**Southeast Alaska Acoustic
Measurement Facility (SEAFAC)
Environmental Data Base
Review, Evaluation,
and Upgrade**

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**Pacific Northwest Laboratory
Richland, Washington 99352**

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SOUTHEAST ALASKA ACOUSTIC
MEASUREMENT FACILITY (SEAFAC)
ENVIRONMENTAL DATA BASE REVIEW,
EVALUATION, AND UPGRADE

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EXECUTIVE SUMMARY

This report summarizes the principal issues of public concern, the adequacy of the environmental data base to answer the issues of concern, and the additional data collection required to support a National Environmental Policy Act (NEPA) review of the proposed Southeast Alaska Acoustic Measurement Facility (SEAFAC). The report is based on a review of the readily available environmental literature and a site visit. Representatives of local, state, and federal agencies were also interviewed for their personal insights and concerns not discovered during the literature review.

PHYSICAL ENVIRONMENT

The principal public concerns relate to water quality, geology, soils, and seismicity. The potential for water quality impacts increase as human activities on Back Island increase. Spillage of diesel fuel and leaching of creosote and other antifouling residues from docking facilities all have a finite probability of impacting the environment. The soils of Back Island are thin and a high potential exists for erosion if mitigative measures are not followed during construction. Earthquake and tsunami events could also increase the potential for pollution impacts if diesel fuel storage and sewage containment systems are not properly designed.

Only the data bases for airborne acoustics (noise), geology, soils, and seismicity are inadequate to prepare the requisite Physical Environment sections of the Environmental Statement (ES). In each case, site-specific data are lacking.

ECOLOGICAL ENVIRONMENT

One of the most visible public concerns is the perception that surface buoys, barges, and range operation will limit or otherwise impact commercial, recreational, or subsistence fishing for salmon and ground fish. Of near equal importance is the concern of fishery biologists that construction of the pier and cable facilities may impact herring spawning, valued shellfish

resources (scallops, abalone, clams, crabs, mussels), and other invertebrates and aquatic plants if they are found close to Back Island. Some public concern was also expressed regarding potential disturbance of marine mammals by aircraft, underwater sound, and SEAFAC range operation. Potential public concern for the terrestrial habitat relates to animals or birds of endangered or legal status such as the Prince of Wales Island subspecies of the northern flying squirrel and the bald eagle. Whether protection of either species becomes an issue will depend on public perception and their presence on Back Island.

Our reviews of the literature and professional resources suggest that DTNSRDC should support additional data collection in both aquatic and terrestrial habitats. Although adequate data are available to address issues pertaining to potential impacts on finfish, almost no site-specific data exist on shellfish, other invertebrates, and aquatic plants. Also, surveys to determine potential use of Behm Canal by marine mammals should be included. Tree and plant cover by habitat type in addition to breeding bird and small mammal trapping surveys (to include endangered and legal status birds and animals) are also required to properly develop the ecological environmental sections of the ES.

SOCIOECONOMIC ENVIRONMENT

The principal socioeconomic concerns focus on land and water use. The public perceives that land-based facilities may prevent or significantly limit recreational use of Back Island for picnicking, camping, hunting, trapping, and subsistence wood cutting. Similarly, the in-water facilities are perceived to interfere with navigation and various commercial, recreational, and subsistence fishing, including salmon trolling and gill netting, harvesting of herring roe, and long-lining for sable fish and halibut. Some public concern also exists that SEAFAC may have an aesthetic impact on the wilderness qualities of Behm Canal. The discovery of native burial sites or other historic sites on Back Island could also increase public concern.

Adequate data are available to address potential impacts on regional demography, labor force and housing, public institutions, and educational facilities. However, additional data need to be collected to more accurately estimate impacts on community services and land and water use, particularly impacts on recreation and aesthetics and prehistoric and historic resources.

CONTENTS

ACKNOWLEDGEMENTS	iii
EXECUTIVE SUMMARY	v
1.0 INTRODUCTION	1
2.0 PHYSICAL ENVIRONMENT	3
2.1 ISSUES OF POTENTIAL CONCERN OR CONFLICT	3
2.1.1 Hydrology and Water Quality	3
2.1.2 Acoustics	4
2.1.3 Geology and Soils	5
2.1.4 Seismicity	5
2.1.5 Climate and Air Quality	5
2.2 DATA BASE AVAILABILITY	6
2.2.1 Hydrology and Water Quality	6
2.2.2 Acoustics	9
2.2.3 Geology and Soils	10
2.2.4 Seismicity	13
2.2.5 Climate and Air Quality	14
2.3 DATA BASE ADEQUACY	16
2.3.1 Hydrology and Water Quality	16
2.3.2 Acoustics	18
2.3.3 Geology and Soils	19
2.3.4 Seismicity	19
2.3.5 Climate and Air Quality	19
3.0 ECOLOGICAL ENVIRONMENT	21
3.1 AQUATIC ENVIRONMENT	21
3.1.1 Issues of Potential Concern or Conflict	21
3.1.2 Data Base Availability	24
3.1.3 Data Base Adequacy	31
3.2 TERRESTRIAL ENVIRONMENT	33
3.2.1 Issues of Potential Concern or Conflict	33
3.2.2 Data Base Availability	35
3.2.3 Data Base Adequacy	40

4.0	SOCIOECONOMIC ENVIRONMENT	41
4.1	ISSUES OF POTENTIAL CONCERN OR CONFLICT	41
4.1.1	Regional Demography	41
4.1.2	Labor Force and Housing	41
4.1.3	Community Services	42
4.1.4	Public Institutions and Educational Facilities	43
4.1.5	Land Use	43
4.1.6	Water Use	44
4.1.7	Prehistoric and Historic Resources	46
4.2	DATA BASE AVAILABILITY	46
4.2.1	Regional Demography	46
4.2.2	Labor Force and Housing	46
4.2.3	Community Services	47
4.2.4	Public Institutions and Educational Facilities	47
4.2.5	Land Use	47
4.2.6	Water Use	48
4.2.7	Prehistoric and Historic Resources	49
4.3	DATA BASE ADEQUACY	49
4.3.1	Regional Demography	49
4.3.2	Labor Force and Housing	49
4.3.3	Community Services	50
4.3.4	Public Institutions and Educational Facilities	50
4.3.5	Land Use	50
4.3.6	Water Use	50
4.3.7	Prehistoric and Historic Resources	51
5.0	RECOMMENDED STUDIES TO CORRECT REAL OR PERCEIVED DATA DEFICIENCIES	53
5.1	PHYSICAL ENVIRONMENT	53
5.1.1	Acoustics	53
5.1.2	Geology, Soils, and Seismicity	55
5.2	ECOLOGICAL ENVIRONMENT	57
5.2.1	Aquatic Environment	57
5.2.2	Terrestrial Environment	60
5.3	SOCIOECONOMIC ENVIRONMENT	64
5.3.1	Community Services	64
5.3.2	Recreational Use	65

5.3.3	Aesthetics	67
5.3.4	Prehistoric and Historic Resources	68
6.0	LIST OF INDIVIDUALS CONTACTED DURING STUDY	69
7.0	REFERENCES	75
8.0	BIBLIOGRAPHY	82
8.1	PHYSICAL ENVIRONMENT	82
8.1.1	Hydrology and Water Quality	82
8.1.2	Acoustics	83
8.1.3	Geology and Soils	84
8.1.4	Seismicity	85
8.1.5	Climate and Air Quality	86
8.2	ECOLOGICAL ENVIRONMENT	87
8.2.1	Aquatic Environment	87
8.2.2	Terrestrial Environment	90
8.3	SOCIOECONOMIC ENVIRONMENT	95
8.3.1	Regional Demography	95
8.3.2	Labor Force and Housing	95
8.3.3	Community Services	95
8.3.4	Public Institutions and Educational Facilities	97
8.3.5	Land Use	97
8.3.6	Water Use	99
8.3.7	Prehistoric and Historic Resources	100

FIGURES

1	Schedule for Acoustic Surveys	56
2	Schedule for Geology, Soils, and Seismicity Surveys	58
3	Schedule for Shellfish, Other Invertebrates, and Aquatic Plant Surveys	60
4	Schedule for Marine Mammal and Prey Surveys	61
5	Schedule for Forest Surveys	63
6	Schedule for Faunal Surveys	65
7	Schedule for Community Services Survey	69
8	Schedule for Recreational Land and Water Use Survey	68
9	Schedule for Aesthetics Survey (Recreational Survey)	69

TABLES

1	Labor Needed for Acoustic (Airborne Noise) Surveys	57
2	Labor Needed for Geology, Soils, and Seismicity Field Surveys	59
3	Labor Needed for Shellfish, Other Invertebrate, and Aquatic Plant Surveys	60
4	Labor Needed for Marine Mammal and Prey Surveys	62
5	Labor Needed for Forest Survey	64
6	Labor Needed for Faunal Surveys	66
7	Labor Needed for Community Services Survey	67
8	Labor Needed for Recreational Land and Water Use Survey	68
9	Labor Needs for Aesthetics Survey	69

SOUTHEAST ALASKA ACOUSTIC MEASUREMENT FACILITY (SEAFAC)
ENVIRONMENTAL DATA BASE REVIEW, EVALUATION, AND UPGRADE

1.0 INTRODUCTION

The objective of this study was to catalog all readily available environmental data and determine whether these are adequate to prepare an Environmental Statement (ES) for the proposed U.S. Navy and the David Taylor Naval Ship R&D Center (DTNSRDC) Behm Canal Acoustic Measurement Facility in Ketchikan Gateway Borough, Alaska. The environments evaluated included 1) the physical environment consisting of hydrology and water quality, acoustics (noise), geology and soils, seismicity, climate, and air quality; 2) the ecological environment composed of the aquatic habitat (fish, shellfish and other invertebrates, marine mammals, plants, and rare and endangered animals) and terrestrial habitat (forest type and composition, wildlife and game animals, and rare and endangered species); and 3) the socioeconomic environment considering regional demography, labor force and housing, community services, public institutions and educational facilities, land and water use, and pre-historic and historic resources.

This effort was accomplished by both searching the literature and visiting the site. Representatives of local, state, and federal agencies were also visited and asked for personal insights and concerns.

Our effort serves two purposes: 1) the resulting data base may be used during the ES process to prepare the description of the site and the requisite assessments of impact, and 2) the recommended future studies may be used by DTNSRDC to correct potential deficiencies in the data base that could seriously impede the ES process.

Sections 2.0, 3.0, and 4.0 first describe the principal issues of concern or conflict likely to arise if SEAFAC is located on Back Island in Behm Canal. These sections also examine whether the data are adequate to address and answer the issues of concern or conflict. Section 5.0 summarizes the additional data that need to be collected to prepare an

acceptable ES. Included in Section 5.0 are plans for collecting the requisite information and some cost estimates for these efforts. Section 6.0 provides a list of individuals contacted during the course of this study. Additional information on the data sources for SEAFAC and vicinity can be found in Section 7.0.

It should be understood that the environmental issues discussed in Sections 2.0, 3.0, and 4.0 were derived from the site visit and associated discussions with agency staff, and that additional environmental issues of concern or conflict could arise as a result of public participation in the National Environmental Policy Act (NEPA) process beginning later this year.

2.0 PHYSICAL ENVIRONMENT

The portions of Behm Canal and land required for the SEAFAC shore support facilities are located within the jurisdiction of the Tongass National Forest. The Canal is a large deep protected body of water located approximately 13 miles from Ketchikan in southeast Alaska. The overall environmental profile identifies the area as pristine water corridors with surrounding land areas of great beauty, abundant wildlife habitat, and rich in natural resources.

In general, the topography of the area has been fashioned by glaciers. The results are visible everywhere in the rounded slopes, U-shaped valleys, exposed smooth bedrock, glacial mountain lakes and a network of glacially carved, sheer, granite-walled fjords.

2.1 ISSUES OF POTENTIAL CONCERN OR CONFLICT

Potential areas of impact to the physical environment as a result of construction and operation of SEAFAC include hydrology and water quality, acoustics (noise), geology and soils, seismicity, and climate and air quality.

2.1.1 Hydrology and Water Quality

The in-water portions of SEAFAC, consisting of buoys, hydrophone arrays and various cables and anchors, probably will not adversely affect the physical environment of Behm Canal and, accordingly, will not likely be an issue of concern. However, water quality could become an issue of some importance as human activities on Back Island and in the environs increase. Spillage of diesel fuel oil could have some local adverse impacts. Creosote and certain antifouling paint residues from the pier facilities may also be added to the water column, although probably in low concentrations. In addition, precipitation runoff from a helicopter pad and other paved surfaces may allow hydrocarbons and other potential contaminants to eventually enter marine waters. Potential routine or accidental releases of radioactivity from submarine operations may also be raised as an issue, although there is no public concern at this time.

2.1.2 Acoustics

The acoustics and environmental noise addressed in the ES will be divided into two categories: airborne sound and waterborne sound. The former affects the environment of the human population and the land-dwelling wildlife population, while the latter affects the environment of permanent and transient marine biota. As is the case with other topics of the ES, the noise section will deal with

- the potential impact of the proposed action
- the baseline noise environment of the study area
- the increment of noise caused by the action
- the resulting acoustical environment
- the response of the affected populations to the increment
- feasible noise mitigation measures.

The potential for impact to the acoustic environments (air and water) is related to noise-generating activities of both the construction of the proposed facility and its operation. Because various transportation corridors will be used during both of these activities, the affected area not only includes the site and its immediate environs, but also the highways and waterways that will be used for delivery of materials and supplies, and for commuting by construction crews and operating staff. To assess the magnitude of these impacts, the airborne and waterborne sounds generated by these activities are compared with the existing levels.

Because marine biota are present in the waters constituting and surrounding the site, the waterborne sound environment must also be discussed. Except for different measurement techniques and use of a different reference value for sound levels, the baseline sound levels are characterized in much the same way as airborne noise. That is, appropriate measurement locations and sampling times must be chosen, and sufficient data must be acquired to establish a representative data base that can be used to assess the impact on aquatic animals.

Our preliminary surveys did not indicate that noise, either in air or water, constitutes a public problem or concern. The one possible concern relates to whether underwater noise alters marine mammal behavior in Behm Canal; however, in the opinion of the professional biologists contacted, no foreseeable adverse impacts would result from SEAFAC operations. The proposed acoustic measurements are mostly passive, where no sound source (pinger) is introduced to the water body. Nonetheless, concern for marine mammals may become an issue in the future. Accordingly, the Navy may wish to re-examine the issue if public interest in SEAFAC increases.

2.1.3 Geology and Soils

The main issue of concern is the relatively thin nature of the soils and the high potential for erosion if mitigative measures are not used during site preparation and facility construction.

2.1.4 Seismicity

Certain land-based facilities (diesel fuel storage, packaged primary sewage treatment plant), unless properly designed, could become pollution sources in response to earthquake and tsunami events.

2.1.5 Climate and Air Quality

Air quality is not likely to be degraded as a result of SEAFAC operation. This conclusion is reached as follows. The primary impact of SEAFAC on the atmospheric environment is likely to be caused by emissions from the engines driving the generators that supply electrical power to the facility. Using U.S. Environmental Protection Agency (EPA 1978) emission factors for diesel engines capable of providing sufficient power for SEAFAC operation, and assuming that 1 MW of power is required for 800 hours per year and 0.35 MW is required for the remainder of the year, preliminary evaluation indicates that the emissions of the motors will not cause SEAFAC to be classified as a major pollutant source (EPA 1980). Further, the proposed SEAFAC location is not in the vicinity of any of the designated Class I areas, which have stringent air quality regulations (DOE 1979). Thus, demonstrating that SEAFAC operation will not result in a violation of National Ambient Air Quality Standards (NAAQB) will be sufficient to avoid having air quality become a major issue.

2.2 DATA BASE AVAILABILITY

2.2.1 Hydrology and Water Quality

The NEPA process requires a description of the physical environment as part of the ES of which tides, water circulation and currents and water quality are included. An excellent description of West Behm Canal and Revillagigedo Island are provided in the "Atlas of the Ketchikan Region" (Martinson and Kuklok 1979). The description includes the physical dimensions of Behm Canal such as length, widths, and depths. Although Back Island and surrounding islands are not specifically discussed in this document, topographic and bathymetric information can be obtained from maps and charts in the atlas. Additional information on the physical setting of Behm Canal including topography and bathymetry can be obtained from the U.S. Geological Survey's topographic sheets of the Ketchikan region and U.S. National Ocean Survey nautical charts of the region.

Behm Canal can be technically classified as a fjord because it was created by glacial scour and has the characteristic sill at the mouth of the canal. A good description of physical and oceanographic characteristics of fjords can be found in Freeland et al. (1980).

Tides in West Behm Canal are of the mixed semi-diurnal type, meaning that two high and two low tides of unequal heights occur each day. Predicted daily tide tables for Ketchikan, Alaska, are published annually by the U.S. National Ocean Survey (1985). Corrections for time of high and low water and height corrections for various locations in West Behm Canal are provided in Table 2, Tidal Differences and Other Constants. Locations 1367, 1369, 1371, 1373, 1375, 1377, and 1379 pertain to West Behm Canal. The closest location to Back Island and the range course is Loring and Naha Bay (Lat. 55°36', Long. 131°38'). The time and height differences for high tide at Loring are minus one minute and plus 0.4 feet, respectively. The time and height of low tide at Loring correspond to those at Ketchikan. The mean and diurnal tidal ranges at Loring are 13.4 feet and 15.7 feet, respectively. The mean tide level is 8.2 feet.

A good general description of tides and currents in southeast Alaska with some historical significance is provided in Woodworth and Haight (1927). This document is available through the U.S. National Ocean Survey, Anchorage Chart Sales Office, Anchorage, Alaska.

Little information could be found on water circulation patterns and currents in West Behm Canal. A number of engineering firms and the University of Alaska were contacted for information pertaining to current regime studies in West Behm Canal. The only studies directly applicable to West Behm Canal were those performed by TRACOR, Inc. in 1983 in relation to SEAFAC (Henderson 1983a,b; 1984a,b). In these studies, TRACOR, Inc. measured currents in West Behm Canal near the center of the proposed range course and near the proposed static test site. Moored current meter and current profile data were collected during the months of March, June, July, September, and November 1983. The moored current meter array was deployed near the center of the proposed range at depths of 100, 400, and 600 feet below the surface and 50 feet above the bottom. The upper current meter was later relocated to a depth of 50 feet below the surface. Highest current velocities were found to occur at the upper current meter where the maximum recorded velocity was 0.8 knots. The maximum recorded current velocity at the deepest current meter was 0.2 knots.

The "United States Coast Pilot 8, Pacific Coast of Alaska: Dixon Entrance to Cape Spencer" (U.S. National Ocean Survey 1978) gives a short description of tidal currents in Behm Canal. It is stated in the Coast Pilot that

The flood current enters Behm Canal at each end and meets somewhere in the vicinity of Burroughs Bay. In general the currents are not very strong, ordinarily from 1 to 2 knots. Tide rips generally occur on the ebb at the mouths of various tributaries.

The U.S. National Ocean Survey also publishes annual predicted tidal current tables for the Pacific Coast of North America and Asia (U.S. National Ocean Survey 1985). Time differences, velocity ratios, and maximum currents are given for three locations in West Behm Canal, based on the predicted

currents in Wrangell Narrows. The three locations are Behm Narrows (2425), Helm Point (2430) and 2 miles northwest of Guard Islands (2435). The closest station to the range course is Helm Point. The maximum average flood and ebb currents at this location are both reported as 1.2 knots.

Predicted currents reported by the U.S. National Ocean Survey (1985a,b) are slightly higher than those reported by TRACOR, Inc. (Henderson 1983a,b; 1984a,b). The slight variations could be due to the differences in locations or depths where the currents were measured. Normally, the predicted currents are based on near-surface currents, whereas those reported by Henderson were 50 to 100 feet below the surface.

