESPIE RD	10-03-77	180.0	6.0	076	DRI			20	10	BED					
092B.032.4.4.1	002					77			00	00	00	002	54	GROUSE NEST		01-08-63	223.0	6.0	108	DRI	10.0	GPM	UNK	10	BED					
092B.032.4.4.1	003					77			00	00	00	002	54	GROUSE NEST		01-01-50	300.0	0.0	043				UNK	UNK	UNC					
092B.032.4.4.1	004					69			00	00	00	004	54	GEORGE S NAGLE	GILLESPIE ROAD	30-09-79	425.0	6.0	076	DRI			UNK	19	BED					
092B.032.4.4.1	005	2	20544			70			00	00	00	006	54	CHRIS MEDLEY		25-04-69	110.0	0.0	076	DRI	3.0	GPM	UNK	14	BED					
092B.032.4.4.1	006	1	20980			70			00	00	00	008	54	E HODGETTS		01-09-71	120.0	6.0	076	DRI	6.0	GPM	UNK	23	BED					
092B.032.4.4.1	007	1	13445			70			00	00	00	015	54	W WILSON		01-12-75	300.0	0.0	135				UNK	10	BED					
092B.032.4.4.1	008	1	13445			70			00	00	00	020	54	WOODS	GILLESPIE RD	01-07-78	125.0	6.0	076	DRI	25.0	GPM	UNK	2	BED					
092B.032.4.4.1	009	3	23371			70			00	00	00	021	54	B CAMERON	GILLESPIE RD	01-02-76	275.0	6.0	076	DRI	5.0	GPM	UNK	11	BED					
092B.032.4.4.1	010	1	13445			70			00	00	00	022	54	C S SANDS	GILLESPIE RD	01-07-79	125.0	6.0	076	DRI	3.0	GPM	UNK	18	BED					
092B.032.4.4.2	001	10	32025			116	7		00	00	00	005	54	BLOCK BROS	CONNIE RD SUBD	07-05-80	100.0	6.0	076	DRI	3.0	GPM	UNK	2	BED					
092B.032.4.4.2	002	11	32025			116	7		00	00	00	006	54	BLOCK BROS	CONNIE RD SUBD	28-05-80	375.0	6.0	076	DRI	0.7	GPM	UNK	3	BED					
092B.032.4.4.2	003	13	32025			116	7		00	00	00	007	54	BLOCK BROS	CONNIE RD SUBD	04-06-80	465.0	6.0	076	DRI	0.3	GPM	UNK	3	BED					
092B.032.4.4.2	004	9	32025			122	7		00	00	00	010	54	BLOCK BROS	1878 CONNIE RD	29-04-80	148.0	6.0	076	DRI	9.0	GPM	UNK	28	BED					
092B.032.4.4.3	001	1	16293			118			00	00	00	001	54	ROYAL ENSIGN HOTEL	SOOKE RD	17-09-73	450.0	0.0	076		1.0	GPM	UNK	43	BED					
092B.032.4.4.3	002	8	14095			60			00	00	00	001	54	EVERGREEN COTTAGE		13-01-73	322.0	0.0	076		0.5	GPM	UNK	8	BED					
092B.032.4.4.3	003	A	25453			59			00	00	00	001	54	LEO LAPPIN	5200 SOOKE RD	14-05-80	300.0	6.0	033	DRI	1.0	GPM	UNK	7	BED					
092B.032.4.4.3	004		5653						00	00	00	001	54	F FOULDS		01-06-75	325.0	6.0	076				UNK	26	BED					