Some general information about currents in southeast Alaska may be obtained from Woodworth and Haight (1927).

Water surface and depth profiles of temperatures and salinities in West Behm Canal were reported by Pickard (1967) at six locations along the canal in June 1964 and August 1965. Typical longitudinal distributions of surface water temperatures occur in West Behm Canal. Water surface temperatures during the early summer decrease and salinities increase from the head of the canal (Unuck River) toward the mouth of Clarence Strait. A rapid decrease in water temperature and increase in salinity occurred in the near-surface waters of West Behm Canal in June 1964 and August 1965. Below about 650 feet the water temperature and salinity were fairly uniform at about 6°C and 33 ppt, respectively.

Henderson (1983a,b; 1984a,b) also investigated the vertical water temperature and salinity distributions in West Behm Canal during the summer and fall of 1983. Henderson found conditions in June 1983 similar to those reported by Pickard (1967) in June 1964 and August 1965. However, in September 1983 the rapid decrease in temperature and increase in salinity with depth were not nearly as pronounced as in early summer. By November 1983 and in January 1984 the water temperatures and salinities were nearly uniform with depth, indicating typical high-latitude fjord characteristics.

Another possible source of data on water temperature and salinity conditions in West Behm Canal is a report by the U.S. Fish and Wildlife Survey for

Traitors Cove, Revillagigedo Island (McLain 1968). The only other water quality parameters that have been collected in West Behm Canal to our knowledge are water transparency and dissolved oxygen. Dissolved oxygen and secchi disk data were collected in June 1964 and August 1965 at six locations in West Behm Canal by Pickard (1967). Henderson (1983a,b; 1984a,b) collected dissolved oxygen data at the proposed course range in 1983 and 1984.

2.2.2 Acoustics

Two types of information are needed to assess noise impact resulting from construction and operation of the proposal facility:

- noise response criteria
- population density in the affected areas.

Noise response criteria for the human population relate degree of annoyance, interference with activity, and health effects to the magnitude of the noise environment, the absolute noise magnitude, and the times at which the noise occurs. Such criteria are well documented (EPA 1982). Criteria for animal populations are less well-defined, and it may be necessary to assume or develop criteria if none are found.

Data on population density are needed to assess the impact in terms of the number of people, animals, etc., that would be affected by construction of the facility.

A limited amount of data on baseline sound level in the air environment of southeast Alaska has been identified. Documented measurements were carried out in 1982 in connection with the Environmental Impact Statement (EIS) for the proposed molybdenum mine at Quartz Hill, 50 miles (80 kilometer) east of Ketchikan (U.S. Borax 1983). The Ketchikan Gateway Borough and the State of Alaska sponsored a study for an Airport Master Plan in 1982. Although the methodology for generating $L_{dn}^{(a)}$ contours for commercial air traffic does not require measurement of ambient levels, data on peak sound levels at the airport and in downtown Ketchikan may be available (Rodman 1985a). No other data have been identified for the airborne sound environment.

(a) Accepted metric unit of measure for airborne environmental noise is the day-night noise level, designated as L_{dn} .

A limited number of data on aircraft noise is available in the form of study notes made in connection with the Ketchikan International Airport Master Plan (Rodman 1985b).

A limited amount of data on underwater sound in Behm Canal are available in reports (Holliday and Henderson 1981; Henderson and Bonnett 1982, Henderson 1983a,b, 1984a,b) that summarize the results of a preliminary evaluation of the sound baseline of the proposed test facility.

2.2.3 Geology and Soils

A description of the geology of the Ketchikan region is provided in the Atlas of the Ketchikan region (Martinson and Kuklok 1979). The geologic description includes the geologic history of southeastern Alaska, geology and minerals, and landforms and soils. Numerous references are cited in the atlas that were not obtained for this review. Some of these references are included in Section 7.0.

2.2.3.1 Geologic History

A description of the tectonic evolution of southeastern Alaska from 1,600 to 600 million years ago to the present is provided by Wheeler and Gabrielse (1972). Other descriptions of the tectonic evolution of southeastern Alaska are provided by Brew et al. (1966), Jones et al. (1972), Monger et al. (1972) and Van Wormer et al. (1974).

2.2.3.2 Geology and Minerals

The geology of the Ketchikan area is discussed by Buddington (1929) and Berg (1973). Berg (1973) in his report emphasizes the geology of Gravina Island, which has received more attention than Revillagigedo Island because of the discovery of large molybdenum ore deposits. We understand that a geologic investigation and map of Revillagigedo Island have been made by the U.S. Geological Survey, but they were not obtained for this review.

The geologic formations on Back Island and surrounding islands are primarily Upper Triassic slate with interlayered sandstone in the upper portion. A portion of Betton Island, located directly to the south of Back Island has Upper Jurassic or Lower Cretaceous formations of quartz diorite, locally varying toward grandiorite.

Metallic mineral deposits, consisting of copper, lead, silver, molybdenum, and iron, are associated with the Upper Triassic Formation in the Ketchikan area. However, no metallic mineral deposits are shown to occur in the Upper Triassic Formation on Hump and Betton islands, directly south of Back Island.

Other information on geology and minerals of southeastern Alaska and the Ketchikan region can be found in Wright and Wright (1908), Chapin (1918), Brew (1966), Bufuers (1967), Cobb (1968), Wolf and Heiner (1971), and Selkregg (1976).

2.2.3.3 Landforms and Soils

Landforms in the Ketchikan region are of the glacial type with high relief and rugged terrain. A description of the landforms is provided in the Atlas of the Ketchikan region (Martinson and Kuklok 1979). Back Island is fairly flat and has low relief in comparison to surrounding islands.

Soils of the Ketchikan region are also discussed in Martinson and Kuklok (1979), who obtained their information from Billings (1974). Soil types on Back Island are not discussed in these references, but can probably be related through a site investigation of similar soils on Revillagigedo Island. The soils on Back Island are likely to be of the forested type and fairly thin. Additional information on the soils of southeastern Alaska may be found in Stephens (1966).

No specific information could be found on the stability of the soils and shoreline of Back Island. The relatively flat slopes of Back Island and what are believed to be thin soils overlying bedrock are an indication of relatively little sliding and slumping. Swanston (1969) provides a general description of slides (soil mass movement) in southeastern Alaska. This document can be used along with a field reconnaissance of Back Island to provide an evaluation of slope stability of the island.

The shoreline of Back Island is composed of low bedrock bluffs with small shingle 'pocket' beaches. Generally, these features indicate a stable shoreline with little if any erosion. Because no supporting information is available on the stability of the Back Island shoreline, a field reconnaissance of

the island to evaluate the stability of the shoreline is recommended especially in the immediate vicinity of any buildings, piers/docks, and shore cable crossings associated with SEAFAC.

No streams or creeks of any substantial size are located on Back Island, so flooding associated with over-bank runoff will not occur or will be minimal. Depending on the drainage characteristics of the soils and the slopes on the island, and whether native vegetation is destroyed during construction, overland runoff from intense precipitation events could result in localized ponding and flooding. However, no specific information was found on the drainage characteristics of the soils on Back Island.

2.2.4 Seismicity

The Behm Canal area is in seismic zone 2 as defined by the International Conference of Building Officials (Lemke 1975). Earthquakes of Richter magnitude 4.5 to 6 can be expected in a seismic zone 2; however, no earthquakes over magnitude 5 have been recorded in this area. Earthquakes strong enough to be felt in Behm Canal most likely would occur along the Fairweather - Queen Charlotte Islands Fault, approximately 150 miles west (Lemke 1975). It is interesting to note that the U.S. Army Corps of Engineers (USACE) places the area in zone 3 where earthquakes of magnitude 6 or greater may be expected.

A short description of tectonic activity and faults in the Ketchikan region is given by Martinson and Kuklok (1979) in the "Atlas of the Ketchikan Region." Included with the description is a map of "Inferred Faults and Earthquakes Epicenters, 1899-1973" prepared from the U.S. Geological Survey Alaska Map Series E. Numerous fault zones are located in the Ketchikan area. The two largest fault zones are the Clarence Strait Linement to the west of Behm Canal and the Coast Range Linement to the east. Numerous smaller fault zones are present on Revillagigedo Island, some of which cross West Behm Canal. However, no earthquake epicenters are shown in the vicinity of Ketchikan and Behm Canal. The closest epicenters with Richter scale magnitudes of greater than 5 are located along the Fairweather - Queen Charlotte Islands Fault.

Possible effects of earthquakes can generally include land level changes caused by faulting or large-scale regional deformation; ground shaking, compaction, liquification, subaerial and submarine sliding/slumping; water-sediment ejection and ground fracturing, reaction to sensitive and quick clays; and effects of tsunamis, seiches, and other abnormal water waves (Lemke 1975). Back Island could be subject to these possible effects of earthquakes, but to our knowledge potential seismic events have not been investigated at Back Island.

Other sources of information on seismic activity in southeastern Alaska can be obtained from Twinhofel and Sainsburg (1958), Davis and Ehols (1962), and Lemke and Yehle (1972).

Description of seismic waves or tsunamis recorded in Alaska are given in the "Catalog of Tsunamis in Alaska" (Cox and Pararas-Caryannis 1976). West Behm Canal and the Ketchikan area are well protected from the open ocean so large tsunamis are unlikely to occur (Martinson and Kuklok 1979). Cox and Pararas-Caryannis (1976) mention two small tsunamis reported in Ketchikan. One tsunami on August 21, 1949, was recorded at a height of 0.3 feet in Ketchikan, and the other on March 27, 1964, was estimated at 2.0 feet high. Neither tsunami would have affected the SEAFAC shore facilities on Back Island.

2.2.5 Climate and Air Quality

In the area of interest, Behm Canal has a generally southwest-northeast orientation. It is protected on the northwest by Cleveland Peninsula and on the southeast by Revillagigedo Island. On both sides of the canal, terrain rises rapidly to elevations in excess of 1,000 feet. Back Island is located on the southeastern side of Behm Canal at the head of Clover Passage. In addition to being protected by Cleveland Peninsula and Revillagigedo Island, it is protected by Betton Island less than a mile to the southwest. These terrain features can be expected to have a substantial influence on the climate of the site.

The section on the atmosphere in the "Atlas of the Ketchikan Region" (Martinson and Kuklok 1979) is a good summary of the regional climate and

local climatic variations. Considering the nature of SEAFAC, an adequate climatic description for an ES could probably be produced from using this document as a basis. However, information in the Atlas should be supplemented by more detailed information if possible.

The closest location for which the National Climatic Data Center routinely publishes climatological summaries is Annette Island, Alaska, approximately 30 miles southeast of Back Island. These summaries, which contain information on normal and extremes of temperature, wind, and precipitation, are based on more than 20 years of record. They can be used to help establish a regional climatological setting, but differences in the topographic settings of Annette Island and Behm Canal are sufficient that they are not likely to be useful in establishing a detailed climatology for Behm Canal and Back Island.

Data for a station identified as Ketchikan (WBAN #23320) (Changery 1978) have been collected since 1930. The observations were made on Gravina Island across the Tongass Narrows from Ketchikan. The Tongass Narrows have a northwest-southeast orientation and intersect Behm Canal at its southwestern end at an angle of about 90 degrees. Climatological data for Ketchikan would be expected to show a strong topographic influence, particularly in the channeling of winds. Partial summaries of these data appear in several publications, for example, "The Climate of Alaska" by Watson (1968) and "Atlas of the Ketchikan Region" (Martinson and Kuklok 1979). Full data for the station can be obtained on microfiche from the National Climatic Data Center.

The second set of data available from the National Climatic Data Center that is identified as Ketchikan includes meteorological observations taken at the U.S. Coast Guard Station at Bell Island on George Inlet. The Bell Island location is sheltered in all directions. Consequently, it is not likely that these data would contribute significantly to characterization of the climatology of the Behm Canal site.

Guard Island lies at the northwest end of the Tongass Narrows at its intersection with western Behm Canal. Changery (1978) indicates that meteorological data collected at Guard Island (WBAN #25320) from 1940 through 1969 are available from the National Climatic Data Center on microfiche, and Wise

et al. (1980) indicates that climatological data summaries have been prepared for Guard Island. The Guard Island data set is likely to be more representative of the proposed Behm Canal site than the previously described data sets. However, the relative influences of the topographic features surrounding the Tongass Narrows, West Behm Canal, and the Clarence Strait have to be evaluated to determine how representative they are. Partial summaries of these data have been published along with the Ketchikan data. In addition, a summary of means and extremes of temperature and precipitation, prepared by the Alaska Climate Center at the University of Alaska, has been obtained from the Tongass National Forest Hydrologist. A summary of Guard Island wind data has not been located.

West Sound Associates have been collecting wind and precipitation data at Trunk Island on northwest side of Behm Canal for the DTNSRDC since June 1982. However, the instrument exposure at Trunk Island is less than ideal. The instruments are situated on a point of land that juts out into Behm Canal and may modify the airflow when the wind is along the canal, and there is a stand of trees behind the instruments that will shelter them during northwesterly winds. The trees may also decrease speeds or deflect the wind during southeasterly flow. The data will need to be examined in detail to determine whether they are representative.

Climatological data for the West Behm Canal region is abundant in comparison with air quality data. According to the Alaska Department of Environmental Conservation (DEC), air quality measurements in the Ketchikan area have been limited to total suspended particulates (TSP) and oxides of sulfur. Total suspended particulates were measured in downtown Ketchikan and near the Ward Cove pulp mill during the period from 1975 through 1978, and measurements of oxides of sulfur are currently being made in the vicinity of the pulp mill. Apparently there have been no measurements of other pollutants.

The highest TSP levels in Ketchikan are associated with dust that occurs in the spring following several days without rain. It was the opinion of Tom Chapple, an Environmental Engineer in the DEC, that low levels of carbon monoxide and oxides of nitrogen resulting from traffic might be measurable in downtown Ketchikan, but that these probably would not be measurable elsewhere.

2.3 DATA BASE ADEQUACY

2.3.1 Hydrology and Water Quality

The existing hydrology and water quality data base for West Behm Canal is small, mainly because no major development has occurred along the canal shores. This situation implies that the water quality characteristics should be good. The major man-related activities in West Behm Canal that could affect water quality are logging operations and small resorts. The effects of these operations on the waters of West Behm Canal are not known, but are suspected to be minimal. The closest major development is the city of Ketchikan along Tongass Narrows.

Four primary hydrology and water quality data sources were found, none of which are complete. These sources include 1) the "Atlas of the Ketchikan Region" (Martinson and Kuklok 1979), 2) TRACOR, Inc. oceanographic monitoring studies in the West Behm Canal associated with SEAFAC (Henderson 1983a,b; 1984a,b), 3) a study of the oceanographic characteristics of some of the larger inlets in southeast Alaska, including Behm Canal (Pickard 1967), and 4) nautical charts and topographic sheets of the region published by the U.S. National Ocean Survey and U.S. Geological Survey.

The available information on the physical setting, bathymetric features, and tides related to hydrology and water quality in West Behm Canal are adequate for preparation of an Environmental Statement. The "Atlas of the Ketchikan Region" (Martinson and Kuklok 1979), tide tables (U.S. National Ocean Survey 1985a,b), and nautical charts and topographic sheets are the primary sources of information.

Little information was found on water circulation and currents in West Behm Canal. The most comprehensive set of data was collected by TRACOR, Inc. in 1983, in association with characterization studies of the proposed SEAFAC site in West Behm Canal (Henderson 1983a,b; 1984a,b). The current data collected during the characterization studies were comprehensive in that continuous recording current meters at four depths were deployed, and current velocity profiles were obtained covering the entire water column. These current measurements, however, were obtained at only two locations, and only during a

portion of the year. The current data collected by TRACOR, Inc. along with the predicted tidal current tables (U.S. National Ocean Survey 1985b) should be adequate for preparation of an ES because the in-water portions of the facilities should not alter the existing water circulation characteristics or current velocities in West Behm Canal.

The available information on water circulation and currents will not be adequate if hydrodynamic/contaminant transport modeling should be required in association with any accident or risk assessment analyses from a nuclear powered submarine radioactivity release accident or oil spill from the diesel storage tank on Back Island. At this time, we do not foresee that such analyses will be required. However, the subject of accident and risk assessment analyses are mentioned because regulatory agency and public reactions to SEAFAC are not totally developed at this time, and the costs would be high for collecting field data and performing hydrodynamic/contaminant transport modeling related to accident and risk assessment analysis in West Behm Canal.

The water quality data base for West Behm Canal is also small. The two principal sources of information are the temperature, salinity and dissolved oxygen measurements conducted in 1983 by TRACOR, Inc. (Henderson 1983a,b; 1984a,b) and the two surveys (June 1964, and August 1965) conducted by the Fisheries Research Board of Canada (Pickard 1967) where temperature, salinity, dissolved oxygen, and water transparency measurements were collected in West Behm Canal. Site-specific monthly or seasonal measurements of these or other water quality parameters, to our knowledge, have not been systematically collected in the vicinity of the proposed SEAFAC site. Because no discharges per se to Behm Canal surface water will occur during the construction and operation of SEAFAC, the existing information on water quality of Behm Canal should be adequate for preparing an ES.

2.3.2 Acoustics

The baseline acoustic environmental data from Quartz Hill, while of high quality, are not considered to be representative of the potential impact area of SEAFAC. In addition to being remote from the site, the Quartz Hill area is much different from the standpoint of sound sources and sound propagation characteristics. For these reasons, the use of these data is not recommended.

Data on noise produced by motor vehicles in Ketchikan are generally not available; however, one of several mathematical models can be used to generate a useful estimate. One such model is described by Sharp and Donovan (Harris 1978). Also, no data on airborne noise from watercraft have been located.

Noise from mining operations would be generated primarily by blasting. A current source (DuPont 1985) states that five million pounds of explosives are delivered in the southeast Alaska market annually. Data on the areas of explosive use could be obtained from the Fire Marshal, Ketchikan Gateway Borough. Estimates of noise levels caused by blasting can then be obtained using any of several models (Rodman 1985c).

The limited quantity of data on underwater sound in Behm Canal (Holliday and Henderson 1981; Henderson and Bonnett 1982; Henderson 1983a,b, 1984a,b) are not of sufficient scope to fully characterize the range of ambient sound level; however, these are completely suitable for characterizing the underwater sound environment.

2.3.3 Geology and Soils

A wealth of information is available on the geology of the Ketchikan region, mainly because of the interest in metallic mineral resources. The available geologic information is sufficient to describe the regional geologic setting. The available geologic information does not specifically include Back Island, however, its geology can be inferred from geologic descriptions and maps of Revillagigedo Island. As part of the engineering design of the land-based structures, a geology and soils field reconnaissance of Back Island should be performed. The field reconnaissance should include observations of phenomena such as bedrock outcrops and description and drainage characteristics of soils. This field reconnaissance can be combined with that described in the section on Seismicity.

2.3.4 Seismicity

General information on seismicity in southeastern Alaska is available in the literature, but no specific information on Back Island could be found.

Accordingly, it is not likely that the existing data base would be judged adequate in light of NEPA and U.S. Army Corps of Engineers permitting requirements.

2.3.5 Climate and Air Quality

To evaluate the potential effect of SEAFAC on air quality, atmospheric diffusion must be estimated. The accepted models for estimating diffusion use wind speed and atmospheric stability to characterize the atmosphere when short-term (for example, one-hour average) concentrations are computed. For longer term concentration computations, variability of wind direction is also incorporated in the models.

Because SEAFAC will operate intensely over intermittent periods, air quality should meet the NAAQS for annual average concentrations. In an ES for SEAFAC, the primary emphasis should be placed on evaluating SEAFAC's impact in worst-case conditions and estimating the frequency of occurrence of those conditions. Worst-case conditions typically involve low wind speeds and stable atmospheric conditions. The available meteorological data appear to be adequate to make an acceptable assessment of wind speeds at the proposed SEAFAC site. The more significant problem will be to evaluate the atmospheric stability at the proposed site and the joint frequency of occurrence of wind speed and stability.

The usual method of estimating atmospheric stability at a remote location (Gifford 1961) is to use sky cover, wind speed, and solar insolation data from a nearby airport. In this case, the Ketchikan airport would be the most likely choice. However, the topographical setting of the airport is significantly different than the proposed Back Island location for the onshore portion of SEAFAC. The data for Guard Island may provide better estimates of stability if they are sufficient. In either case, stability estimated using the usual method should be evaluated carefully to ensure that it is reasonable. Particular attention should be given to how the temperature difference between air and water affects stability.

The lowest layer of the atmosphere will be unstable when the water surface temperature exceeds the air temperature. Typically this occurs at night.

Over land the surface temperature at night is typically less than the air temperature, and the atmosphere is stable. As a result, the usual method of estimating atmospheric stability may not give stability estimates that are appropriate for Back Island. A method may be needed for estimating stability that includes the air/water temperature difference. Whether the water temperature data base is adequate for use in estimating atmospheric stability is unknown. The Atlas gives the annual variation of mean water temperature for Ketchikan. This value may be sufficient because temporal and spatial variations of water temperature are likely to be small compared to variations in air temperature.

In summary, the climatological data base appears to be adequate to support preparation of an ES for SEAFAC. The data should also be adequate to support the diffusion modeling needed to evaluate the impact of emissions from SEAFAC on air quality.

3.0 ECOLOGICAL ENVIRONMENT

The proposed location of SEAFAC is at a site considered to be a pristine environment characterized by an abundance of aquatic and terrestrial resources. Timber and wildlife as well as commercial and sport fisheries are an integral part of this local environment. Back Island and Behm Canal are important contributors to these resources. As such, environmental issues concerning SEAFAC generally fall into one of two categories. The ES must address these categories of concern:

- direct effects on the recreational and commercial uses of the natural resources
- potential effects on the integrity of the natural systems, which, in turn, could affect resource use through adverse ecological change.

The first of these issues is essentially a socioeconomic concern that is addressed elsewhere (Section 4.0). Here the focus of the discussion is to identify potential short- and long-term effects of SEAFAC on ecological resources.

3.1 AQUATIC ENVIRONMENT

Based on the current plans for SEAFAC, aquatic impacts will be assessed for Behm Canal and Back Island in the vicinity of the proposed pier, cable facilities, static facility, and in the operations area. Environmental conflicts, if any, will depend on resident flora and fauna as well as seasonal use by migratory species. However, the relatively small area of Behm Canal affected should limit the potential impact on resident aquatic communities.

3.1.1 Issues of Potential Concern or Conflict

3.1.1.1 Fish

Many of the fish and wildlife biologists from the Alaska Department of Fish and Game (ADFG) (J. Gustafson, C. Smith, D. Siedelman, D. Blankenbeckler), U.S. Forest Service (USFS) (M. Prather), as well as commercial fishermen,

suggested that surface buoys, barges, etc. may pose a certain navigational hazard and limit both sport and commercial fishing.

One fisherman who traps sablefish with pots, at depths up to 200 fathoms, also asked about the possibility of entanglement of bottomfishing gear by submarines. Another concern expressed suggested that operation of the static facility, if placed off the west shore of Grant Island, might alter the migration pattern of salmon returning to the Neets Bay hatchery (D. Siedelman, personal communication). Similarly, the proprietor (Herb Laughlin, personal communication) of Knudsen Cove, a sport fishing facility in Clover Passage, expressed concern that noise associated with SEAFAC activities might adversely affect fish, and so his business. Concern was also expressed regarding potential adverse biotic effects to herring near Back Island, particularly during environmentally sensitive times in the herring's annual cycle (J. Hall). For example, during spawning, fish are concentrated close to shore and therefore may be adversely affected by certain nearshore human activities (e.g., a spill of diesel fuel could have disastrous effects on a local spawning area). Also, it was pointed out that creosote from creosoted wooden pier pilings may cause deformities in herring in the early life stages. It was suggested that the seasonality and life stages of potentially affected species be taken into account both during the construction and operation phases of SEAFAC. In addition to being a valuable commercial species, herring serve as an important food species for other commercially and recreationally important species. Therefore, activities that may have an adverse effect on herring stocks would be of importance to other fish species.

3.1.1.2 Shellfish and Other Invertebrates

The only issue raised in regard to shellfish concerned the potential adverse impacts of nearshore activities. In particular, concerns were raised that construction of the pier and cable facilities, disposal of fill, or fuel oil spills, would have an adverse impact on shellfish and invertebrates in the immediate vicinity of Back Island, particularly in the nearshore environment (intertidal and subtidal zones). As a specific example, a fish biologist with

ADFG (D. Blankenbeckler, personal communication) suggested that if a shellfish survey demonstrated a productive abalone bed at the proposed site for the supply/maintenance pier, ADFG would be inclined to recommend an alternative site for the pier.

3.1.1.3 Marine Mammals

A concern was expressed regarding the potential disturbance of marine mammals, particularly pinnipeds, by aircraft. Helicopters in particular were noted as having a high potential for disrupting pinnipeds on haulout areas and rookeries. Disturbance of seals and/or sea lions on rookeries has led to death of young pinnipeds, in part because of abandonment (J. Burns, personal communication). Marine mammals apparently have a greater capacity to become acclimated to fixed position, constant engine sounds rather than to varying engine sounds, and to reciprocating engines rather than turbo engines. It was suggested that vessel based support of the SEAFAC would be better than aircraft-based support in terms of minimizing potential adverse influences on marine mammals.

In addition, the time of use of Behm Canal waters by various marine mammal species should be considered in the construction and operation of SEAFAC. The possibility of low-level chronic releases of contaminants (diesel fuel, sewage) having adverse impacts on species such as sea otter also was raised as a potential issue. A concern was voiced that underwater noise associated with SEAFAC (principally pingers for navigational purposes) might also adversely influence marine mammals. A scientist who has worked extensively with humpback whales (S. Baker, personal communication) indicated that whales tend to be shallow water (i.e., near-surface) feeders and, therefore, if submarine activities were confined to deep water, the potential conflict may be minimized. However, most people we talked with who were knowledgeable about marine mammals did not anticipate any major problems with the SEAFAC (e.g., C. Schneider, Tamra Faris, personal communication).

3.1.1.4 Plants

Only one potential issue of concern arose. Because herring use kelp and other aquatic plants for spawning and because of the concerns expressed about

the potential sensitivity of herring to some SEAFAC activities, particularly during spawning, there may be some concern regarding possible adverse impacts on kelp and related plants. Herring spawn on kelp and some harvesting of herring roe from kelp is done on a commercial basis in Behm Canal. This concern was not voiced by anyone we talked with in Alaska, but could arise as a secondary concern in relation to the herring fishing.

3.1.1.5 Rare and Endangered Species

As previously stated (Section 3.1.1.3), some concern was expressed regarding potential disturbance of humpback whale by SEAFAC related noise (e.g., 'pingers' for navigation) or underwater range operation.

3.1.2 Data Base Availability

3.1.2.1 Fish

Interest associated with finfish in Behm Canal focuses on commercial and sport fishery species. The most important species are the salmonids, including Chinook (Oncorhynchus tshawytscha), coho (O. kisutch), pink (O. gorbuscha), chum (O. keta) and sockeye (O. nerka) salmon. To a lesser extent, trout are also harvested, including steelhead (Salmo gairdneri) and cutthroat trout (S. clarki) and Dolly Varden char (Salvelinus malma) (Siedelman and Schwan 1981). Bottomfish of importance include Pacific halibut (Hyppoglossus stenolepis), Saffron cod (Eleginus gracilis) and Pacific cod (Gadus macrocephalus) and sablefish (Anoplopoma fimbria) (Siedelman and Schwan 1981; Neimark 1984; Skud 1959). Pacific herring (Clupea harengus pallasii) are harvested for food, bait, and roe and also serve as part of the food base for other fishes. In addition to these main sport and commercial fish species, subsistence fishing for species such as capelin (Mallotus villosus), smelt and eulachon (Thaleichthys pacificus) occurs (J. Hall, personal communication). Additional species that occur in Southeastern Alaska are described in a variety of publications (e.g., USDA 1979; Carlson et al. 1982; Hart 1973).

The ADFG conducts a continuing program of harvest estimates of selected fisheries throughout southeastern Alaska. Estimates are obtained through the

use of creel surveys; such as the numbers of fishermen, numbers of boats, amount of fishing time, numbers of various species caught, and catch-per-unit-effort (CPUE). Results of these surveys, specific to certain areas of southeastern Alaska as well as more regional summaries, are published periodically (e.g., Siedelman and Schwan 1981; Neimark 1984). In addition, raw statistics on catch and effort are maintained in a computerized data base in the regional office of ADFG at Juneau, Alaska (D. Mecum, ADFG). Similar types of data are also available for commercial fish species (D. House, personal communication). In addition, commercial catch statistics associated with the Southern Southeast Regional Aquaculture Association (SSRAA) hatchery at Neets Bay are kept by SSRAA in Ketchikan (D. Amend, personal communication). For example, in 1985 at the peak of the season (June-October), two fish tenders in Neets Bay serviced a fleet of up to 65 salmon seiners, processing approximately 200,000 pounds of fish per day.

The ADFG annually conducts herring spawning surveys from boats and from the air to identify spawning areas. Through this process in 1983, the areas along the west shore of Betton Island and all around Back Island were identified as important herring spawning areas. Of particular note, the east shore of Back Island in the general vicinity of the proposed SEAFAC supply dock is identified as an area where spawning herring congregate (J. Hall, D. Blankenbeckler, personal communication). Herring spawn primarily in kelp and so use of a particular spawning area may vary from year to year depending on the abundance of kelp and other aquatic plants. Studies have been conducted on seasonal distribution and environment of herring that include distinction of five separate stocks of herring in southeastern Alaska (Carlson 1977; Carlson 1980).

The National Marine Fisheries Service (NMFS), sometimes in conjunction with other agencies (e.g., ADFG, U.S. Fish & Wildlife Service [USFWS]) periodically conducts trawl survey cruises to gather a variety of information on marine fish and invertebrates. Although such a cruise apparently has not been conducted in the western arm of Behm Canal, as late as the spring of 1980, a cruise had been conducted in the eastern arm of Behm Canal (cf. NOAA Cruise

Report, Cruise No. JC-80-01). This cruise yielded information on demersal fish biology and numbers. A similar survey in 1977 (NOAA Cruise Report, Cruise No. JC-77-1) was conducted partly in the vicinity of Smeaton Bay and Boca de Quadra, a proposed site for development of a molybdenum mine. This site is near the southern end of the eastern arm of Behm Canal. A synopsis of the catch obtained on similar cruises, but concentrating on northern southeastern Alaska, is provided by Carlson et al. (1982).

Little or no site-specific data were found that described the diversity, abundance and distribution of embryonic and larval life stages of either resident or migratory finfish. However, from data collected on neighboring fjords (Boca de Quadra, Wilson Arm), it is likely that Behm Canal serves as a nursery area for herring, pollock, rockfish, flatfish (rock, flathead, English sole), smelt, smoothtongue, and sandlance. Maximum densities of larvae of these species occurred between March and June and were distributed throughout all areas (VTN 1982a).

3.1.2.2 Shellfish and Other Invertebrates

Relatively few site-specific data seem to be available for the Behm Canal - Back Island area. However, shellfish species which are likely harvested for sport, commercial, or subsistence include Dungeness crab, king crab, tanner crab, clams, abalone, scallops, octopus, chiton, and mussels. Phil Doherty, with ADFG in Ketchikan, mentioned commercial fishing for Dungeness crab at Traitors Cove and Helm Bay. Generally speaking, crabs have a tendency to congregate near the mouths of salmon spawning streams (D. Blankenbeckler, personal communication). At least for abalone, regional data seem to be available regarding harvest levels. These harvest levels are apparently used to assess effects of season lengths, harvest guidelines, etc. Similar data may be available on other shellfish species.

Some qualitative data are available from select areas around the Ketchikan area where log rafts are stored. In an effort to assess the potential adverse effects of log rafts in bays, the U.S. Fish and Wildlife Service and National Marine Fisheries Service conduct dive surveys in proposed log

storage areas to determine the presence/absence of intertidal/subtidal marine organisms. These assessments may include shellfish taken for sport, commercial and/or subsistence use. However, no such dives have been conducted in the immediate vicinity of Back Island or Clover Passage. The closest such dive appears to have been at Ward Cove, in association with a pulp mill operation (C. Osborn, personal communication). Some data, covering the period 1969 to 1981 are also available regarding shellfish collected during bottom trawl cruises conducted by NMFS. These data are mainly for the northern portion of southeastern Alaska (Carlson et al. 1982). In addition, data are available from intertidal and subtidal surveys of proposed log storage sites on Prince of Wales Island (USFWS and NMFS 1985).

Similarly, few or no site-specific data are available on diversity, abundance, or distribution of shellfish early life stages. Decapods are known to use Behm Canal and larval pandalid shrimp, Dungeness crab, king crab, and tanner crab are expected in the plankton during the spring, with peak densities in May or June. It is also likely that these species are spawned in Behm Canal.

Few site-specific data are available that describe the invertebrate fauna inhabiting the Back Island nearshore environment (intertidal, subtidal, and pelagic zones). In other fjords, the rocky intertidal areas are dominated by rockweed (Fucus distichus), acorn barnacles (Balanus glandula), and blue mussels (Mytilus edulis) which characterize three distinct vertically stratified biotic zones. The ochre seastar (Pisaster ochraceus) is another inhabitant of the nearshore environment. In the subtidal environment, kelp (Laminaria saccharina), macroalgae (Constantinea subulifera), sea urchins (Strongylocentrotus spp.), eelgrass (Zostera marina), sunstars (Solaster stimpsoni), Dungeness crabs (Cancer magister), and sea cucumber (Stichopus californicus) are likely to be found. However, several excellent generalized reviews of southeastern Alaska nearshore ecology give species lists (Martinson and Kuklok 1979). In addition, VTN (1980, 1981, 1982a,b) described the nearshore ecology of Boca de Quadra and Wilson Arm, two neighboring fjords.

3.1.2.3 Marine Mammals

Marine mammal species that would be expected to occur or have been reported in or near Behm Canal include killer (Orcinus orca), humpback (Megaptera novaeangliae), minke (Balaenoptera acutorostrata), beaked (Ziphiidae), and gray (Eschrichtius robustus) whales; harbor (Phocoena phocoena) and Dall's porpoise (Phocoenoides dalli); harbor (Phoca vitulina), fur (Callorhinus ursinus), and northern elephant seal (Mirounga angustirostris); and northern sea lion (Eumetopias jubatus). Although southeastern Alaska was not included in the historical range of the elephant seal, sightings of this species have been increasing in recent years (K. Krieger, B. Wing, personal communication). In addition, sea otters (Enhydra lutris) may be found in Behm Canal.

Compared to that available for northern southeastern Alaska, relatively little information is available on marine mammals in southern southeastern Alaska (H. Brahms, personal communication). Much of the material that is available on humpback whales is specific to Glacier Bay and is associated with cruise ship traffic in that area. Studies conducted in this geographical area have emphasized the effects of cruise boat activity on humpbacks, the relationships between humpbacks and forage species, such as euphausiids and herring, and the influence of sound (noise) on whales (S. Baker, K. Krieger, B. Wing, C. Malme, personal communication). Studies done on humpback feeding have shown a high correlation between occurrence of humpbacks and concentrations of euphausiids. Organized sighting programs, which rely primarily on observations of commercial fishermen (trollers) and naturalists aboard ferries, provide records of sighting of marine mammals on an opportunistic basis. Although praising these programs, several biologists who work with marine mammals in southeast Alaska pointed out the limitations of these programs (S. Baker, B. Wing, J. Burns, C. Schneider, personal communication). Because sightings are concentrated in areas where people concentrate, the sightings are biased. Other areas that may also be used by marine mammals are not covered under these programs. These sighting records are part of a "platforms of opportunity" program associated with NMFS. An example of the type of

information that can be gleaned from this program is reflected in a paper on the distribution of killer whales in southeast Alaska (Leatherwood et al. 1984). Currently, NMFS is developing a computer database that will include marine mammal species accounts and maps for coastal and nearshore habitats. Although this data base is still being developed, it may be possible to obtain a listing of any sightings of marine mammals by specifying appropriate latitude and longitude for the area of concern. Such a request could be made to the Northwest Alaska Land Fisheries Center of NMFS in Seattle. Identified herring spawning areas in Behm Canal, in particular on the west shore of Betton Island and around Back Island suggest the potential for attracting species such as humpback and minke whales, which use herring extensively as a food source (J. Gustafson, K. Krieger, B. Wing, personal communication).

The ADFG periodically conducts surveys for pinnipeds, which include identifying haulout and rookery areas. In addition to organized marine mammal sighting programs, anecdotal accounts of sightings are available from local wildlife and fisheries biologists, commercial fishermen, and knowledgeable, reliable public. Species sighted recently (i.e., within the last two years) in Behm Canal included, but were not necessarily limited to, humpback whales, killer whales, a minke whale, and elephant seals (C. Smith, L. Peltz, M. Prather, C. Coombs, D. Bishop, personal communication). A commercial fisherman considered quite knowledgeable about marine life in general (D. Bishop) reported a haulout area that was used intermittently by pinnipeds on the west shore of Revillagigedo Island between Nose and Chin Points. It was suggested (C. Smith, personal communication) that the people who operate the fishing lodge in Yes Bay might also be a potential source of marine mammal sighting information, particularly for the northern end of Behm Canal.

3.1.2.4 Plants

Species of aquatic plants that may be present in the Behm Canal area include the brown algae (Agarum cribrosum, Costaria costata, Desmarestia intermedia, Laminaria spp., Macrocystis pyrifera, and Fucus distichus), the red algae (Callophyllis spp., Constantinea simplex, Corallina spp., Lithothamnium spp., Membranoptera spp., Pterosiphonia bipinnata and

Rhodomenia spp.), and the green algae (Codium fragile), and a Ulva/Monostroma complex. These plant species were recorded on Prince of Wales Island in the course of nearshore plant community surveys for potential log storage sites (USFWS and NMFS 1985). Because Prince of Wales Island is near Behm Canal (across Clarence Strait) these species are also likely to occur in the study area. Marine herbs such as Zostera marina and Phyllospadix scouleri may also be present.

As indicated for shellfish and other invertebrates (in Section 3.1.1.2 above), limited information is available describing the nearshore marine community of Back Island, including aquatic plants and phytoplankton. During our site visit to Back Island we did observe one species of kelp (Nereocystis luetkeana) that had washed ashore. Because herring are known to spawn primarily on kelp (J. Hall, D. Blankenbeckler, personal communication), identification of Back Island as a spawning site for herring, particularly the east shore, also suggests the presence of kelp at Back Island. Although phytoplankton, chlorophyll-a, cell densities, and primary production rates are available for the neighboring fjords of Boca de Quadra (VTN 1980, 1981, 1982c) and Wilson Arm (VTN 1981, 1982c), no comparable data specific to Behm Canal and Back Island were found.

3.1.2.5 Rare and Endangered Species

Aquatic species occurring in southeastern Alaska that are included on the federal Threatened and Endangered Species list include the humpback, sperm (Physeter catodon), fin (Balaenoptera physalus), sei (B. borealis), blue (B. musculus), right (Eubalaena glacialis), and bowhead (B. mysticetus) whales. In addition, the Pacific leatherback turtle (Dermochelys coriacea) is classified as threatened and endangered (U.S. Forest Service 1979). The large baleen whales, however, such as fin, gray, and blue whales, occur primarily outside the southeastern Alaska barrier islands in the open ocean (K. Krieger, B. Wing, personal communication). Other information pertinent to describing the diversity, density, and distribution of marine mammals is found in Section 3.1.2.3.