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BCGS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (d/m/y)	Well Depth (ft.)	Well Diam. (in.)	Drill Cntr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092B.032.4.4.3	005	9	12204			70			00	00	00	001	54	J H BELLINGER		18-10-67	148.0	0.0	076	DRI	0.5	GPM	UNK	32	BED					
092B.032.4.4.3	006	2	25504			68			00	00	00	001	54	RUBIN	SOOKE RD	04-07-75	150.0	6.0	076		1.0	GPM	UNK	15	BED					
092B.032.4.4.3	007	3	8042			69			00	00	00	001	54	MIKE MAZUR		29-09-69	360.0	0.0	076	DRI	0.5	GPM	UNK	16	BED					
092B.032.4.4.3	008	12	12204			70			00	00	00	002	54	MORAG WALLINGER	MAZUR RD	01-06-79	550.0	6.0	033				UNK	6	BED					
092B.032.4.4.3	009	3	8042			69			00	00	00	002	54	MIKE MAZUR	SOOKE RD	01-09-78	64.0	6.0	076	DRI			UNK	18	UNC					
092B.032.4.4.3	010	A	39883			68			00	00	00	002	54	JOHN FOLLETT	5262 SOOKE RD	22-12-82	275.0	6.0	076	DRI	1.0	GPM	UNK	20	BED					
092B.032.4.4.3	011	4	37313			71			00	00	00	002	54	FRANK FOULDS	GILLESPIE RD	17-09-81	350.0	0.0	135	DRI	5.0	GPM	UNK	21	BED					
092B.032.4.4.3	012	21	12204			60			00	00	00	002	54	PETER VANDERWART		23-08-70	320.0	0.0	076	DRI	1.5	GPM	UNK	0	BED					
092B.032.4.4.3	013	2	33085			59			00	00	00	002	54	BILL CRAWFORD	5211 SOOKE RD	01-03-81	320.0	0.0	033	DRI			UNK	2	BED					
092B.032.4.4.3	014	11	14095			60			00	00	00	003	54	MACKENZIE	ROCKMEADE RD	01-04-78	89.0	6.0	076	DRI	2.0	GPM	18	UNK	BED					
092B.032.4.4.3	015	7	14095			60			00	00	00	004	54	RAYMOND & L HAGEN	ROCKMEDE PLACE	01-01-79	450.0	6.0	033	DRI	1.0	GPM	UNK	15	BED					
092B.032.4.4.3	016	C	41996			59			00	00	00	005	54	ROBERT ASHWORTH	SOOKE RD	11-10-84	400.0	0.0	033	DRI	0.5	GPM	UNK	16	BED					
092B.032.4.4.3	017	1	5653			71			00	00	00	003	54	LAWRENCE E JERVIS	SOOKE RD	01-05-79	320.0	6.0	033	DRI	1.5	GPM	UNK	2	BED					
092B.032.4.4.3	018	4	25504			68			00	00	00	003	54	NEXUS HLDS G BRETIER	N OF SOOKE RD	23-06-84	550.0	6.0	072	DRI	1.5	GPM	UNK	12	BED					
092B.032.4.4.3	019		83						00	00	00	003	54	C S FLITTON	SOOKE RD	24-01-75	220.0	6.0	076				UNK	0	BED					
092B.032.4.4.3	020	1	12204			70			00	00	00	003	54	JOHN SCHLURMAN	SOOKE RD	27-04-68	122.0	0.0	076	DRI			UNK	2	BED					
092B.032.4.4.3	021	9	12204			70			00	00	00	004	54	J BELLINGER		11-06-68	298.0	0.0	076	DRI	6.0	GPH	UNK	25	BED					
092B.032.4.4.3	022	5	12204			70			00	00	00	005	54	FRED JARVIS		19-10-67	25.0	0.0	076	DRI	2.0	GPM	UNK	UNK	UNC					
092B.032.4.4.3	023	6	12204			70			00	00	00	007	54	C J BADGET		01-06-71	290.0	6.0	076	DRI	1.0	GPM	UNK	30	BED					
092B.032.4.4.3	024	8	12204			70			00	00	00	009	54	F ZEILINGER		01-08-73	220.0	6.0	076		1.0	GPM	UNK	12	BED					
092B.032.4.4.3	025	11	12204			70			00	00	00	010	54	C N DOMMETT		01-06-71	190.0	6.0	076	DRI	7.0	GPM	UNK	45	BED					
092B.032.4.4.3	026	15	12204			70			00	00	00	011	54	J WILLIAMS		01-06-73	270.0	6.0	076				UNK	6	BED					
092B.032.4.4.3	027	19	14095			70			00	00	00	012	54	GORDON	MANZER & SOOKE RD	01-06-71	90.0	6.0	076	DRI	1.5	GPM	UNK	3	BED					
092B.032.4.4.3	028	13	12204			70			00	00	00	013	54	STU FYFE	MANZER RD	28-08-75	400.0	6.0	076		0.5	GPM	UNK	4	BED					
092B.032.4.4.3	029	14	12204			70			00	00	00	014	54	K JOHANSEN	MANZER RD	07-05-75	195.0	6.0	076		1.5	GPM	UNK	3	BED					
092B.032.4.4.3	030	16	12204			70			00	00	70	016	54	K G SUTTON	MANZER RD	01-02-75	270.0	0.0	135	DRI			UNK	5	BED			Y		
092B.032.4.4.3	031	7	12204			70			00	00	70	017	54	KEITH BROOKS	MANZER RD	01-02-76	400.0	6.0	076	DRI			UNK	3	BED					
092B.032.4.4.3	032	4	12204			70			00	00	70	018	54	JIM PERKINS	MANZER RD	01-02-76	295.0	6.0	076	DRI	2.0	GPM	UNK	17	BED					
092B.032.4.4.3	033	2	14978			70			00	00	00	019	54	D LASH	SOOKE RD	24-01-78	325.0	0.0	076	DRI			UNK	UNK	BED					
092B.032.4.4.3	034	1	16362			70			00	00	00	023	54	A E MARRIOTT	GILLESPIE RD	07-10-80	180.0	6.0	033	DRI	15.0	GPM	UNK	49	BED					
092B.032.4.4.3	035	2	23371			70			00	00	00	024	54	ARTHUR KRATZMAN	GILLESPIE RD	04-06-82	200.0	6.0	033	DRI	3.5	GPM	UNK	5	BED					