3.1.3 Data Base Adequacy

3.1.3.1 Fish

Data from creel surveys conducted periodically by ADFG provide information on intensity of fishing in the Ketchikan area in general and, to a lesser degree, in specific areas of interest in Behm Canal. The most often voiced concern was the potential conflict between SEAFAC operations and the sport fishing use of the Betton Island, Back Island, and Clover Passage area. Fortunately, the data gathered during the ADFG creel surveys indicate the intensity of use of the area as well as the seasonality of that use. These data are probably adequate to address any effects of SEAFAC on recreational use of the area for sport fishing and would not need to be supplemented.

Herring spawning surveys conducted regularly by ADFG also provide adequate information to address the concern regarding sensitivity of herring during certain times of the year, notably the spawning periods when the fish are concentrated near shore.

Existing ADFG harvest data are also viewed as being adequate to describe commercial fishing intensity and to address the concerns voiced about potential adverse influences of facilities (particularly the static test facility if sited off the west shore of Grant Island) operations and noise on commercial fishing in other areas of Behm Canal. Because little or no noise will enter the waters of Behm Canal, this concern may not need to be considered. In addition, any long-term effects of construction and operation on eggs and larvae of benthic species (rockfish, flatfish, etc.) are likely to be negligible because relatively widespread spawning occurs in most, if not all, fjords in southeast Alaska.

3.1.3.2 Shellfish and Other Invertebrates

Some concern was expressed by biologists with ADFG that shoreline activities associated with SEAFAC may have an adverse impact on shellfish and other invertebrates in the vicinity of the pier and cable facilities. Because information is lacking on the prevalence, species, and location of shellfish around Back Island, some data would need to be acquired to address this issue.

3.1.3.3 Marine Mammals

Data obtained from "platforms of opportunity" programs should be searched to address, in part, the concern about potential adverse effects of aircraft (or other varying) noise on marine mammals. Both location and timing of sightings could provide necessary information to assess the potential effects of SEAFAC activities on marine mammals. Because pinnipeds were noted as being particularly susceptible to disturbance by aircraft, data from seal surveys flown by ADFG should be reviewed to identify seal haulout areas that might be affected by SEAFAC air or vessel traffic. Although the "platforms of opportunity" programs, along with information from local biologists and the public, provide some indication of marine mammal use of Behm Canal, the information is biased toward areas frequented by people. Although in the opinion of the professional biologists we consulted, few, if any, adverse impacts on cetaceans would result from SEAFAC operations, it may be prudent to supplement the existing data with an unbiased survey of Behm Canal for cetacean use. While such a survey would not provide absolutely definitive data regarding the use or potential use of Behm Canal by cetaceans, the data would supplement the opportunistic sightings and contribute to a more complete information base. However, an effort to supplement the data base should be delayed until public awareness and sensitivity about marine mammals increases. In other words, there is little need at this time to undertake such additional studies. Accordingly, we should re-examine the issue in about a year to determine whether the public believes that whales and other aquatic mammals are threatened by SEAFAC development.

3.1.3.4 Plants

Information regarding aquatic plants is apparently insufficient, specifically for the vicinity of Back Island, to address the potential concern regarding adverse impacts on herring spawning sites. Concerns expressed about possible direct adverse effects of diesel spills, construction, etc. on herring may also apply to effects of such activities on herring habitat components such as kelp and other aquatic plants.

3.1.3.5 Rare and Endangered Species

The adequacy of available data to describe or assess impacts to rare and endangered species, principally whales, is discussed in Section 3.1.3.3.

3.2 TERRESTRIAL ENVIRONMENT

Based on the current plans for SEAFAC, terrestrial impacts from development will be limited to Back Island. These effects are anticipated to be small and localized at the construction site. Back Island is located within the jurisdiction of the Tongass National Forest. Environmental conflicts, if any, will depend on the local fauna and flora present and any transient species that occasionally occur on the island. The small size of the island should limit the prospect of a significant wildlife population and facilitate surveys of the natural resources. Conversely, the presence of an endangered or protected species anywhere on the island could have a major effect on proposed land use activities throughout the island. Preliminary investigations do not indicate that such a problem exists.

3.2.1 Issues of Potential Concern or Conflict

3.2.1.1 Forest Type and Composition

During our discussions with state and federal agencies, no specific concerns about possible impacts on the forest resources on Back Island were expressed. The LUD II designation has already withdrawn the island from commercial timber production, so the proposed facility will not impact the harvest potential of the region. Rather, any impacts to the forest as a result of constructing the facility will need to be evaluated in terms of secondary effects on fish, wildlife, and recreational resources of the island.

Among the secondary effects that must be considered are soil erosion and a diminished aesthetic value of the island. The Borough of Ketchikan has implemented a local coastal plan (LCP) which, like the USFS, places restrictions on island development. The purpose of the LCP is to preserve recreational uses and retain the island as a visual resource. Prevention of bank erosion may also be important in protecting herring spawning areas

around the island from siltation. Consequently, forested areas cleared for construction should be selected to ensure that shelter belts are retained to minimize both soil erosion and visual impacts of the facility. Individuals from the Borough of Ketchikan and ADFG (J. Hall, personal communication) have indicated a willingness to work with the Navy to ensure that local concerns are mitigated.

The other important indirect effect of forest cutting is how changing the habitat will affect local wildlife populations. Old-growth forests have been positively correlated with the occurrence of bald eagles and the Prince of Wales Island subspecies of northern flying squirrel. Land management decisions could alter the suitability of Back Island for these animal species. Disregard for wildlife habitat could be perceived negatively by the public and should be avoided. For instance, prominent forest areas along the shoreline of Back Island currently provide occasional bald eagle perching sites and should be retained. Again, Navy interactions with local experts should help eliminate their concerns.

3.2.1.2 Wildlife and Game Animals

Our discussions with state and federal agency personnel did not identify any serious concerns about possible impacts on the game species, passerines, or small mammal populations of Back Island (M. Prather, personal communication). Raptors and furbearing animals were also considered unlikely to be adversely affected by SEAFAC. The only exceptions to the above were bald eagles and the Prince of Wales Island subspecies of the northern flying squirrel mentioned earlier. Neither species is known to occupy Back Island, but these concerns are discussed in Section 3.2.1.3.

3.2.1.3 Rare and Endangered Species

In terrestrial populations, bald eagles and the subspecies of flying squirrel are the only two animals of endangered (or legal) status that SEAFAC must consider. The island habitat of the proposed SEAFAC site is generally regarded as prime habitat for nesting bald eagles (Robards and Hodges 1976). Similarly, the old-growth habitat of the island is also favorable for flying squirrels. Whether effects to either species will become an issue will depend

on their presence on the island. If they are not present, little action needs to be taken. Maintenance of eagle perching sites along the shoreline may be the only corrective action necessary. Should eagle nests occur on the island, substantial mitigative actions may be necessary. Such actions may include modifying construction plans and activity schedules on the island during both construction and operational phases of SEAFAC. The corrective actions necessary, should eagle nesting occur, are summarized in an USFS draft document (R. Coose, personal communication).

3.2.2 Data Base Availability

3.2.2.1 Forest Type and Composition

The forest type of Sitka spruce (Picea sitchensis), western hemlock (Tsuga heterophylla), and western red cedar (Thuja plicata) on Back Island is typical for southeast Alaska. The island itself is low and tree covered with a shoreline composed of a 6- to 8-foot rock shoulder leading to a cobblestone and gravel beach. Undergrowth is dense and provides good wildlife cover. On the north and east shores, old-growth trees extend to the shoreline providing suitable sites for eagle nesting and perching. Snags suitable for wildlife are present but are not considered to be abundant.

The previous logging history of Back Island is unknown. The presence of old-growth timber (generally assumed to be ≥ 150 years old) and younger trees suggests some logging probably occurred in the past on the small island. The island currently has a USFS designation of LUD II which is intended to prevent any future timber harvesting on the island. This land use designation of LUD II also carries with it other restrictions to preserve the primitive wild environment including limited road construction and appropriate landscaping of authorized buildings.

Our reviews of the literature and professional resources brought forth no site-specific data on the timber resources of Back Island. The timber resource survey conducted for the Tongass Land Management Plan by the USFS provides the closest source to a site-specific survey (USDA 1978a). Value Comparison Unit (VCU) Number 864.1 for Clover Pass (including Back Island) constitutes

5,388 acres of island habitat. The survey found this VCU to be 95.4% hemlock-spruce habitat and 4.6% cedar forest. Trees in the VCU were 95.4% old saw timber with an average yield of 22,500 board feet/acre. The survey also indicated that 69.0% of the acreage was in valley bottoms with 30.5% in glacial valley walls. The USFS survey was based on aerial photographic analysis and not ground surveys. However, based on remarks from forest personnel, we anticipate the VCU averages to be representative of Back Island. No comparable information for understory characteristics has been found.

Recent publications by Alaback (1981) and Alaback and Tappeiner (1984) discuss the forest vegetation of southeast Alaska and the processes of secondary succession. These publications should provide an adequate reference base to project both short- and long-term effects of forest cutting on Back Island. Similarly, the series of reports by the U.S. Forest Service entitled "Wildlife and Fisheries Habitat Management Notes" (USDA 1981, 1982, 1985) describe the interactions of Alaskan wildlife and their habitat. These USFS reports should provide a basis to assess the possible environmental impacts to wildlife as a result of habitat change.

3.2.2.2 Wildlife and Game Animals

The predominant game species of Back Island is the Sitka black-tailed deer (Odocoileus hemionus sitkensis). Historically, deer hunting has occurred on the island (M. Prather, personal communication). Island populations of deer may also be present at higher than normal densities (W. Sidle, personal communication) because of a general lack of predators. Numerous studies indicate that old-growth Sitka spruce-western hemlock forests as on the island are important to the species. Transient black bear (Ursus americanus) can occasionally be found on Back Island along with furbearers such as mink (Mustela vison) and marten (Martes americana).

Raptors that may occur on the island include the bald eagle, goshawk (Accipiter gentilis), sharp-shinned hawk (Accipiter striatus), red-tailed hawk (Buteo jamaicensis), and gyrfalcon (Falco rusticolus). Owls that may be present include the great horned owl (Bubo virginianus), snowy owl (Nyctea scandiaca) and short-eared owl (Asio flammeus). The island is expected to

have its complement of small mammals and passerine species but discussions with state and federal agency personnel indicated no undue concern about these populations. Red fox (Vulpes vulpes) may be expected, but coyotes (Canis latrans) are unlikely, and the neighboring island of Revillagigedo has a pack of wolves (M. Prather, personal communication). Amphibians and reptiles anticipated to be present include the rough-skinned newt (Taricha granulosa), western toad (Bufo boreas), and common garter snake (Thamnophis sirtalis).

Some loss of recreational hunting and commercial trapping may be expected by the development of the SEAFAC Facility. Changes in exploitation rates, however, are not foreseen to be a potential cause for changes in the population dynamics of local species. No known critical wildlife habitat has been identified on the island nor the presence of an endangered or threatened species. The low bank profile of the Island does not appear to be conducive to sea bird colonies. Rookery or haulout areas for marine animals do not occur on Back Island.

Fourteen animal species or subspecies in Alaska are listed on the Federal Endangered Species List. The state of Alaska includes five of these 14 species in their state list. Nine of the endangered species are cetaceans (i.e., whales), the remaining are all bird species. On Back Island only the Aleutian Canada goose and the short-tailed albatross are possible or occasional residents. Both species occur accidentally or uncommonly in southeast Alaska.

Discussions with personnel from USFS, ADFG, U.S. Fish and Wildlife Service (USFWS) and the University of Alaska (UA) were unable to identify any wildlife research conducted specifically on Back Island. Some graduate wildlife research studies in southeast Alaska on furbearers (Harbo 1958), eagles (Corr 1974) and black-tailed deer are available from the University of Alaska for input to the ES. As part of the Tongass Land Management Plan, VCU 864.1, was evaluated for its suitability to support eleven different wildlife species (USDA 1978b). As for the forest survey performed by USFS, this survey was performed remotely using literature data and no field inventories. The result of the survey gave VCU 864.1 a rating of 3 on a scale of 1 to 5. A rating of 3 indicates good but not exceptional wildlife habitat.

The single largest body of literature on southeast Alaskan wildlife concerns the Sitka black-tailed deer. Important references on deer management include the Sitka Black-Tailed Deer Conference Proceedings (Wallmo and Schoen 1979), Wallmo and Schoen (1980) and Suring and Prather (1985). These publications among others provide an adequate data base to infer possible consequences of SEAFAC on Back Island deer populations.

Bird populations have also received considerable attention in southeast Alaska. Important publications include USDA (1979), Noble (1977), and workshop proceedings on nongame birds (USDA 1975, 1978c). This literature focuses on the relationships among bird populations and forest habitat or logging practices including secondary succession. Again literature appears adequate to make informed inferences concerning possible consequences of SEAFAC on local nongame bird populations.

3.2.2.3 Rare and Endangered Species

Although not endangered in Alaska, the bald eagle is protected through the Bald Eagle Protection Act and the Memorandum of Understanding (MOU) between the USFWS and USFS. The Endangered Species Act of 1973 protects bald eagle habitat only in the contiguous United States. These laws and agreements in Alaska place special restrictions on land use which serve to protect the species and their nests. Parts of southeast Alaska have among the highest eagle densities anywhere in the world (>1 nest/mile shoreline: Hodges 1982a,b) with islet habitat being a favorite of eagles.

The current MOU protects eagle nests by restricting road construction, logging, and developments within 330 feet of an eagle nest. New USFS guidelines under consideration would extend the zone to a 1/8-mile beach area around a nest. A variance to the MOU may be requested of the USFS should an eagle nest be found on Back Island if all five of the following questions can be answered with a "no":

- Can the project be abandoned?
- Is there a reasonable alternative?
- When the proposed activity is combined with previous activities, are the cumulative effects too great?

- Does the nest have special significance?
- Could the activity result in a violation of the Bald Eagle Protection Act?

No bald eagle nesting surveys have been conducted on Back Island to determine whether eagle nesting will be an issue or not (J. Jacobson and P. Schempf, personal communication). Similarly, no site-specific information on the northern flying squirrel has been gathered from Back Island (G. Clevenger, personal communication). All current information on either species is limited to habitat suitability and regional studies.

The nesting and feeding requirements of bald eagles in southeastern Alaska are reasonably well understood (Hansen et al. 1984; Robards and Hodges 1976; Robards and King 1966). Projecting the effects of changes in habitat on Back Island relative to eagle nestability should therefore be reasonably straightforward. Previous nest surveys on Admiralty Island (Robards and King 1966, average of 1 nest/.55 miles), and Glass Peninsula (Robards and Hodges 1976, 1 nest/.54 miles) and Seymour Canal (Hodges 1982, 1 nest/mile) have shown high nest densities. Jake Jacobson and Phil Schempf (personal communication) have conducted nest surveys along the eastern shore of Clover Passage and the western shore of Behm Canal and have similarly located numerous nests. They also stated that Back, Betton, and Grant islands have not been surveyed but recent activities in the Ketchikan area may prompt agencies to survey the site in spring of 1986.

A variance to the MOU can be given, but the USFWS does not have the authority to permit disturbance or any other violation of the Bald Eagle Protection Act for development purposes.

The current and future status of the Prince of Wales Island flying squirrel (Glaucomys sabrinus griseifrons) needs to be clarified for Back Island. This subspecies of the northern flying squirrel is being considered for inclusion in the state of Alaska's endangered species list. Usually inclusion in a state list precedes the inclusion in the federal endangered species list. Although the flying squirrel is not known to occupy Back Island or its immediate neighboring islands, the old-growth habitat and proximity to Prince of

Wales Island makes residence a possibility. Old-growth forests and the presence of snags appear to be an important habitat component of the species (Suring 1985). Presence of the species on Back Island will need to be determined as part of the ES process.

3.2.3 Data Base Adequacy

3.2.3.1 Forest Type and Composition

General habitat requirements of predominant wildlife species appear to be sufficiently well known to assess impacts to wildlife populations from the proposed habitat disturbance. The findings in Alaback (1981) and Alaback and Tappeiner (1984) should adequately address the terrestrial concerns in the ES. This conclusion appears sound in light of the few concerns voiced by forestry personnel with regard to timber resources.

The only apparent shortcoming in the existing data base is site-specific information on Back Island. Relying solely on the photographic surveys of USFS could result in unwanted surprises during the ES process. Such a situation is not unlikely because Back Island is only a small component of VCU Number 864.1.

3.2.3.2 Wildlife and Game Animals

The regional data base seems adequate for ES purposes given the lack of identified concerns about SEAFAC on terrestrial animal populations. Again, the only identified shortcoming is the lack of site-specific information on local wildlife populations of Back Island. Additional literature reviews probably would not identify any new information.

3.2.3.3 Rare and Endangered Species

The biology, distribution, and natural history of the bald eagle is well documented. Numerous reports are also available about bald eagle nesting preferences in southeast Alaska. Basic research on eagle or flying squirrel natural history as part of the Navy ES will probably be unnecessary. However, knowledge of the site-specific occurrence of eagles and flying squirrels on Back Island is essential to the ES process.

4.0 SOCIOECONOMIC ENVIRONMENT

To assess the potential impacts of locating SEAFAC on Back Island, a number of factors should be examined to satisfy an ES, including SEAFAC's potential effects on regional employment, community services and educational facilities, use of land and water, and on any adjacent prehistoric or historic sites. Although SEAFAC's proposed site is within 15 miles of Ketchikan, the construction and operation of the facility is not expected to have a significant impact on local employment and demand for local goods and services for several reasons. First, the construction of SEAFAC will be a relatively small-scale operation and of short duration. The buildings on Back Island will be few in number and are relatively small, the largest being 4,800 square feet. In addition, the Navy intends to use pre-engineered construction wherever possible. Second, only 24 Navy personnel will be required to operate SEAFAC, and they will live on Back Island, minimizing any economic impacts on Ketchikan. Operation of SEAFAC, however, may interfere with several commercial endeavors, including salmon trolling and gill netting, the harvesting of herring for roe, and longline fishing for ground fish. Also, SEAFAC may adversely impact the area in terms of aesthetics. The land-based facility and large barges and buoys of the static site may degrade the pristine quality of the area.

4.1 ISSUES OF POTENTIAL CONCERN OR CONFLICT

4.1.1 Regional Demography

SEAFAC is not expected to impact the distribution or size of the population in the Ketchikan area. The facility will be operated by an average of 24 Navy personnel for 1 to 2 weeks per month who will live at the facility. In addition, construction of the facility will be relatively small in scale and will be completed in a fairly short period of time. As a result, in-migration of outside workers and their dependents will probably not occur.

4.1.2 Labor Force and Housing

A potential concern surrounding the construction and operation of most facilities is how they will impact the local labor force and housing. SEAFAC

will have only minor effects on the labor force, and almost no effects on the demand for housing. The labor force effects can be divided into two distinct phases. The first and perhaps most significant impact will occur during the initial construction phase. Local contractors and construction workers will likely be employed in building SEAFAC. However, this increased demand for labor will be short-lived and of insufficient magnitude to raise wage rates. If security requirements prohibit employment of construction workers without security clearances, there will probably not be any direct effect on employment.

Employment impacts could also occur as construction workers spend their incomes. Local business revenues will rise, which may stimulate more hiring. In a similar manner, an increased demand for locally produced materials may result in increased production, with local firms employing more labor. However, impacts on employment will be of negligible magnitude in Ketchikan, because SEAFAC will not provide a large amount of income for Ketchikan's economy nor require much in the way of locally produced materials.

The second phase of SEAFAC following construction is the operations phase. During this phase no direct local employment is likely to be required. SEAFAC personnel will probably spend some money locally, but this amount will be too small to affect local business hiring.