092B.032.4.4.3	036	1	23371			70			00	00	00	025	54	TED FORBES	GILLESPIE RD	10-05-82	260.0	6.0	033	DRI	2.5	GPM	UNK	0	BED					
092B.032.4.4.3	037					71			00	00	00	004	54	BOB JONES	GILLESPIE RD	02-06-84	243.0	0.0	033	DRI	1.0	GPM	UNK	12	BED					
092B.032.4.4.4	001	2	32025			116		7	00	00	00	001	54	BLOCK BROS	CONNIE RD SUBD	06-03-80	326.0	6.0	076	DRI	2.5	GPM	UNK	5	BED					
092B.032.4.4.4	002	7	18382			24			00	00	00	001	54	RON THORNE		17-04-73	445.0	6.0	076		0.5	GPM	UNK	20	BED					
092B.032.4.4.4	003	6	3351			65			00	00	00	001	54	H MCLEISH	SOOKE RD	01-08-78	345.0	6.0	076	DRI	1.0	GPM	UNK	14	BED					
092B.032.4.4.4	004		6594			116			00	00	00	001	54	GERNER CARLSEN		01-10-74	275.0	0.0	135		3.0	GPH	UNK	15	BED					
092B.032.4.4.4	005	1	18938			12			00	00	00	002	23	F L HODGETTS	SOOKE RD	31-10-72	160.0	6.0	076	DRI	6.0	GPM	UNK	5	BED					
092B.032.4.4.4	006	1	32025			116		7	00	00	00	002	23	BLOCK BROS	CONNIE RD SUBD	05-05-80	267.0	6.0	076	DRI	2.0	GPM	UNK	5	BED					
092B.032.4.4.4	007	2	3351			65			00	00	00	002	23	T STEVENS	SOOKE RD	01-01-73	100.0	5.0	048	DRI	2.3	GPM	UNK	7	BED					
092B.032.4.4.4	008	15	18382			24			00	00	00	002	23	J EILERTSEN	SOOKE RD	01-04-74	150.0	0.0	136		3.5	GPM	UNK	7	BED					
092B.032.4.4.4	009	16	18382			24			00	00	00	003	23	D ANDROWSKI		01-10-74	175.0	0.0	136		1.5	GPM	UNK	9	BED					
092B.032.4.4.4	010	17	34712			116		7	00	00	00	003	23	BLOCK BROS	CONNIE RD	01-05-80	187.0	6.0	076	DRI	2.0	GPM	UNK	4	BED					
092B.032.4.4.4	011	4	32025			116		7	00	00	00	003	23	BLOCK BROS	CONNIE RD	24-03-80	328.0	6.0	076	DRI	1.5	GPM	UNK	25	BED					
092B.032.4.4.4	012	5	32025			116		7	00	00	00	004	23	BLOCK BROS	CONNIE RD	10-04-80	406.0	6.0	076	DRI	1.5	GPM	UNK	21	BED					
092B.032.4.4.4	013	1	32025			116		7	00	00	00	004	23	BLOCK BROS	CONNIE RD	11-02-80	40.0	6.0	076	DRI	1.0	GPM	UNK	35	BED					
092B.032.4.4.4	014	12	18382			24			00	00	00	004	23	RICK SMITH	SOOKE RD		300.0	6.0	033	DRI	0.5	GPM	UNK	12	BED					
092B.032.4.4.4	015	14	32025			116		7	00	00	00	008	54	BLOCK BROS	CONNIE RD	21-04-80	582.0	6.0	076	DRI	0.3	GPM	UNK	3	BED					