The demand for housing in Ketchikan and environs will not be affected by SEAFAC. Because the construction phase of the facility will be short and on a small scale, an in-migration of labor will not be required, and SEAFAC personnel will live on Back Island.

4.1.3 Community Services

Community services include police and fire protection, parks, sewage treatment, utilities, and public transportation. SEAFAC is anticipated to have little or no impact on community services, except for a possible need for more police protection. Police protection may need to be increased if SEAFAC proves unpopular with the local citizenry or outside protests are stimulated. SEAFAC has substantial energy requirements, but these will be met through diesel-fired generators, not by the local utility. Other community services

are left unaffected because SEAFAC has no impact on Ketchikan's population. Population growth is strongly linked to services.

The tax revenue base that finances community services will not be increased by the presence of SEAFAC. A potential concern, therefore, is that SEAFAC will necessitate an increase in the demand for police services, while providing no financial support. At this time, it is not possible to assess how much extra police protection might be needed or how it would be provided.

4.1.4 Public Institutions and Educational Facilities

SEAFAC will not affect Ketchikan's public institutions and educational facilities. Both are strongly influenced by demographic factors, none of which will change as a result of SEAFAC.

4.1.5 Land Use

The principal concerns about land use focus on recreational use of Back Island. The island appears to be used for picnicking, camping, hunting, collecting of wood for subsistence, and some trapping. Although the extent of use for each of these activities is not known at this time, Back Island's suitability for recreational use is apparent. Located in a picturesque setting, Back Island is flat relative to the neighboring islands and has easily accessible beaches on its eastern side. Ketchikan residents can even reach the island during inclement weather because Clover Passage is relatively calm. The presence of SEAFAC on Back Island would clearly interrupt some recreational use of the island. The extent of the conflict would depend on how much of the island the Navy places off-limits. If the entire island were off-limits, the loss of recreational opportunities could be substantial. If only the northern third of the island were restricted, the impacts on recreational use would be less. Under the latter scenario some activities, such as deer hunting and beach picnicking, might suffer adverse impacts. The presence of SEAFAC might well decrease the deer population. Also, the 20-foot x 160-foot pier may lower the aesthetic quality of the area and result in less beach picnicking and other recreational pursuits. Noise from the diesel generators or helicopters might also detract from enjoyment of other recreational pursuits.

Another potential issue centers on how the pristine state of Back Island relates to the land use of adjacent areas. Land use of these areas may, to some extent, depend on the perception of Back Island as wilderness. To illustrate by example, recreational use of Grant Island, a mile to the east, may depend on viewing adjacent areas in their natural state, Back Island included. Thus, the presence of SEAFAC, by detracting from Back Island's wilderness quality, could alter land use patterns on adjacent lands. In particular, SEAFAC could potentially impact the planned construction of resorts or private residences in the area; however, the probability of such impacts is small.

Back Island is classified by the USFS as Land Use Designation 2 (LUD2), which is defined as generally roadless area. If SEAFAC requires a road between the pier and the main facility, a conflict may result. This issue will be addressed in an Interagency Memorandum of Understanding between the Navy and the USFS, but may require an independent NEPA action (D. Coose, personal communication).

In addition, the Draft October 1984 Ketchikan Gateway Borough Comprehensive Plan states that the Clover Passage area be adopted as scenic, and that land in this area "be reserved for large lot residential, recreation and open space needs and... commercial use should be limited to those which support recreation or tourist activities." Because Back Island falls within this area, SEAFAC does not appear to comply with the Comprehensive Plan.

Note that no mining or logging is conducted on Back Island and that no residences or resorts are located there. Thus, SEAFAC would not affect any commercial land use activities occurring on the island.

4.1.6 Water Use

Commercial and sport fishing are a major source of income for Ketchikan residents. Back Island is located in waters that are very popular for fishing. Clover Passage, in particular, is a central sport fishing area on Behm Canal. If SEAFAC is perceived to affect this activity, the potential for adverse public opinion is great. Although state and federal agency personnel indicate that SEAFAC probably will not adversely affect the stocks of salmon, steelhead, and other important species, the significance of adverse public

opinion cannot be ignored. SEAFAC is not likely to impact these fish stocks; however, if fishermen believe otherwise, the potential for conflict exists and could present a serious obstacle to licensing.

Several other issues related to fishing must also be considered. The 20-foot x 160-foot pier extending off the east side of the island presents two potential problems. First, the pier will be located where herring have been known to spawn. Building and operating the pier may either force the fish to spawn elsewhere or hinder the harvesting efforts of fishermen. Second, the pier may affect commercially important shellfish species. The underwater acoustics array in Behm Canal, although placed very deep, may potentially snag the lines of longline fishermen in pursuit of halibut and sable fish. In addition, subsistence harvesting of shellfish on the Back Island beaches would be prohibited if the island were placed off-limits to public use.

The degradation of water quality is another potential concern. Effects on water quality can significantly affect the socioeconomic status of an area if commercial and recreational activities are affected. SEAFAC is not expected to pollute the surrounding waters, and no economic effects are anticipated. The site will have a packaged primary sewage plant. The one concern pertaining to water quality is the potential for spillage of the diesel fuel required to run the generators. If spillage were to occur during herring spawning, the impacts could be substantial (see Section 3.1.1.1).

It should be mentioned that log rafts are occasionally towed through Clover Passage. Although it is not probable, the static site off Grant Island and the 160-foot long pier might pose navigational hazards to such use.

4.1.7 Prehistoric and Historic Resources

If a native burial or historical site were discovered on Back Island, controversy over how to best use the island might be great, especially if the burial or other historical site were located in the island's northern third. However, SEALASKA and Cape Fox Village, the relevant native corporations, have revealed that to the best of their knowledge, no such sites exist on the island.

4.2 DATA BASE AVAILABILITY

4.2.1 Regional Demography

Data on the Ketchikan Gateway Borough population are available from the Alaska Department of Commerce and Economic Development, which annually produces the "Alaska Economic and Statistical Review", as well as from the Alaska Department of Labor and U.S. Bureau of the Census. The "Alaskan Population Overview" published by the Alaska Department of Labor provides population data at a very detailed level. For example, this document estimates the population of the Clover Passage area.

4.2.2 Labor Force and Housing

Detailed data on the Ketchikan Gateway Borough work force are available from the Alaska Department of Labor (ADL) in statistical quarterlies for all of 1984 and the first quarter of 1985. These data provide details, by specific industry, of the total number of persons employed by month, the average monthly wage, and the total payroll. The Alaska Department of Labor also provides unemployment rate data. Other sources of labor force information include Ketchikan Gateway Borough for data on retail establishments and the Alaska Department of Commerce and Economic Development for data on spending by industry. These data sources can be used to infer any possible indirect or induced effects of SEAFAC on employment.

The Alaska Department of Labor publishes quarterly reports on housing, which include data on new housing starts data for the Borough. Information on

housing and rental units is also available in a report entitled "Managing Social Impacts in the Ketchikan Gateway Borough Resulting from the Proposed Quartz Hill Molybdenum Mine" (Morehouse and Associates 1982).

4.2.3 Community Services

Information on Ketchikan Gateway Borough's community services is available from at least four published sources. The level of police protection in the Borough, the one community service that potentially may be impacted by SEAFAC, is well documented in these sources. Of the four sources, two are studies that the impact of the Quartz Hill molybdenum mine would have on Ketchikan. Because the Quartz Hill project would require a higher level of fire and police protection and public transportation, these studies carefully characterize Ketchikan's baseline community service data.

4.2.4 Public Institutions and Educational Facilities

The Ketchikan Gateway Borough has information on both public institutions and educational facilities. Three assessments of the Quartz Hill project also provide data on these two factors.

4.2.5 Land Use

To our knowledge, no data are available to estimate the recreational use of Back Island for picnicking, camping, hunting, subsistence gathering of firewood, and trapping.

To attempt to obtain some qualitative estimate of recreational use of Back Island, various Alaskan agency personnel were questioned. The responses that we received were not consistent. One source indicated that Back Island is "very popular" for deer hunting, while another said that deer hunting on the island occurs on a small scale. Just assessing how many people visit Back Island is difficult, let alone determining the specific reason for their visit. Without these data, it is impossible to assess what recreational losses will follow partial or complete closure of Back Island. Partial or complete closure of Back Island is a key question that needs to be answered by the Navy.

Data on land use in areas adjacent to Back Island are available. Lisa Naylor of the USFS has provided U.S. Geological Survey maps of Behm Canal identifying planned or present land use activities, such as special-permit recreational residences, state-selected planned parks on nearby Grant and Betton islands, and the location of resorts. The Alaska Department of Natural Resources (DNR) has information on the status of permit activities such as the planned resort at Second Waterfall Creek. No information is readily available to estimate how use of any of these adjacent lands would be impacted by the aesthetic effect of SEAFAC.

The Alaska DNR is the source for information on mining claims in the area; none are located on Back Island. Copies of these claims can be obtained if desired. Information on logging in the area is provided by the USFS. No timber harvesting occurs on Back Island, except wood gathering for subsistence.

4.2.6 Water Use

The primary use of the waters near Back Island is fishing, both sport and commercial. Data on fishing are available from two central sources: the ADFG and the Commercial Fisheries Entry Commission (CFEC). Alaska Department of Fish and Game has an extensive data base of fish statistics, detailing the level of species harvested and type of gear used, and sorted by geographical area. Data can be obtained in monthly increments back to the mid 1970s.

The CFEC maintains a data base of annual commercial fishing activity by permits issued and fished, and provides information on species gear, vessel size, fishing employment, pounds caught, and gross earnings. These data can be used to determine the extent of commercial fishing activity in the general Ketchikan area regardless of where the permit holder lives. However, if a measure of the economic dependency of Ketchikan permit holders on fishing in waters near Back Island is desired, these data can also be obtained.

As for the herring spawning issue, at least two sources identify Back Island as a spawning location. First, D. Blankenbeckler of ADFG,

Ketchikan, notes that herring spawn on Back Island's eastern side in the general vicinity of the proposed pier. Blankenbeckler is considered our most knowledgeable contact on herring and shellfish and should be contacted for more specific information. He also alluded to the likelihood of finding valuable shellfish (abalone, scallops, clams) in this area. Second, page II-13 of the Ketchikan District Coastal Management Program (1982) clearly marks the entire littoral zone of Back Island as an area of herring spawning.

Data on subsistence harvesting of shellfish on the Back Island fringe (if any goes on) are not available. Information on the number of boat trips to Back Island or the general area is also not documented. To estimate boat use of the area, the Coast Guard suggested the Knudson Cove marina be contacted for information on boat rentals and the number of trips with Back Island specified as the destination. Understandably, no data are available on how boaters/sightseers value the aesthetics of Back Island.

4.2.7 Prehistoric and Historic Resources

Information on native historic and burial sites in the area is available from these sources: "Native Cemetary and Historic Sites of Southeast Alaska", prepared for SEALASKA Corporation; page III-5 of the "Ketchikan District Coastal Management Program", with a map of native archaeological and historic sites around Ketchikan; and a personal communication with Billy Williams, Cape Fox Corporation. All three sources indicate that no native site exists on Back Island.

4.3 DATA BASE ADEQUACY

4.3.1 Regional Demography

SEAFAC is not expected to cause any demographic impacts, and the available data are adequate to describe existing regional demography.

4.3.2 Labor Force and Housing

SEAFAC is not expected to affect Ketchikan housing. The positive effects of SEAFAC on employment during initial construction will be felt primarily in the construction industry. Data available are adequate to estimate this effect. The employment impacts resulting from the demand for construction

materials and spending by SEAFAC labor will be negligible; however, data on money spent in Ketchikan and on employment in supplier industries are available if needed.

4.3.3 Community Services

The only community service of concern is police protection. If SEAFAC is accepted by the Ketchikan community and if national and statewide environmental and antinuclear groups do not oppose development of SEAFAC at the Back Island site, the need for police protection beyond that which would be normally provided by Navy security should be minimal. If the site becomes a focus for protest activity, however, additional civilian police personnel, equipment, and training may become necessary. Baseline data on police protection are inadequate to address this possibility.

4.3.4 Public Institutions and Educational Facilities

Data exist to describe present public institutions and educational facilities. SEAFAC is not expected to affect public institutions or place demands on the existing educational facilities.

4.3.5 Land Use

Quantitative data on recreational use of Back Island are unavailable, and informed opinions are not consistent. Consequently, existing information on recreational use of Back Island is inadequate to address the impact of SEAFAC. This situation is exacerbated by lack of knowledge of the Navy's intentions regarding public access to Back Island.

Information on use of adjacent lands is adequate. Information on any link between the negative aesthetic impacts of SEAFAC on adjacent land use is unavailable. Although obtaining such information would be difficult, the aesthetic value of an area perceived by the public can be assessed. Section 5.3.3 provides a description of such a technique.

4.3.6 Water Use

The available data are generally adequate to assess the importance of sport and commercial fishing in the waters of Back Island. The importance of the general area to fishermen of southeastern Alaska, in general, and

Ketchikan, in particular, can be ascertained by review of the catch data. However, the data are not adequate to address two concerns. First, whether the proposed location of the 160-foot pier overlaps the location of known or suspected herring spawning grounds. At present, we know only that herring spawn somewhere on Back Island's eastern shore. Second, the Navy needs to establish whether the pier interacts with beds of valued shellfish (abalone, scallops, clams, etc.). The presence of shellfish of commercial value on the east side of Back Island is of some concern.

4.3.7 Prehistoric and Historic Resources

All three native archaeological data sources indicate that no native sites are documented on Back Island. However, these sources cannot be considered definitive. The fact that no sites have been discovered on Back Island does not mean that no sites exist on the island. The corroborating evidence of an onsite examination is required.

5.0 RECOMMENDED STUDIES TO CORRECT REAL OR PERCEIVED DATA DEFICIENCIES

5.1 PHYSICAL ENVIRONMENT

Adequate data seem to be available to address issues regarding the impacts of SEAFAC construction and operation on hydrology and water quality, and climate and air quality. Only the data bases for airborne acoustics (noise), and geology, soils, and seismicity are inadequate to prepare the requisite physical environment sections of the ES.

5.1.1 Acoustics

As mentioned earlier, no applicable data are available for the airborne noise baseline for the specific Behm Canal site or the transportation routes serving it. The following measurement plan is proposed:

At a minimum, a 1-week to 10-day measurement study including weekdays and weekends during daylight hours, should be planned and implemented. In order to obtain baseline values, the measurements should be taken at Back Island. Baseline measurements at Back Island will ensure that maximum noise impact from SEAFAC operations can be assessed. The measurements should be made during late spring or early summer, at a time when the likelihood of rain is at a minimum. Adjustments for seasonal variations could be made on the basis of estimates of biotic activity, water traffic, and weather conditions.

Measurements should include statistical and energy averaged values of A-weighted noise level ($L_{\max}$, $L_{\min}$, L_{eq} , L_{dn}) as well as coincidental manual checks of octave-band sound levels with a hand-held meter. The accepted single metric unit measure for airborne environmental noise is the day-night noise level, designated L_{dn} . Because the units (dB), frequency weighting (A-weighting) and time weighting (a 10 dB penalty for nighttime sound levels) are implicit in the definition, it is customary to express L_{dn} as a numerical value without units. Although L_{dn} is a single number, it requires

around-the-clock data for its determination. In theory, each hour of the day should be measured for a period of time long enough to produce a data set that includes the time-energy equivalent sound level, L_{eq} , and is representative of the hour. This period could be as short as 5 minutes or as long as 60 minutes. Additional hourly statistics that are useful in characterizing the environment are values of L_x where x is the range of numerical values between zero and 1 and L_x is the level exceeded x percent of the time. Frequently used values are L_{100} which is also called L_{min} , L_0 which is L_{max} , L_{10} which is the median noise level, and L_{90} often considered the residual noise level.

Because the proposed test site is isolated, and because wildlife are present and the land is used for recreation, it is especially important that the ES address existing sound levels, the increase expected, and potential impact on humans and wildlife. Without a set of data to document the baseline, it will be extremely difficult to assess the magnitude of the impact from airborne noise caused by the proposed site. This reasoning applies to modeling noise from sources that are not present during the measurement campaign, but which are reasonably certain to influence the acoustical environment.

The studies of airborne noise can be conducted in May 1986.

Key: 1 Onsite survey.
2 Submit survey results.

FIGURE 1 . Schedule for Acoustic Surveys

The anticipated labor needs (Table 1) total 75 man-days with no provisions for delay that might be caused by rain. Acoustic surveys cannot be conducted during the rain. Accordingly, cost of the surveys could be increased significantly if the weather is inclement. With the additional provisions for subsistence, transportation, and final report publication, we estimated the cost of the airborne noise surveys at \$48K.

TABLE 1. Labor Needed for Acoustic
(Airborne Noise) Surveys

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Onsite survey	22 days	5 days
Analyses and final report	<u>30</u>	<u>20</u>
Total	50	25

The need for additional underwater acoustic measurements in Behm Canal will be covered in a separate study entitled "Acoustic Measurement System Design and Site Acoustic Characterization Plan."

5.1.2 Geology, Soils, and Seismicity

Little site-specific information is available on the geology, soils, and seismicity of Back Island. The presence of numerous fault zones and classification of the Behm Canal area as a seismic zone 2 will greatly increase public awareness during the NEPA review process of potential hazards to SEAFAC facilities and operation resulting from seismic activity. A field reconnaissance for geology, soils, and seismicity is recommended to relate the geologic characteristics of Back Island to those of Revillagigedo and Gravina islands where detailed geologic descriptions have been prepared.

The field surveys will concentrate on four major geologic aspects of Back Island for which little or no site-specific information is available:

- geology and soils
- evidence of seismic activity

- slope and shoreline stability
- flooding and drainage.

The field reconnaissance will consist of a detailed review of existing geologic information on Revillagigedo and Gravina islands, a 5-day site visit, and a report correlating the geology, soils, and seismicity of Back Island with similar areas on Revillagigedo and Gravina islands. These data will also be evaluated to determine how they relate to the construction and operation of SEAFAC.

The field surveys can coincide with the other recommended surveys in June 1986. The review of existing geology, soils, and seismicity information will commence one month before the site inspection and the draft report will be completed two months after the site inspection. A total of three months will be required to complete the recommended field surveys. Figure 2 shows the proposed schedule.

FIGURE 2. Schedule for Geology, Soils, and Seismicity Surveys

The anticipated labor needs are summarized in Table 2. An estimated 40 man-days of scientific effort and 7 support man-days are required for the field reconnaissance. The estimated costs with provisions for subsistence, transportation, and final report publication are \$28K.

TABLE 2. Labor Needed for Geology, Soils and Seismicity Field Surveys

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Review	15 days	1 days
Site inspection	10	1
Report	<u>15</u>	<u>5</u>
Total	40	7

5.2 ECOLOGICAL ENVIRONMENT

5.2.1 Aquatic Environment

Adequate data are available to address issues pertaining to impacts on resident and migratory finfish; however, additional data collection will be required to estimate impacts on shellfish, other invertebrates, and aquatic plants. The potential for public sensitivity also prompts us to recommend that surveys be conducted to increase the knowledge base about marine mammals in Behm Canal.

5.2.1.1 Shellfish, Other Invertebrates, and Aquatic Plants

As part of the baseline characterization of Back Island, we recommend that systematic diver surveys be performed to identify predominant shellfish populations, potential herring spawning areas, and other plant and invertebrate communities. Similar diver surveys have been performed by USFWS and NMFS personnel to assess the possible impacts of log rafting on intertidal and subtidal communities in southeast Alaska. Because nearshore communities are strongly influenced by the nature of the substrate, the diver surveys should also map the substrate types and locations.

Using this approach, potentially vulnerable shellfish, other invertebrate, and aquatic plant resources of Back Island can be cataloged; this approach will not rigorously quantify the diversity and distribution of these aquatic assemblages. Line transects would be established perpendicular to the beach, and extend for 100 m, as measured from the high-water mark.