BCGS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (dmy)	Well Depth (ft.)	Well Diam. (in.)	Drill Cntr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092B.032.4.4.4	016	13	34712			122			00	00	00	009	54	BOB MALCOMSON	CONNIE RD	09-09-82	660.0	6.0	076	DRI	0.5	GPM	UNK	2	BED					
092B.032.4.4.4	017	6	34712			122			00	00	00	011	54	STEVE BRODSKY	1871 CONNIE RD.	26-11-83	610.0	6.0	076	DRI			100	26	BED					
092B.032.4.4.4	018	1	3351			65			00	00	00	000	23	JIM MITCHELL	5010 SOOKE RD	01-11-76	300.0	0.0	076				UNK	24	BED					
092C.050.3.1.2	001							54	00	00	00	000	46	DEPT OF PUBLIC WORKS	ROSEMOND & CLINCH CR	01-01-75	118.0	0.0	UNK		10.0	GPM	UNK	UNK	UNC					
092C.058.4.2.2	001	6						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	450.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	002	5						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	150.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	003	4						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	110.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	004	3						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	110.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	005	2						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	110.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	006	1						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	110.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	007	7						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	130.0	0.0	078				UNK	UNK	UNC					
092C.058.4.2.2	008	8						17	00	00	00	000	46	LADER DEVELOPMENTS		01-11-76	70.0	0.0	078				UNK	UNK	UNC					
092C.059.3.1.1	001								00	00	00	000	46	BC FOREST PRODUCTS		01-01-50	20.0	0.0	168	DRI			UNK	20	UNC					
092C.059.3.1.1	002								00	00	00	000	46	BC FOREST PRODUCTS		01-01-50	130.0	0.0	168	DRI			UNK	33	UNC					
092C.059.3.1.1	003								00	00	00	000	46	BC FOREST PRODUCTS		01-01-50	31.0	0.0	168	DRI			8	UNK	UNC					
092C.059.3.1.1	004								00	00	00	000	46	BC FOREST PRODUCTS			40.0	0.0	168	DRI			UNK	29	UNC					
092C.059.3.1.1	005								00	00	00	000	46	BC FOREST PRODUCTS			85.0	0.0	168	DRI			UNK	UNK	UNC					
092C.085.1.2.2	001								00	00	00	005	02	ANACLA INDIAN RES #3		01-05-76	40.0	6.0	078	DRI			UNK	UNK	UNC					
092C.085.1.2.2	002								00	00	00	000	02	OHIAT BAND		02-02-86	400.0	6.0	039	DRI	4.0	GPM	30	15	BED					
092C.085.1.2.2	003								00	00	00	000	02	ANACLA RESERVE 12		21-05-86	34.0	5.0	032	DRI	30.0	GPM	UNK	UNK	UNC	26-31				
092C.085.1.2.2	004								00	00	00	000	02	ANACLA RESERVE 12		23-05-76	24.0	6.0	078		25.0	GPM	UNK	UNK	UNC	20-24				
092C.085.1.2.2	005								00	00	00	000	02	ANACLA		11-01-69	100.0	6.0	101	DRI	480.0	GPH	5	UNK	UNC	13-27				
092C.085.1.4.1	001								00	00	00	000	02	WEST CAN UNV MAR BIO		01-01-72	302.0	8.0	032	DRI			UNK	UNK	UNC					
092C.085.1.4.1	002								00	00	00	000	02	HOLMES		01-01-72	400.0	0.0	032	DRI			UNK	4	BED					
092C.085.1.4.1	003								00	00	00	000	02	BAMFIELD RESORTS LTD		01-06-75	150.0	0.0	135		1.5	GPM	UNK	3	BED					
092C.085.1.4.1	004								00	00	00	000	02	A & H MCDERMID		01-05-75	125.0	0.0	135	DRI	3.0	GPM	UNK	UNK	UNC					
092C.085.1.4.1	005	1	18606		1	20			00	00	00	000	02	BEVERLY GARCIA		01-05-76	60.0	6.0	078	DRI	12.0	GPM	15	53	BED					
092C.085.1.4.1	006	2	26181		1	20			00	00	00	000	02	W RUSSELL DONALDSON		01-06-75	140.0	0.0	135	DRI			UNK	UNK	UNC					
092C.093.1.4.1	001		14416	3		21			00	00	00	000	09	BERT MACK	TOQUART BAY	11-10-83	330.0	6.0	039	DRI	50.0	USGM	UNK	36	BED					
092C.093.3.1.3	001	A	33592					469	00	00	00	000	09	TED WALKER	2325 UCLUELET HWY	13-06-84	500.0	6.0	039	DRI	0.5	GPM	50	5	BED					
092C.093.3.2.3	001								00	00	00	000	09	PACIFIC RIM TECHNICA	PACIFIC RIM NATIONAL	01-01-80	100.0	8.0	UNK		10.0	USGM	24	UNK	UNC	95-100		Y		
092C.093.3.3.1	001	18	1692					468	00	00	00	000	09	DAVID ISFANOR	2425 UCLUELET HIGHWA	01-01-86	65.0	6.0	039	DRI	70.0	GPM	25	UNK	UNC					
092C.093.3.3.3	001								00	00	00	000	09	PACIFIC RIM TECHNICA	PACIFIC RIM NATIONAL	01-01-80	54.0	8.0	UNK		370.0	USGM	10	UNK	UNC	48-54		Y		
092C.093.3.3.3	002								00	00	00	000	09	PACIFIC RIM TECHNICA	PACIFIC RIM NATIONAL	01-01-80	59.5	8.0	UNK		240.0	USGM	18	UNK	UNC	58-59		Y		
092C.093.3.3.3	003							20	00	00	00	000	09	PACIFIC RIM TECHNICA	PACIFIC RIM NATIONAL	01-01-80	34.0	8.0	UNK				UNK	UNK	UNC					
092C.093.3.4.1	001								00	00	00	000	09	A BAILLIE		17-05-77	104.0	6.5	076	DRI			UNK	UNK	UNC					

Ministry of Environment – Water Management Branch – Groundwater Section
Groundwater Database System
Data Summary – with Legal Descriptions and Old Coordinates

NTS Map Area	Well No.	Lot No.	Plan No.	Blk No.	TP	SC	RG	D.L.	Z	X	Y	Old Well No.	L.D.	Owner's Name	Site Address	Date Constructed (dmy)	Well Depth (ft.)	Well Diam. (in.)	Drill Contr No.	Const. Method	Well Yield	Yld. Unt.	Depth to Water (ft.)	Depth to Bedrk (ft.)	Aquif Litho	Screen Interval (ft.)	G.W. Rpt	Chem Lab	Chem Fld	Chem Site No.
092F.001.3.3.1	001							2	00	00	00	000	20	M GOOD	SOUTH FORK ROAD	15-12-75	264.0	6.0	046	DRI	15.0	GPH	39	36	BED					
092F.001.3.3.4	001	21	1527			10			00	00	00	000	32	RAY PAGANELLO		09-10-70	170.0	0.0	101	DRI	4.0	GPM	70	48	BED					
092F.002.2.1.4	001								00	00	00	000	09	PARKS PACIFIC RIM	WICKINNINISH INN	11-04-74	490.0	6.0	032	DRI	2.0	GPM	UNK	353	BED		Y			
092F.002.2.1.4	002								00	00	00	000	09	PARKS PACIFIC RIM	WICKINNINISH INN	16-04-74	80.0	6.0	032	DRI	2.2	USGM	9	UNK	UNC	20-25	Y	Y		
092F.002.2.1.4	003								00	00	00	000	09	DEPT INDIAN AFFAIRS	PACIFIC RIM NATION P	01-01-50	205.0	0.0	UNK				UNK	UNK	UNC					
092F.002.2.1.4	004								00	00	00	000	09	NATIONAL PARKS BRANC	PACIFIC RIM NATIONAL	01-01-50	200.0	0.0	101				UNK	UNK	UNC					
092F.002.2.2.2	001								00	00	00	000	09	PACIFIC RIM PARK	LOST SHOE CREEK	27-03-74	88.0	6.0	032	DRI	40.0	GPM	18	UNK	UNC	48-57		Y		
092F.002.3.1.3	001								00	00	00	000	09	DEPT INDIAN AFFAIRS	PACIFIC RIM NATIONAL	01-01-50	200.0	0.0	101				UNK	UNK	UNC					
092F.002.3.1.3	002								00	00	00	000	09	PARKS PACIFIC RIM		27-03-74	102.0	6.0	032	DRI			18	UNK	UNC	48-57				
092F.002.3.1.3	003								00	00	00	000	09	PACIFIC RIM PARK	AIRPORT SITE	01-01-75	9.0	0.0	032	DRI	15.0	USGM	3	UNK	UNC		Y	Y		1401636
092F.002.3.1.4	001								00	00	00	000	09	DEPT INDIAN AFFAIRS	PACIFIC RIM NATIONAL	01-01-50	50.0	0.0	101				UNK	UNK	UNC					
092F.002.3.2.2	001							138	00	00	00	000	09	PARKS BRANCH		01-07-64	166.0	8.0	120	DRI			UNK	147	UNC			Y		
092F.002.3.2.2	002							138	00	00	00	000	09	PARKS BRANCH		01-08-64	130.0	8.0	120	DRI			42	UNK	UNC					
092F.002.3.3.1	001								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	17-01-63	60.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.1	002								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	18-01-63	40.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.1	003								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	19-01-63	70.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.1	004								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	21-01-63	38.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.2	001								00	00	00	000	09	DEPT OF TRANSPORT		01-11-62	87.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.2	002								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	01-11-62	90.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.2	003								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	01-12-62	95.0	4.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.2	004								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	14-01-63	75.0	4.0	UNK	OTH	8.7	GPM	UNK	UNK	UNC			Y		
092F.002.3.3.2	005								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	21-01-63	65.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.002.3.3.2	006								00	00	00	000	09	DEPT OF TRANSPORT	AIRPORT	22-01-63	30.0	0.0	UNK	OTH			UNK	UNK	UNC					
092F.003.1.3.4	001								00	00	00	000	09	PACIFIC RIM PARK	KENNEDY LAKE	18-04-74	300.0	6.0	032	DRI	0.5	GPM	UNK	UNK	UNC		Y	Y		
092F.011.1.4.4	001	1	21657					127	00	00	00	000	09	R MCKENZIE BEACH RES		14-02-76	210.0	8.0	099	DRI	1.0	GPM	1	9	BED					
092F.011.3.3.2	001	12	26387			20	4		00	00	00	000	32	MURRAY NIXON	JINGLE POT RD	16-01-77	125.0	6.0	046	DRI			30	4	BED					
092F.011.3.3.2	002	8	26387			20	4		00	00	00	000	32	CLAY MILLAN	JINGLE POT RD	07-04-77	110.0	0.0	078	DRI			UNK	8	BED					
092F.011.3.3.2	003	8	26387			20	4		00	00	00	000	32	CLAY MILLAN	JINGLE POT RD	12-04-77	90.0	6.0	UNK	DRI	30.0	GPM	42	12	BED					
092F.011.3.4.4	001								00	00	00	000	33	DEPT OF REC AND CON	NEWCASTLE ISLAND MAR	17-12-74	150.0	0.0	032	DRI	40.0	GPM	65	5	BED			Y		