Using SCUBA, observations on substrate composition, plant and animal species, and water depth would be made at 5- to 10-m intervals along the line. Additional lines of observation would be established at the proposed locations of docks and communication cable routes. If scheduled in early spring, the dive survey could also observe the incidence of herring spawning activity and locations of spawning beds around the island. The schedule for the benthic surveys is shown in Figure 3. We estimate that the benthic dive surveys will cost \$22K, which includes labor (Table 3), subsistence, transportation, and report preparation.

Key: 1 Benthic survey.
 2 Submit final survey report.

FIGURE 3. Schedule for Shellfish, Other Invertebrates, and Aquatic Plant Survey

TABLE 3. Labor Needed for Surveys of Shellfish, Other Invertebrates, and Aquatic Plants

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Spring survey	18 days	2 days
Report	<u>10</u>	<u>10</u>
Total	28	12

5.2.1.2 Marine Mammals

No noticeable public or agency concern was expressed over potential impacts of SEAFAC on marine mammal populations. This lack of concern, along with evidence that local whale abundance would not be particularly affected by vessel or acoustic activities (Malme et al. 1985), suggests that no additional environmental data need to be collected during fiscal year 1986. Should public perceptions or sensitivity change during this next year, however, we suggest that baseline surveys of marine mammal populations be performed. Unbiased boat surveys similar to those conducted in Glacier Bay for humpback whales (S. Baker, personal communication) would be recommended during spring, summer, and fall. Concurrently with these surveys, hydroacoustic surveys should be conducted to determine the presence/absence, locations, and abundance of prey species, such as euphausiids and herring, used by whales such as the humpback and minke. Because of the strong correlation between abundance of these prey species and abundance of humpback whales, a survey of the prevalence of whale prey species could provide information regarding the potential use of Behm Canal by humpbacks and other species of cetaceans. For example, a large food base and an absence of whales would be a strong indicator of a general lack of use of Behm Canal by whales. Similarly, low densities of forage species would generally indicate an unfavorable environment for large whale species such as humpback or gray.

A suggested schedule for the marine mammal and marine mammal prey studies is shown in Figure 4.

- Key:
- 1 Spring survey of whales and prey species.
 - 2 Summer survey of whales and prey species.
 - 3 Fall survey of whales and prey species.
 - 4 Submit final survey report.

FIGURE 4. Schedule for Marine Mammal and Prey Surveys

Surveys will require intensive labor for the field studies (Table 4). An additional cost is the rental of a suitable vessel. The Auke Bay Laboratory of NMFS has estimated the cost of the surveys at \$50K should their staff do the work. The NMFS has experience in conducting hydroacoustic surveys for whale prey species; consequently, should another organization perform the investigation, the cost could increase by perhaps 50% to bring the cost of the prey surveys to \$75K. We are estimating the cost of the marine mammal sighting surveys to be \$80K, which includes labor, subsistence, transportation, vessel rental, and final report publication. The combined marine mammal sighting and prey species surveys are estimated to cost \$130K.

5.2.2 Terrestrial Environment

Surveys of tree and plant cover by habitat type in addition to surveys of breeding birds and small mammals are required for Back Island.

5.2.2.1 Forest Type and Composition

The small size of Back Island readily lends itself to a forest survey. Such a survey is recommended as an integral part of the baseline studies and should be directed to map forest overstory, understory, and vegetation cover types. Baseline investigations of the wildlife would also benefit from this mapping exercise because between habitat and wildlife resources are strongly interrelated.

TABLE 4. Labor Needed for Marine Mammal and Prey Surveys

	<u>Marine Mammals</u>		<u>Prey Species</u>	
	<u>Technical Staff</u>	<u>Support Staff</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Spring survey	20 days	2 days	20 days	5 days
Summer survey	20	2	18	4
Fall survey	20	2	18	4
Report	<u>15</u>	<u>10</u>	<u>21</u>	<u>15</u>
Total	75	16	77	28

The forest survey should collect the following information:

- habitat maps drawn to scale and overlaid with the proposed facility siting
- species lists and estimates of tree and plant cover by habitat type (e.g., frequency, land area)
- wildlife usage maps including the locations of den trees, raptor nests, forage areas, and shelter belts.

The anticipated result would be a survey of forest resources and timber types that could then be used to assess impacts on the visual and wildlife resources of the island.

A forest survey of Back Island is recommended during both the spring and fall seasons (Figure 5). Timber and shrubs are best surveyed in spring before foliage can interfere with the survey. A second survey during the fall season would be used to quantify plant cover and identify wildlife usage patterns.

- Key:
- 1 Timber survey and initial mapping of wildlife use patterns.
 - 2 Plant surveys and additional mapping of wildlife use patterns.
 - 3 Submit survey results.

FIGURE 5. Schedule for Forest Surveys

The anticipated labor needs for the forest survey are summarized in Table 5. Conducted independently, the survey would require approximately 38 man-days of technical labor and 13 man-days of secretarial support to prepare reports, maps, and documentation. Coordination with other field efforts and use of local expertise could reduce the anticipated levels of effort.

TABLE 5. Labor Needed for Forest Survey

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Spring survey	19 days	3 days
Fall survey	14	3
Final report and analysis	<u>5</u>	<u>9</u>
Total	38	15

Addition of subsistence, transportation, and final report publication would bring the costs to \$32K.

5.2.2.2 Wildlife and Game Animals

A breeding bird census and small mammal trapping are recommended to supplement existing data on local wildlife populations. The objective of these surveys would be to detect any unanticipated species requiring special management provisions. Estimates of baseline densities and abundance levels would be obtained from the surveys using tag-recapture, line transect, or point sampling techniques. Estimates of abundance and species lists would provide the basis to compare the island populations with other wildlife communities studied elsewhere.

The Navy should coordinate their activities with USFWS and encourage the USFWS to perform an eagle nesting survey in the vicinity of Back Island. Jake Jacobson and Phil Schempf of USFWS perform these activities as part of their normal duties with the agency. Such surveys should be performed during the spring of 1986 because timeliness is important. The results of these surveys could be available to the Navy or its contractors at little or no cost.

A survey of flying squirrel populations could be performed on Back Island as a component of the forest and/or small mammal surveys described earlier (Sections 5.2.2.1 and 5.2.2.2). If conducted as an integral component of those surveys, the cost of the flying squirrel study would be negligible. Captured specimens would be compared to type specimens of subspecies of northern flying squirrel for classification.

The wildlife surveys should be timed to coincide with the timber surveys discussed previously (Figure 6). The breeding bird census needs to be conducted in spring. Preliminary small mammal trapping should also be conducted at these same time to collect qualitative data for a species list. During the fall, a more intensive small mammal trapping program should be conducted to collect quantitative data on species abundance. Four or more sampling grids should be established to estimate mean densities and spatial variation.

The anticipated labor needed for the recommended faunal surveys is summarized in Table 6. Should the faunal surveys be conducted independently, the bird census would require approximately 25 man-days of labor, and the springtime small mammal studies an additional 4 man-days. The mammal surveys in the fall are projected to require an additional 18 man-days of scientific labor. As in the forest surveys, the level of effort will depend on the extent of quantitative versus qualitative information gathered from the baseline investigations. Levels reported here should provide baseline estimates with reasonable precision (i.e., $\pm 50\%$ of the mean, 90% of the time). With the additional provisions for subsistence, transportation, and final report publication, we have estimated the cost of faunal surveys at \$42K.

- Key: 1 Breeding bird survey.
 2 Small mammal trapping program.
 3 Submit survey results.

FIGURE 6. Schedule for Faunal Surveys

TABLE 6. Labor Needed for Faunal Surveys

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Spring bird	25 days	3 days
Spring mammal	4	0
Fall mammal	18	3
Final report and analysis	<u>12</u>	<u>10</u>
Total	59	16

5.3 SOCIOECONOMIC ENVIRONMENT

Adequate data are available to address potential impacts on regional demography, labor force and housing, public institutions and educational facilities. However, additional data need to be collected to more accurately estimate impacts on community services, land use, and water use (particularly for recreation and aesthetics), and prehistoric and historic resources.

5.3.1 Community Services

If the Ketchikan community accepts SEAFAC and if national and statewide environmental and antinuclear groups do not aggressively protest SEAFAC, there should be minimal need for local police protection beyond the current level or that provided by the Navy. If, however, the site becomes a regular focus for protest activity, similar to the Bangor, Washington, facility, additional civilian police personnel, equipment, and training may become necessary. Although we do not know how much civilian police protection might be needed, we estimate that 28 man-days would be required to supply such an estimate (Table 7). We would survey a number of local police agencies to obtain estimates of the number of personnel and the budget required. The survey could also be designed to measure local attitudes (see Aesthetic Impact, below). This information could be obtained at almost any time, but May 1986 has been suggested as a deadline because other studies are planned (Figure 7). The total cost of the survey including labor, subsistence, transportation, and final report publication is \$15K.

TABLE 7. Labor Needed for Community Services Survey

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Site Survey	10 days	10 days
Analyses and Final Report	<u>5</u>	<u>3</u>
Total	15	13

Key: 1 Site survey.
2 Submit final report.

FIGURE 7. Schedule for Community Services Survey

5.3.2 Recreational Use

It is apparent, based on contact with the ADFG, U.S. Coast Guard, USFS, and Ketchikan Gateway Borough, that Back Island is used for picnicking, hunting, trapping, wood gathering, and camping, and surrounding waters are heavily used for recreational fishing for fin and shellfish. With the exception of sports fishing, no quantitative data are available on the level of recreational use.

We recommend that a field survey be conducted to evaluate recreational use of Back Island and surrounding waters at varying times during the recreational season (Figure 8). The survey can be accomplished by 1) taking aerial photographs at varying times of the day and week to substantiate numbers of users, and 2) performing a follow-up field survey during key periods (e.g.,

during shellfish seasons, during peak wood-gathering periods) to obtain such data on catch, extent of participation, recreation alternatives, and characteristics of recreationists.

We estimate that perhaps 10 flights over the area might be adequate, along with 10 to 15 man-days of surveying the boats/shore-based recreationists in the area, either at the dock or on the island and surrounding waters. We would design a relatively simple sampling technique and survey instrument for 10 man-days of effort. It might be best to fund Alaska DNR, ADFG, or USFWS to perform the survey itself. Besides field survey and design time, this effort would require airplane support time at about \$200 per hour for aerial photography and boat time at \$50 to \$500 per day for access to the island. Labor hours required to perform the survey, summarize the data and prepare the report are shown in Figure 8. Total costs are estimated to be between \$25 and \$30K.

- Key: 1 Recreational use surveys.
2 Analyses and submit final report.

FIGURE 8. Schedule for Recreational Land and Water Use Survey

TABLE 8. Labor Needed for Recreational Land and Water Use Survey

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Survey Design and Pretest	15 days	10 days
Spring survey	5	5
Summer survey	5	5
Fall survey	5	5
Analyses and Final Report	<u>10</u>	<u>5</u>
Total	40	30

5.3.3 Aesthetics

The potential aesthetic impact of the facility is unknown at this time. A random household field survey could be done of persons living in the area to determine if the aesthetic impact constitutes an issue. The survey team would show residents photographs of the sites, altered to display an artist's concept of the shore-based facility, battleship buoys, and dock. The survey team would then question residents on the feelings and value (contingent valuation) that the individual ascribes to the aesthetic change. We have performed such studies in the past for the visual aesthetics of nuclear power plants and other hard-to-measure socioeconomic impacts (Adams et al. 1980).

The aesthetics survey could be performed almost any time; however, it is best scheduled at the time of intense recreational use of Behm Canal (Figure 9). Labor needed to perform this survey is shown in Table 9. Total costs including labor, subsistence, transportation, and final report publication are estimated to be \$25K.

FIGURE 9. Schedule for Aesthetics Survey
(Recreational Survey)

TABLE 9. Labor Needs for Aesthetics Survey

<u>Labor</u>	<u>Technical Staff</u>	<u>Support Staff</u>
Site survey	15 days	15 days
Analyses and final report	<u>10</u>	<u>5</u>
Total	25	20

5.3.4 Prehistoric and Historic Resources

Neither SEALASKA Corporation nor Cape Fox Corporation, the cognizant native groups for the Ketchikan area, were aware of any native burial sites or other native historical sites on Back Island. However, these two groups and the USFS concede that Back Island has not been closely surveyed. We recommend that the Navy ask the USFS to have their archaeologist perform a walking survey of the Island and determine whether any archaeological sites exist on the island. It is our understanding that the USFS will be receptive to the Navy's overture. This undertaking is estimated to require between 1 man-day and 3 man-days, depending on whether the entire island were covered and the detail of the search, as well as including time for preparing a report. This survey can probably be performed by the USFS at no cost to the Navy.

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7.0 REFERENCES

- Adams, R. C., et al. 1980. The Visual Aesthetic Impact of Alternative Closed Cycle Cooling Systems. NUREG/CR-0989, U.S. Nuclear Regulatory Commission, Washington, D.C.
- Alaback, P. B. 1981. Dynamics of Understory Biomass in Sitka Spruce-Western Hemlock Forests of Southeast Alaska. Final Report to USFS, Forest Science Laboratory, Juneau, Alaska.
- Alaback, P. B. and J. C. Tappeiner, II. 1984. Response of Understory Vegetation to Thinning in the Sitka Spruce-Western Hemlock Forests of Southeast Alaska. USFS, Forest Science Laboratory, Juneau, Alaska.
- Berg, P. C. 1973. "Geology of Gravina Island, Alaska". U.S. Geological Survey, Bull. 1371.
- Billings, R. F. 1974. Soil Management Report for the Ketchikan Area, Alaska. Ketchikan Gateway Borough, Ketchikan, Alaska.
- Brew, D. A. 1966. Geological Map of Southeastern Alaska. Canadian Institute of Mining and Metallurgy.
- Brew, D. A., R. A. Loney and L. J. P. Muffler. 1966. "Tectonic History of Southeastern Alaska." In A Symposium of the Tectonic History of Mineral Deposits of the Western Cordillera, Vancouver, B.C., Canada. 1964. Canadian Institute of Mining and Metallurgy Special Volume 8:149-170.
- Buddington, A. F. and T. Chapin. 1929. "Geology and Mineral Deposits of Southeastern Alaska." U.S. Geological Survey, Bull. 800.
- Bufuers, J. 1967. History of Mines and Prospects, Ketchikan District, Prior to 1952. State of Alaska, Department of Natural Resources, Div. of Mines and Minerals.
- Carlson, H. R. 1977. Results of a tagging study of Pacific Herring in Southeastern Alaska in 1960-62 Using Radioactive Body Cavity Tags. Northwest and Alaska Fisheries Center Processed Report, Northwest and Alaska Fisheries Center, Auke Bay, Alaska.
- Carlson, H. R. 1980. "Seasonal Distribution and Environment of Pacific Herring Near Auke Bay, Lynn Canal, Southeastern Alaska." Trans. Amer. Fish. Soc. 109:71-78.
- Carlson, H. R., R. E. Haight and K. J. Krieger. 1982. Species Composition and Relative Abundance of Demersal Marine Life in Waters of Southeastern Alaska, 1969-81. Northwest and Alaska Fisheries Center, Processed Report 82-16, Northwest and Alaska Fisheries Center, Auke Bay, Alaska.
- Changery, J. M. 1978. National Wind Data Index. HCD/T1041-01, National Climatic Center, Asheville, North Carolina.

- Chapin, Theodore. 1918. "The Structure and Stratigraphy of Gravina and Revillagigedo Islands, Alaska." U.S. Geological Survey, Professional Paper 120-D.
- Cobb, E. H. 1968. "Metallic Mineral Resources Map of the Ketchikan Quadrangle, Alaska." U.S. Geological Survey, Open-File report, Miscellaneous Field Studies Map No. 420.
- Corr, P. O. 1974. "Bald Eagle Nesting Related to Forestry in Southeastern Alaska." M.S. Thesis, University of Alaska. Fairbanks, Alaska.
- Cox, D. C. and G. Pararas-Caryannis. 1976. "Catalog of Tsunamis in Alaska. World Data Center A for Solid Earth Physics." U.S. National Oceanic and Atmospheric Administration, Environmental Data Service. Report SE-1, Revised 1976.
- Davis, T. N. and C. Eholis. 1962. "A Table of Alaskan Earthquakes, 1788-1961." Geophysical Institute, University of Alaska, Fairbanks, AK Research Report 8.
- DOE. 1979. Regional Issue Identification and Assessment. U.S. Department of Energy, Washington, D.C.
- DuPont. 1985. "Neither Rain, Nor Fog, Nor Rough Seas." DuPont Magazine September/October 1985, 79, No. 5, DuPont de Nemours and Co., Wilmington, Delaware.
- Freeland, H. J., D. M. Farmer and C. L. Levings. 1980. Fjord Oceanography. Plenum Press, New York.
- Gifford, F. A. 1961. "Use of Routine Meteorological Observation for Estimating Atmospheric Dispersion." Nuclear Safety 2:47-51.
- Hansen, A. J., E. L. Bocher, J. I. Hodges and D. R. Cline. 1984. Bald Eagles of the Chilkat Valley, Alaska: Ecology, Behavior and Management. National Audubon Society, New York, New York.
- Harbo, S. J., Jr. 1958. "An Investigation of Mink in Interior and Southeastern Alaska". M.S. Thesis, University of Alaska, Fairbanks, Alaska.
- Harris. 1978. "Motor Vehicle Noise." In Handbook of Noise Control, Chapter 32, ed., Cyril M. Harris, McGraw-Hill, New York, New York.
- Hart, J. L. 1973. Food and feeding habits of Pacific Herring in the Vicinity of Auke Bay, Southeastern Alaska. Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska.
- Henderson, J. A. 1983a. Behm Canal Engineering and Environmental Measurement Program - Cycle #1. TRACOR, Inc., Silverdale, Washington.
- Henderson, J. A. 1983b. Behm Canal Engineering and Environmental Measurement Program - Cycle #2. TRACOR, Inc., Silverdale, Washington.

- Henderson, J. A. 1984a. Behm Canal Engineering and Environmental Measurement Program - Cycle #3. TRACOR, Inc., Silverdale, Washington.
- Henderson, J. A. 1984b. Behm Canal Engineering and Environmental Measurement Program - Cycle #4. TRACOR, Inc. Silverdale, Washington.
- Henderson, J. A., and D. E. Bonnett. 1982. Behm Canal Preliminary Acoustic Range Evaluation. U.S. Navy, C/N N00123-82-C-0010. Tracor, Inc., Silverdale, Washington.
- Hodges, J. I. 1982a. "Bald Eagle Nesting Studies in Seymour Canal, Southeast Alaska." Condor 84:125-127.
- Hodges, J. I. 1982b. "Observations of 3,850 Bald Eagle Nests in Southeast Alaska." In Proceedings of Raptor Manage. and Biol. Symp., eds. W. N. Ladd and P. F. Schempt, pp. 37-46. USDI Fish Wildlife Service, Alaska Regional Office, Anchorage, Alaska.
- Holliday, D. V., and J. A. Henderson. 1981. Southeast Alaska Acoustic Reconnaissance. Report No. T-81-50-019-V U.S. Navy C/N N00600-81-D-9008, Tracor, Inc., Silverdale, Washington.
- Jones, D. L., W. D. Irwin, and A. T. Dvenshine. 1972. "Southeastern Alaska Displaced Continental Fragment?" U.S. Geological Survey. Professional Paper 800B.
- Ketchikan District Coastal Management Program, Public Hearing Draft.
Prepared by: Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska. July 1982.
- Leatherwood, S., A. E. Bowles, E. Krygier, J. D. Hall and S. Ignell. 1984. "Killer whales (*Orcinus orca*) in Southeast Alaska, Prince William Sound, and Shelikof Strait; A Review of Available Information." Rep. Int. Whal. Comm. 34:521-530.
- Lemke, R. W. and L. A. Yehle. 1972. "Regional and Other General Factors Bearing on Evaluation of Earthquake and Other Geologic Hazards to Coastal Communities of Southeastern Alaska." U.S. Geological Survey. Open-File Report 516.
- Lemke, R. W. 1975. "Reconnaissance Engineering Geology of the Ketchikan Area, Alaska, with Emphasis on Evaluation of Earthquake and Other Geologic Hazards." U.S. Geological Survey. Open-File Report 75250.
- Malme, C. I., P. R. Miles, P. Tyock, C. W. Clark and D. E. Bird. 1985. Investigation of the Potential Effects of Underwater Voice from Petroleum Industry Activities in Feeding Humpback Whale Behavior. BBN Laboratories, Inc., Cambridge, Maine.
- Martinson, C. and D. Kuklok. 1979. "Atlas of the Ketchikan Region; A Basis for Planning." Ketchikan Gateway Borough Planning Department. Ketchikan, Alaska.