APPENDIX 'E'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #1
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	Marine, moderately stratified mantle.
Surface Expression:	A mantle or blanket of unconsolidated material.
Thickness:	> 1 m
Texture:	Very fine grained silty clay.
Drainage:	The modal soil is moderately well drained (excess moisture for a short but significant period of the year).
General topography:	Undulating, 2 - 5% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Yellowish grey to brown, compact silty clay, fine grained. Where dry, clay very friable.
Drainage:	Dry.
Site Gradient:	Level.
Vegetation:	Previously clear-cut, with regrowth underway.
Elevation:	30 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'F'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #2
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	Fluvioglacial.
Surface Expression:	Fan or cone.
Thickness:	
Texture:	Gravelly loamy sand.
Drainage:	Imperfectly drained, soil wet on subsurface.
General topography:	Predominantly level, 0 - 0.5% slope. Some undulating, 2 - 5% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Reddish brown to light brown, silty to gravelly grained sand. Friable.
Drainage:	Water ponding in some areas.
Site Gradient:	Level.
Vegetation:	Previously clear-cut.
Elevation:	50 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'G'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #3
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	80% colluvium, 20% moraine.
Surface Expression:	Hummocky.
Thickness:	10 cm - 1 m of colluvium veneer. > 1 m morainal blanket.
Texture:	80% Gravelly loamy sand, 20% gravelly sandy loam
Drainage:	80% well drained, no excess moisture most of the year. 20% moderately well drained, excess moisture for short but significant part of the year.
General topography:	Predominantly strongly rolling, 15 - 30% slope. Some moderately rolling 9 - 15% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Light brown, very fine grained silty clay. Friable.
Drainage:	Appeared dry.
Site Gradient:	Level.
Vegetation:	Previously clear-cut, no regrowth.
Elevation:	50 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'H'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #4
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	60% moraine, 40% colluvium.
Surface Expression:	Sandy morainal blanket.
Thickness:	> 1 m.
Texture:	80% gravelly sandy loam, 20% gravelly loamy sand.
Drainage:	80% moderately well drained, excess moisture for a short but significant part of the year. 20% well drained, no excess moisture for most of the year.
General topography:	Predominantly gently rolling, 5 - 9% slope. Some moderately rolling 15 - 30% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Not tested
Drainage:	Not seen.
Site Gradient:	Level.
Vegetation:	Not seen. Very likely previously clear-cut as evidenced by logging roads which were not passable.
Elevation:	40 metres a.s.l.
Distance to nearest surface waterway:	750 m
Available working area:	> 5 ha

APPENDIX 'I'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #5
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	50% colluvium, 50% moraine (schist derived).
Surface Expression:	Colluvium/ morainal veneer overlying bedrock.
Thickness:	10 cm to 1 m.
Texture:	Gravelly loam.
Drainage:	Well drained, no excess moisture for most of the year.
General topography:	Predominantly moderately rolling, 9 - 15% slope. Some hilly, 30 - 60% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Not tested
Drainage:	Not seen.
Site Gradient:	Dipping 3.3° or 6% to the SSW.
Vegetation:	Not seen.
Elevation:	400 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'J'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #6
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	60% fluvial, 20% moraine, and 20% colluvium.
Surface Expression:	Morainal blanket
Thickness:	> 1 m
Texture:	60% very gravelly loamy sand, 20% gravelly sandy loam, 20% gravelly loam.
Drainage:	Moderately well drained to well drained.
General topography:	Steeply sloping, 15 - 30% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Not tested due to predominant stumpage.
Drainage:	Dry.
Site Gradient:	Dipping 10° or 18% to the SSW.
Vegetation:	Clear-cut, no regrowth.
Elevation:	140 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'K'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #7
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	60% fluvial, 40% moraine.
Surface Expression:	Morainal blanket.
Thickness:	> 1 m
Texture:	60% gravelly sandy loam, 40% very gravelly loamy sand.
Drainage:	Well drained to moderately well drained.
General topography:	Predominantly gently rolling, 5 - 9% slope. Some steeply rolling, 15 - 30% slope.
Vegetation Zonation:	Coastal western hemlock-Pacific silver fir zone; western red cedar subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Light coloured gravelly sandy loam.
Drainage:	Dry.
Site Gradient:	Dipping 5° or 9% to the SW.
Vegetation:	Just clear-cut.
Elevation:	120 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'L'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #8
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material:	80% moraine, 20% fluvial.
Surface Expression: overlying	60% morainal blanket inter-mixed with 40% fluvioglacial morainal blanket.
Thickness:	> 1 m
Texture:	80% gravelly sandy loam, 20% very gravelly loamy sand.
Drainage:	Well drained to moderately well drained.
General topography:	Predominantly gently rolling, 5 - 9% slope. Some moderately rolling, 9 - 15% slope.
Vegetation Zonation:	Coastal western hemlock zone: coast Douglas-fir subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection:	Not tested.
Drainage:	Not seen.
Site Gradient:	Dipping 3.3° or 6% to the south.
Vegetation:	Not seen.
Elevation:	100 metres a.s.l.
Distance to nearest surface waterway:	400 m
Available working area:	> 5 ha

APPENDIX 'M'

POTENTIAL OILED DEBRIS MANAGEMENT SITE #9
PHYSICAL DATA

SOILS & TERRAIN MAP DATA

Parent Material: 33% moraine, 33% fluvial, 33% colluvium.

Surface Expression: 60% morainal blanket inter-mixed with 20% fluvioglacial and 20% colluvium.

Thickness: > 1 m

Texture: 66% gravelly sandy loam, 33% very gravelly loamy sand.

Drainage: Mostly well drained.

Topography: Moderately rolling, 9 - 15% slope.

Vegetation Zonation: Coastal western hemlock zone: coast Douglas-fir subzone.

SITE INVESTIGATION & TOPOGRAPHICAL MAP DATA

Augered Soil Inspection: Not tested.

Drainage: Not seen.

Site Gradient: Dipping 2.3° or 4% to the SW.

Vegetation: Not seen. Probably previously clear-cut based on extensive logging roads in the area.

Elevation: 140 metres a.s.l.

Distance to nearest surface waterway: 300 m

Available working area: > 5 ha