- McLain, D. R. 1968. Oceanographic Surveys of Traitors Cove, Revillagigedo Island, Alaska. U.S. Fish and Wildlife Service. Special Scientific Report - Fisheries No. 576. pp 1-15.
- Monger, J. W. H., J. G. Souther and H. Gabrielse. 1972. "Evolution of the Canadian Cordillera: A Plate Tectonic Model." Am. J. Sci. 272:577-602.
- Morehouse & Associates. 1983. Managing Social Impacts in the Ketchikan Gateway Borough Resulting from the Proposed Quartz Hill Molybdenum Mine Project.
- Neimark, L. M. 1984. Annual Performance Report for Harvest Estimates of Selected Fisheries Throughout Southeastern Alaska (Part I - Alaska Marine Studies). Vol. 25, Study G-I, State of Alaska Department of Fish and Game.
- Noble, R. E. 1977. Breeding Bird Populations in Hemlock-Spruce Old Growth and Clearcuts, Prince of Wales Island, Alaska. USDA Forest Service, Ketchikan, Alaska.
- Pickard, G. L. 1967. "Some Oceanographic Characteristics of the Larger Inlets of Southeast Alaska". J. Fish. Res. Bd. Canada 24(7):1476-1506.
- Robards, F. C., and J. I. Hodges. 1976. Observations from 2,760 Bald Eagle Nests in Southeast Alaska: Progress Report 1969-1976. USDI Fish and Wildlife Service, Juneau, Alaska.
- Robards, F. C., and J. G. King. 1966. Nesting and Productivity of Bald Eagles in Southeast Alaska. USDI Bureau of Sport Fisheries and Wildlife, Juneau, Alaska.
- Rodman, C. W. 1985a. Personal communication with Richard Coose, Ketchikan Ranger District. USDA Forest Service. November 4, 1985.
- Rodman, C. W. 1985b. Telephone Communication. Charles Rodman, Battelle Columbus Division and Richard Barnum, Reed Middleton Associates. November 11, 1985. Subject Ketchikan International Airport Master Plan.
- Rodman, C. W. 1985. "Use of Spreadsheet Software to Predict Noise from Blasting." NoiseCon 85, Proceedings, Institute of Noise Control Engineering, Columbus, Ohio.
- Selkregg, L. L. (ed.) 1976. "Alaska Regional Profiles, Southeast Region." University of Alaska, Arctic Environmental Information and Data Center, Fairbanks, Alaska.
- Siedelman, D. L., and M. W. Schwan. 1981. Harvest of Selected Fisheries Throughout Southeastern Alaska. Vol. 22, Study G-I, Alaska Dept. of Fish and Game.
- Skud, B. E. 1959. Herring Spawning Surveys in Southeastern Alaska. U.S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 321.

- Stephens, F. R. 1966. Soil and Watershed Characteristics of Southeast Alaska and Some Western Oregon Drainages. USDA Forest Service, Alaska Region. Ketchikan, Alaska.
- Suring, L. H., and M. L. Prather. 1985. Habitat Suitability Index Models: Sitka Black-tailed Deer. USDA Forest Service, Ketchikan, Alaska.
- Suring, L. H. 1985. A Preliminary Overview of Prince of Wales Island Flying Squirrel (*Glaucomys sabrinus griseifrons*). USDA Forest Service, Tongass National Forest, Ketchikan, Alaska.
- Swanston, D. A. 1969. "Mass Wasting in Coastal Alaska." USDA Forest Service, Research Paper PNW-83, Ketchikan, Alaska.
- Twinhofel, W. S. and C. L. Sainsbury. 1958. "Fault Patterns in Southeastern Alaska." Geological Society of America Bull. 69:1431-1442.
- U.S. Borax. 1983. Development of Quartz Hill Molybdenum Project Alaska, Draft Environmental Report. Vol. 1. United States Borax and Chemical Corp. on behalf of Pacific Coast Molybdenum Company.
- USFWS and NMFS. 1985. Report of Field Investigations: Coco Harbor, Rose Inlet and Hamco, Dall Island, Port Caldara, Hetta Inlet near Sulfer and near Jumbo Island, Polk Inlet, Kiva Cove, Tolstoi Bay, Prince of Wales Island. Memo, Ketchikan, Alaska.
- U.S. National Ocean Survey. 1978. United States Coast Pilot 8, Pacific Coast Alaska: Dixon Entrance to Cape Spencer. 13th ed., U.S. Department of Commerce.
- U.S. National Ocean Survey. 1985a. Tide Tables, West Coast of North and South America, including the Hawaiian Islands. U.S. Department of Commerce.
- U.S. National Ocean Survey. 1985b. Tidal Current Tables, Pacific Coast of North American and Asia, including the Hawaiian Islands. U.S. Department of Commerce.
- USDA. 1975. Proceedings of the Symposium on Management of Forest and Range Habitats for Nongame Birds. Report WO-1.
- USDA. 1978a. Tongass Land Management Plan. Landtype/Timber Task Force Working Report, TLMP-6, USDA Forest Service, Region 10, Juneau, Alaska.
- USDA. 1978b. Tongass Land Management Report. Wildlife Task Force Working Report. USDA Forest Service, Region 10. Juneau, Alaska.
- USDA. 1978c. Proceedings of the Workshop on Nongame Bird Habitat Management in the Coniferous Forests of the Western United States. USDA Forest Service. General Technical Report PNW-64.

- USDA. 1981. Wildlife and Fisheries Habitat Management Notes. Effects of Clearcutting and Timber Management on Sitka Black-tailed Deer: A Report to the Forest Service. No. 103a. USDA Forest Service, Region 10, Juneau, Alaska.
- USDA. 1982. Wildlife and Fisheries Habitat Management Notes. Wildlife and Second-growth Forests of Southeast Alaska: Problems and Potential for Management. No. 110. USDA Forest Service, Region 10, Juneau, Alaska.
- USDA. 1985. Wildlife and Fisheries Habitat Management Notes. Habitat Management for Forest Birds in Southeast Alaska. No. 146. USDA Forest Service, Region 10, Juneau, Alaska.
- USDA Forest Service. 1979. Species List of Alaskan Birds, Mammals, Fish, Amphibians, Reptiles and Invertebrates. Alaska Region Report Number 82, Ketchikan, Alaska.
- U.S. EPA. 1978. Compilation of Air Pollutant Emission Factors, 3rd ed., AP-42, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.
- U.S. EPA. 1980. Prevention of Significant Deterioration Workshop Manual. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.
- U.S. EPA 1982. Guidelines for Noise Impact Analysis, Report No. 550/9-82-105 (PB82 21905) United States Environmental Protection Agency, Office of Noise Abatement and Control, Washington, DC.
- Van Wormer, J. D., J. Davies, and L. Gedney. 1974. "Seismicity and Plate Tectonics in South Central Alaska." Seismological Society of America. Bull. 64(5):1467-1475.
- VTN. 1980. Aquatic Biology Annual Environmental Baseline Report, Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax & Chemical Corp., Los Angeles, California.
- VTN. 1981. Aquatic Biology Annual Environmental Report, Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax & Chemical Corp., Los Angeles, California.
- VTN. 1982a. Nursery Studies - Finfish, Boca de Quadra and Wilson Arm/Smeaton Bay Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax and Chemical Corp., Los Angeles, California.
- VTN. 1982b. Nursery Studies - Shellfish, Boca de Quadra and Wilson Arm/Smeaton Bay, Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax & Chemical Corp., Los Angeles, California.

- VTN. 1982c. Distribution, Abundance and Food Habits at the Heads of Wilson Arm/Smeaton Bay and Boca de Quadra, Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax & Chemical Corp., Los Angeles, California.
- Wallmo, O. C., and J. W. Schoen. 1979. Sitka Black-tailed Deer Conference Proceedings, USDA Forest Service, Region 10, Juneau, Alaska.
- Wallmo, O. C., and J. W. Schoen. 1980. "Response of Deer to Secondary Forest Succession in Southeast Alaska". Forest Sci. 26:448-462.
- Watson, C. E. 1968. "The Climate of Alaska." In Climates of the States - Vol. 2. Water Information Center, Port Washington, New York.
- Wheeler, J. O. and H. Gabrielse. 1972. "Variations in Tectonic Styles in Canada, The Cordilleran Structural Province." Geological Association of Canada, Special Paper No. 11. 83p.
- Wise, J. S., T. Wentink, R. Becker, A. L. Comiskey, D. L. Elliott, W. R. Barchet, and R. L. George. 1980. Wind Energy Resource Atlas: Vol. 10 - Alaska. PNL-3195 (WERA-10), Pacific Northwest Laboratory, Richland, Washington.
- Wolf, E.N. and L. E. Heiner. 1971. "Mineral Resources of Southeastern Alaska." Report No. 28, Industry Research Laboratory, University of Alaska, Fairbanks, Alaska.
- Woodworth, R. W. and F. J. Haight. 1927. Tides and Currents in Southeast Alaska. U.S. Coast and Geodetic Survey. Serial Number 364, Special Publication No. 127. U.S. National Ocean Survey, Anchorage Chart Sales Office, U.S. Department of Commerce.
- Wright, F.E. and C.W. Wright. 1908. "The Ketchikan and Wrangell Mining Districts, Alaska." U.S. Geological Survey. Bull. 347.

8.0 BIBLIOGRAPHY

8.1 PHYSICAL ENVIRONMENT

8.1.1 Hydrology and Water Quality

- Freeland, H. J., D. M. Farmer and C. L. Levings. 1980. Fjord Oceanography. Plenum Press, New York.
- Henderson, J. A. 1983a. Behm Canal Engineering and Environmental Measurement Program - Cycle #1. TRACOR, Inc., Silverdale, Washington.
- Henderson, J. A. 1983b. Behm Canal Engineering and Environmental Measurement Program - Cycle #2. TRACOR, Inc., Silverdale, Washington.
- Henderson, J. A. 1984a. Behm Canal Engineering and Environmental Measurement Program - Cycle #3. TRACOR, Inc., Silverdale, Washington.
- Henderson, J. A. 1984b. Behm Canal Engineering and Environmental Measurement Program - Cycle #4. TRACOR, Inc. Silverdale, Washington.
- Martinson, C. and D. Kuklok. 1979. Atlas of the Ketchikan Region; A Basis for Planning. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.
- McLain, D. R. 1968. Oceanographic Surveys of Traitors Cove, Revillagigedo Island, Alaska. U.S. Fish and Wildlife Service, Special Scientific Report - Fisheries No. 576. pp 1-15.
- Pickard, G. L. 1967. "Some Oceanographic Characteristics of the Larger Inlets of Southeast Alaska". J. Fish. Res. Bd. Canada 24(7):1476-1506.
- U.S. National Ocean Survey. 1978. United States Coast Pilot 8, Pacific Coast Alaska: Dixon Entrance to Cape Spencer. 13th ed. U.S. Department of Commerce, pp 57-63.
- U.S. National Ocean Survey. 1985a. Tide Tables, West Coast of North and South America, including the Hawaiian Islands. U.S. Department of Commerce.
- U.S. National Ocean Survey. 1985b. Tidal Current Tables, Pacific Coast of North American and Asia, including the Hawaiian Islands. U.S. Department of Commerce.
- Woodworth, R. W. and F. J. Haight. 1927. Tides and Currents in Southeast Alaska. U.S. Coast and Geodetic Survey, Serial Number 364, Special Publication No. 127. U.S. National Ocean Survey, Anchorage Chart Sales Office.

8.1.2 Acoustics

- ANSI. 1971. American National Standard for the Physical Measurement of Sound. (ANSI S1.2-1962 (R1971). American National Standards Institute, New York, New York.
- ANSI. 1983. Specification for Sound Level Meters ANSI S1.4-1983, American National Standards Institute, New York, NY.
- ASTM. 1985. Standard Guide for Measurement of Outdoor A-weighted Sound Levels, ASTM E1014-83, 1985 Annual Book of Standards, Vol. 04-06, American Society for Testing and Materials, Philadelphia, Pennsylvania.
- DuPont. 1985. "Neither Rain, Nor Fog, Nor Rough Seas," DuPont Magazine September/October 1985, 79, No. 5, DuPont de Nemours and Co., Wilmington, Delaware.
- Fletcher, J. and R. Busnel. 1978. Effects of Noise on Wildlife. Academic Press, New York, New York.
- Foote, K. G. 1980. Comment on "Some Frequencies of Underwater Noise Produced by Fishing Boats Affecting Albacore Catch." J. Acoustics Soc. of America 67(3):1064.
- Gales, R. S. 1983a. Effects of Noise of Offshore Oil and Gas Operations on Marine Mammals--An Introductory Assessment. 2:336
- Gales, R. S. 1983b. Effects of Noise of Offshore Oil and Gas Operations on Marine Mammals--An Introductory Assessment. 1:336
- Harris. 1978. "Motor Vehicle Noise." In Handbook of Noise Control, Chapter 32, ed., Cyril M. Harris, McGraw-Hill, New York, New York.
- Henderson, J. A., and D. E. Bonnett. 1982. Behm Canal Preliminary Acoustic Range Evaluation. U.S. Navy, C/N N00123-82-C-0010. Tracor, Inc., Silverdale, Washington.
- Henderson, J. A. 1983. Behm Canal Engineering and Environmental Measurement Program Cycle #2. Tracor, Inc., Silverdale, Washington.
- Henderson, J. A. 1984a. Behm Canal Engineering and Environmental Measurement Program Cycle #3. Tracor, Inc., Silverdale, Washington.
- Henderson, J. A. 1984b. Behm Canal Engineering and Environmental Measurement Program Cycle #4. Tracor, Inc., Silverdale, Washington.
- Holliday, D. V., and J. A. Henderson. 1981. Southeast Alaska Acoustic Reconnaissance. Report No. T-81-50-019-V U.S. Navy C/N N00600-81-D- 9008. Tracor, Inc., Silverdale, Washington.

Martinson, C. and D. Kurklok. 1979. Atlas of the Ketchikan Region: A Basis for Planning. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.

Rodman, C. W. 1985c. "Use of Spreadsheet Software to Predict Noise from Blasting. In NoiseCon 85, Proceedings, Institute of Noise Control Engineering, Columbus, Ohio.

Turl, C. W. 1982. "Possible Effects of Noise from Offshore Oil and Gas Drilling Activities on Marine Mammals: A Survey of the Literature." P. 25. Naval Ocean System Center, San Diego, California,

U.S. EPA. 1974. Information on Levels of Environmental Noise Requisite to Protect the Public Health and Welfare with an Adequate Margin of Safety. EPA-550/9-74-004, U.S. Environmental Protection Agency Report, Washington, D.C.

U.S. EPA. 1982. Guidelines for Noise Impact Analysis, Report No. 550/9-82-105 United States Environmental Protection Agency, Office of Noise Abatement and Control, Washington, D.C.

8.1.3 Geology and Soils

Berg, P. C. 1973. "Geology of Gravina Island, Alaska." U.S. Geological Survey, Bull. 1371.

Billings, R. F. 1974. Soil Management Report for the Ketchikan Area, Alaska. Ketchikan Gateway Borough, Ketchikan, Alaska.

Brew, D. A. 1966. "Geological Map of Southeastern Alaska." Canadian Institute of Mining and Metallurgy.

Brew, D. A., R. A. Loney and L. J. P. Muffler. 1966. "Tectonic History of Southeastern Alaska." In A Symposium of the Tectonic History of Mineral Deposits of the Western Cordillera, Vancouver, B.C., Canada. Canadian Institute of Mining and Metallurgy, Special Volume 8:149-170.

Buddington, A. F. and T. Chapin. 1929. "Geology and Mineral Deposits of Southeastern Alaska." U.S. Geological Survey. Bull. 800. 398p.

Bufuers, J. 1967. "History of Mines and Prospects, Ketchikan District, Prior to 1952." State of Alaska, Department of Natural Resources, Div. of Mines and Minerals.

Chapin, Theodore. 1918. "The Structure and Stratigraphy of Gravina and Revillagigedo Islands, Alaska." U.S. Geological Survey, Professional Paper 120-D.

- Cobb, E. H. 1968. "Metallic Mineral Resources Map of the Ketchikan Quadrangle, Alaska." U.S. Geological Survey, Open file report, Miscellaneous Field Studies Map No. 420.
- Jones, D. L., W. D. Irwin, and A. T. Ovenshine. 1972. "Southeastern Alaska Displaced Continental Fragment?" U.S. Geological Survey, Professional Paper 800B.
- Martinson, C. and D. Kuklok. 1979. Atlas of the Ketchikan Region; A Basis for Planning Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.
- Monger, J. W. H., J. G. Souther and H. Gabrielse. 1972. "Evolution of the Canadian Cordillera: A Plate Tectonic Model." Am. J. Sci. 272:577-602.
- Selkregg, L. L. (ed.) 1976. "Alaska Regional Profiles, Southeast Region." University of Alaska, Arctic Environmental Information and Data Center, Fairbanks, Alaska.
- Stephens, F. R. 1966. Soil and Watershed Characteristics of Southeast Alaska and Some Western Oregon Drainages. USDA Forest Service, Alaska Region, Ketchikan, Alaska.
- Van Wormer, J. D., J. Davies, and L. Gedney. 1974. "Seismicity and Plate Tectonics in South Central Alaska." Seismological Society of America Bull. 64(5):1467-1475.
- Wheeler, J.O. and H. Gabrielse. 1972. "Variations in Tectonic Styles in Canada. The Cordilleran Structural Province." Geological Association of Canada, Special Paper No. 11,
- Wolf, E.N. and L. E. Heiner. 1971. "Mineral Resources of Southeastern Alaska." Report No. 28, Industry Research Laboratory, University of Alaska, Fairbanks, Alaska.
- Wright, F.E. and C.W. Wright. 1908. "The Ketchikan and Wrangell Mining Districts, Alaska." U.S. Geological Survey. Bull. 347.

8.1.4 Seismicity

- Cox, D. C. and G. Pararas-Caryannis. 1976. "Catalog of Tsunamis in Alaska. World Data Center A for Solid Earth Physics." Report SE-1, U.S. National Oceanic and Atmospheric Administration, Environmental Data Service.
- Davis, T. N. and C. Eholis. 1962. A Table of Alaskan Earthquakes, 1788-1961. Research Report 8, Geophysical Institute, University of Alaska, Fairbanks, Alaska.

- Lemke, R. W. and L. A. Yehle. 1972. "Regional and Other General Factors Bearing on Evaluation of Earthquake and Other Geologic Hazards to Coastal Communities of Southeastern Alaska." U.S. Geological Survey, Open-File Report 516. 99p.
- Lemke, R. W. 1975. "Reconnaissance Engineering Geology of the Ketchikan Area, Alaska, with Emphasis on Evaluation of Earthquake and Other Geologic Hazards." U.S. Geological Survey. Open-File Report 75250, 65p.
- Martinson, C. and D. Kuklok. 1979. Atlas of the Ketchikan Region; A Basis for Planning. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.
- Swanston, D. A. 1969. "Mass Wasting in Coastal Alaska." USDA Forest Service, Research Paper PNW-83.
- Twinhofel, W. S. and C. L. Sainsbury. 1958. "Fault Patterns in Southeastern Alaska." Geological Society of America Bull. 69:1431-1442.
- 8.1.5 Climate and Air Quality
- Changery, J. M. 1978. National Wind Data Index. HCD/T1041-01, National Climatic Center, Asheville, North Carolina.
- DOE. 1979. Regional Issue Identification and Assessment. U.S. Department of Energy, Washington, D.C.
- Gifford, F. A. 1961. "Use of Routine Meteorological Observation for Estimating Atmospheric Dispersion." Nuclear Safety 2:47-51.
- Martinson, C. and D. Kuklok. 1979. Atlas of the Ketchikan Region: A Basis for Planning. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.
- U.S. EPA. 1978. Compilation of Air Pollutant Emission Factors. 3rd ed., AP-42, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.
- U.S. EPA. 1980. Prevention of Significant Deterioration Workshop Manual. U.S. Environmental Protection Agency, Research Triangle Park, North Carolina.
- Watson, C. E. 1968. "The Climate of Alaska." In: Climates of the States - Vol. 2. Water Information Center, Port Washington, New York.
- Wise, J. S., T. Wentink, R. Becker, A. L. Comiskey, D. L. Elliott, W. R. Barchet, and R. L. George. 1980. Wind Energy Resource Atlas: Vol. 1D - Alaska. PNL-3195 (WERA-1D), Pacific Northwest Laboratory, Richland, Washington.

8.2 ECOLOGICAL ENVIRONMENT

8.2.1 Aquatic Environment

8.2.1.1 Fish

Bruce, H. E., D. R. McLain, and B. L. Wing. 1977. Annual physical and Chemical Oceanographic Cycles of Auke Bay, Southeastern Alaska. U.S. National Oceanic and Atmospheric Administration Technical Report, National Marine Fisheries Service, Special Scientific Report Fisheries 712 pp.

Carlson, H. R. 1977. Results of a Tagging Study of Pacific Herring in Southeastern Alaska in 1960-62 Using Radioactive Body Cavity Tags. Northwest and Alaska Fisheries Center Processed Report, Northwest and Alaska Fisheries Center, Auke Bay, Alaska.

Carlson, H. R. 1980. "Seasonal Distribution and Environment of Pacific Herring Near Auke Bay, Lynn Canal, Southeastern Alaska." Trans. Amer. Fish. Soc. 109:71-78.

Dahlgren, E. H. 1936. Further Developments in the Tagging of the Pacific Herring, Clupea pallasii. Journal du Conseil, Conseil International pour l'Exploration de la Mer 11:229-247.

Hart, J. L. 1973. Food and feeding habits of Pacific herring in the Vicinity of Auke Bay, Southeastern Alaska. Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska.

Kolloen, L. N., and K. A. Smith. 1953. "Southeastern Alaska exploratory Herring Fishing Operations, Winter 1953/53." Commercial Fisheries Review 15(11):1-24.

Neimark, L. M. 1984. Annual Performance Report for Harvest Estimates of Selected Fisheries Throughout Southeastern Alaska (Part I - Alaska Marine Studies). Vol. 25, Study G-1, State of Alaska Department of Fish and Game.

NOAA. 1977. Cruise Report. Cruise No. JC-80-01. Southeastern Alaska Herring Survey. January 11 to February 19, 1977. National Oceanic and Atmospheric Administration.

NOAA. 1979. Cruise Report, Cruise No. JC-79-01. Southeastern Alaska "CURVES" (Causes Underlying Recruitment Variation in the Ecosystem) Research. February 16 to April 6, 1979, National Oceanic and Atmospheric Administration.

NOAA. 1980. Cruise Report, Cruise No. JC-80-01. Southeastern Alaska "CURVES" (Causes Underlying Recruitment Variation in the Ecosystem) Research. February 21 to April 9, 1980, National Oceanic and Atmospheric Administration.

- NOAA. 1981. "Alaska Southern Coast, Western Part of Behm Canal. Chart 17422." Washington, D.C.
- Outram, D. N., and R. D. Humphreys. 1974. "The Pacific Herring in British Columbia Waters." Circular 100, Fisheries and Marine Service, Pacific Biological Station, Nanaimo, Canada.
- Quast, J. C., and E. L. Hall. 1972. List of Fishes of Alaska with a Guide to Some of Their Literature. NOAA Techn. Rept. NMFS SSRF-658, NOAA, Seattle, Washington.
- Reid, G. M. 1972. "Alaska's fishery resources...the Pacific Herring." Fishery Facts-2, NMFS Extension Publication, Seattle, Washington. 20p.
- Rounsefell, G. A. 1929. "Contribution to the Biology of the Pacific Herring, *Clupea pallasii*, and the Condition of the Fishery in Alaska." U.S. Bureau of Fisheries Bull. 45:227-320.
- Rounsefell, G. A. and E. H. Dahlgren. 1935. "Races of Herring, *Clupea pallasii*, in Southeastern Alaska." U.S. Bureau of Fisheries Bull. 48:119-141.
- Siedelman, D. L., and M. W. Schwan. 1981. Harvest of Selected Fisheries Throughout Southeastern Alaska. Vol. 22, Study G-1, Alaska Dept. of Fish and Game.
- Skud, B. E. 1959. Herring Spawning Surveys in Southeastern Alaska. U.S. Fish and Wildlife Service, Special Scientific Report--Fisheries No. 321.
- Skud, B. E. 1963. Herring Tagging Experiments in Southeastern Alaska. U.S. Bureau of Fisheries Bull. 63:18032.
- USDA Forest Service. 1979. Species List of Alaskan Birds, Mammals, Fish, Amphibians, Reptiles and Invertebrates. Alaska Region Report Number 82, Ketchikan, Alaska.
- VTN. 1982. Nursery Studies - Finfish, Boca de Guadra and Wilson Arm/Smeaton Bay Quartz Hill Molybdenum Project, Southeast Alaska, United States Borax and Chemical Corp., Los Angeles, California.
- Wilimovsky, N. J. 1954. "List of the Fishes of Alaska." Stanford Ichthyol. Bull. 4:279-294.

8.2.1.2 Shellfish and Other Invertebrates

- Carlson, H. R., R. E. Haight and K. J. Krieger. 1982. Species Composition and Relative Abundance of Demersal Marine Life in Waters of Southeastern Alaska, 1969-81. Northwest and Alaska Fisheries Center, Processed Report 82-16, Northwest and Alaska Fisheries Center, Auke Bay, Alaska.

Mauchline, J., and L. R. Fisher. 1969. "The Biology of Euphausiids." In Advances in Marine Biology, Vol. 7. eds., F. S. Russell and M. Young, Academic Press, New York, New York.

VTN. 1980. Aquatic Biology Annual Environmental Baseline Report, Quartz Hill Molybdenum Project, Southeast Alaska. United States Borax & Chemical Corp., Los Angeles, California.

VTN. 1981. Aquatic Biology Annual Environmental Report, Quartz Hill Molybdenum Project, Southeast Alaska. United States Borax & Chemical Corp., Los Angeles, California.

VTN. 1982b. Nursery Studies - Shellfish, Boca de Quadra and Wilson Arm/Smeaton Bay, Quartz Hill Molybdenum Project, Southeast Alaska. United States Borax & Chemical Corp., Los Angeles, California.

VTN. 1982c. Distribution, Abundance and Food Habits at the Heads of Wilson Arm/Smeaton Bay and Boca de Quadra, Quartz Hill Molybdenum Project, Southeast Alaska. United States Borax & Chemical Corp., Los Angeles, California.

8.2.1.3 Marine Mammals

Braham, H. W., and M. E. Dahlheim. 1982. "Killer Whales in Alaska Documented in the Platforms of Opportunity Program." Rep. Int. Whal. Comm. 33:643-6.

Consiglieri, L., and G. C. Bouchet. 1977. Southeast Alaska Troll Logbook Program. 1977 Scientific Report, Marine Mammal Sightings.

Hall, J. S. 1983. Notes on the Distribution and Feeding Behavior of Killer Whales in Prince William Sound, Alaska. In Behavioral Biology of the Killer Whale, eds., B. Kirkevold and J. Lockhard, Plenum Press, New York, New York.

Home, W. S. 1980. "Pacific Pilot Whales: Repeated Localized Sightings in Southeastern Alaska." The Wasmann Journal of Biology 38(1-2):18-20.

International Whaling Commission. 1982. "Report of the Workshop on Identity, Structure and Vital Rates of Killer Whale Populations." Cambridge, England, June 23-25, 1981, Rep. Int. Whal. Comm. 32:617-32.

Krygier, E. E. 1981. Final Report 1980 Troll Logbook Program. Alaska Troller's Association, Juneau, Alaska.

Krygier, E. E. 1982. Final Report 1981 Troll Logbook Program. Alaska Troller's Association, Juneau, Alaska.

Leatherwood, S. (ed.) 1983. Marine Mammals of the southeastern Bering Sea and Shelikof Strait, Alaska; Result of Aerial Surveys April 1982 - April 1983. Final Report to U.S. Dept. of Interior, OMPA, Juneau, Alaska.

Leatherwood, S., A. E. Bowles, E. Krygier, J. D. Hall and S. Ignell. 1984. "Killer Whales (Orcinus orca) in Southeast Alaska, Prince William Sound, and Shelikof Strait: A Review of Available Information." Rep. Int. Whal. Comm. 34:521-530.

Malme, C. I., P. R. Miles, P. Tyock, C. W. Clark and D. E. Bird. 1985. Investigation of the Potential Effects of Underwater Voice from Petroleum Industry Activities in Feeding Humpback Whale Behavior. BBN Laboratories, Inc., Cambridge, Maine.

Matkin, C. O., and S. Leatherwood. 1983. "General Biology of the Killer Whale, Orcinus orca: A Synopsis of Knowledge." In Behavioral Biology of the Killer Whale, eds., B. Kirkevoid and J. Lockart, Plenum Press, New York, New York.

8.2.1.4 Plants

Larrance, J. 1977. "Phytoplankton and Primary Productivity in Northeast Gulf of Alaska and Lower Cook Inlet." In Environmental Assessment of Alaska Continental Shelf, Annual Reports of Principal Investigators. U.S. Dept. of Interior, Bureau of Land Management 10:1-136.

USFWS and NMFS. 1985. Report of Field Investigations: Coco Harbor, Rose Inlet and Hamco, Dall Island, Port Caladara, Hetta Inlet near Sulfer and near Jumbo Island, Polk Inlet, Kiva Cove, Tolstoi Bay, Prince of Wales Island. Memio, Ketchikan, Alaska.

8.2.1.5 Rare and Endangered Species

Consiglieri, L., and G. C. Bouchet. 1977. Southeast Alaska Troll Logbook Program. 1977 Scientific Report. Marine Mammal Sightings.

Hall, J. D. 1979. A Survey of Cetaceans of Prince William Sound and Adjacent Vicinity, Their Numbers and Seasonal Movements. Contr. No. 01-06-022-1560 Final report National Oceanic and Atmospheric Administration Department of Commerce.

Hall, J. D. 1981. Aspects of the Natural History of Cetaceans of Prince William Sound. Ph.D. Dissertation, University of California, Santa Cruz, California.

8.2.2 Terrestrial Environment

8.2.2.1 Forest Type and Composition

Alaback, P. B. 1981. Dynamics of Understory Biomass in Sitka Spruce--Western Hemlock--Forests of Southeast Alaska. Forest Science Laboratory, Juneau, Alaska.

- Alaback, P. B. and J. C. Tappeiner, II. 1984. Response of Understory Vegetation to Thinning in the Sitka Spruce-Western Hemlock Forests of Southeast Alaska. Forest Science Laboratory, Juneau, Alaska.
- Fight, R., P. I. McNamee, L. D. Garrett, and N. C. Sonntag (eds.) SAMM: Southeast Alaska Multi-resource Model. A conceptual Simulation Model for Estimating Multi-Resource Impacts of Forest Management Actions in Southeast Alaska. In preparation.
- Harris, A. S. 1968. "Small Mammals and Natural Reforestation in Southeast Alaska." USDA Forest Service, Pacific Northwest Forest and Range Experiment Station Research Note PNW-75, USDA Forest Service - Alaska Region, Juneau, Alaska.
- Harris, A. S. 1974. "Clearcutting, Reforestation and Stand Developments on Alaska's Tongass National Forest." J. For. 72:330-337.
- Harris, A. S. and W. A. Farr. 1974. The Forest Ecosystem of Southeast Alaska. USDA Forest Service Pacific Northwest Forest Range Experiment Station Technical Report PNW-25, Juneau, Alaska.
- Martin, J. R., W. W. Brady and J. M. Downs. 1985. Preliminary Forest Plant Associations (Habit Types) of Southeast Alaska. USDA Forest Service, Chatham Area, Tongass National Forest, Sitka, Alaska.
- Matthews, J. W. and D. E. McKnight. 1982. "Renewable Resource Commitments and Conflicts in Southeast Alaska." Trans. N. Amer. Wildl. Natur. Resour. Conf. 47:573-582.
- Noble, R. E. 1978. Snag Characteristics in Old-growth Forests, Prince of Wales Island, Alaska. USDA Forest Service, Tongass National Forest, Ketchikan, Alaska.
- Noble, R. E. 1981. Snag Characteristics in Old-growth Forests on Prince of Wales Island, Alaska. USDA Forest Service Alaska Regional Report 125, Ketchikan, Alaska.
- Ruth, R. H., and A. S. Harris. 1979. Management of Western Hemlock-Sitka Spruce Forests for Timber Production. USDA Forest Service, Pacific Forest and Range Experiment Station, Ge. Tech. Report PNW-88, Juneau, Alaska.
- USDA. 1978a. Tongass Land Management Plan. Landtype/Timber Task Force Working Report, TLMP-6, USDA Forest Service, Region 10, Juneau, Alaska.
- USDA. 1981. Wildlife and Fisheries Habitat Management Notes. Effects of Clearcutting and Timber Management on Sitka Black-tailed Deer: A Report to the Forest Service. No. 103a. USDA Forest Service, Region 10, Juneau, Alaska.
- USDA. 1982. Wildlife and Fisheries Habitat Management Notes. Wildlife and Second-growth Forests of Southeast Alaska: Problems and Potential for Management. No. 110. USDA Forest Service, Region 10, Juneau, Alaska.

USDA. 1985. Wildlife and Fisheries Habitat Management Notes. Habitat Management for Forest Birds in Southeast Alaska. No. 146. USDA Forest Service, Region 10, Juneau, Alaska

8.2.2.2 Wildlife and Game Animals

Bloom, A. M. 1978. "Sitka Black-tailed Deer Winter Range in the Kadashan Bay Area, Southeast Alaska." J. Wildl. Manage. 42(1):108-112.

Corr, P. O. 1974. "Bald Eagle Nesting Related to Forestry in Southeastern Alaska. M.S. Thesis, University of Alaska." Fairbanks, Alaska.

Erickson, A. W. 1965. The Black Bear in Alaska: Its Ecology and Management. State of Alaska, Dept. Fish and Game, Fed. Aid in Wildl. Restoration Proj., Rep. Vol. V: W-6-R-5, Work Plan F, Juneau, Alaska.

Gibson, D. D., and S. O. MacDonald. 1975. Bird Species and Habitat Inventory, Mainland Southeast Alaska, Summer 1974. USDA Forest Service, Juneau, Alaska.

Hanley, T. A. 1981. Big Game-Forest Management Relationships in Southeast Alaska, Problem Analysis. (Draft) USDA Forest Service, Forest Sciences Laboratory, Juneau, Alaska.

Hanley, K., and R. D. Taber. 1978. Vertebrate Species Occurrence by Habitat Type in Southeast Alaska. USDA Forest Service, Alaska Regional Office, Juneau, Alaska.

Harbo, S. J., Jr. 1958. "An Investigation of Mink in Interior and Southeastern Alaska." M.S. Thesis, University of Alaska, Fairbanks, Alaska.

Harris, A. S. 1968. Small Mammals and Natural Reforestation in Southeast Alaska, USDA Forest Service, Pacific Northwest Forest and Range Experiment Station Research Note PNW-75, USDA Forest Service, Alaska Regional Office, Juneau, Alaska.

Kessler, W. B. 1979. Responses of Bird Populations to Clearcutting in the Tongass National Forest, Southeast Alaska, Report 71. USDA Forest Service Alaska Regional Office, Juneau, Alaska.

Kessler, W. B. 1980. Bird Populations of Riparian Habitats in the Tongass National Forest, Southeast Alaska. USDA Forest Service, Alaska Regional Office, Juneau, Alaska.

Kessler, W. B., and T. E. Kogut. 1985. "Habitat Orientations of Forest Birds in Southeast Alaska." Northwest Science 59:58-65.

Kirchhoff, M. D., J. W. Schoen and O. C. Wallmo. 1981. Distribution of Deer Use in Relation to Forest-clearcut Edges in Southeast Alaska. State of Alaska, Department of Fish and Game, Juneau, Alaska.

- Lensink, C. J., R. O. Skoog and J. L. Buckley. 1955. "Food Habits of Marten in Interior Alaska and their Significance." J. Wildl. Manage. 19(3):364-368.
- Matthews, J. W., and D. E. McKnight. 1982. "Renewable Resource Commitments and Conflicts in Southeast Alaska". Trans. N. Amer. Wildl. Natur. Resour. Conf. 47:573-582.
- McNay, R. S., and D. Doyle. 1985. A Habitat Suitability Model for Black-tailed Deer. Integrated Wildlife-Intensive Forestry Res. Prog., Ministries of For. and Environ., Victoria, B.C.
- Noble, R. E. 1977. Breeding Bird Populations in Hemlock-Spruce Old Growth and Clearcuts, Prince of Wales Island, Alaska. USDA Forest Service, Ketchikan, Alaska.
- Quick, H. F. 1955. "Food Habits of Marten (*Martes americana*) in Northern British Columbia." Can. Field Natl. 69(4):144-147.
- Rice, K. 1979a. 1979 Deer Winter Range Surveys Progress Report. USDA Forest Service, Tongass National Forest, Ketchikan, Alaska.
- Rice, K. 1980. Special and Unique Habits. Part 5 in Wildlife Relationships for National Forests in Alaska. USDA Forest Service Alaska Regional Report, Juneau, Alaska.
- Schoen, J. W. 1978. Evaluation of Deer Range and Habitat Utilization in Various Successional Stages. State of Alaska, Department of Fish and Game, Fed. Aid Project Report. W-17-10, Job 2.5 R.
- Suring, L. H., and M. L. Prather. 1985. Habitat Suitability Index Models: Sitka Black-tailed Deer. USDA Forest Service, Ketchikan, Alaska.
- Wallmo, O. C., and J. W. Schoen. 1979. Sitka Black-tailed Deer Conference Proceedings. USDA Forest Service, Region 10. Juneau, Alaska.
- Wallmo, O. C., and J. W. Schoen. 1980. "Response of Deer to Secondary Forest Succession in Southeast Alaska." Forest Sci. 26:448-462.
- White, C. M., W. B. Emison and F. S. L. Williamson. 1971. "Dynamics of Raptor Populations on Amchitka Island, Alaska." BioScience 21:623-627.
- USDA. 1975. Proceedings of the Symposium on Management of Forest and Range Habitats for Nongame Birds. Report WO-1, USDA Forest Service, Juneau, Alaska.
- USDA. 1978b. Tongass Land Management Report. Wildlife Task Force Working Report, USDA Forest Service, Region 10. Juneau, Alaska.

USDA. 1978c. Proceedings of the Workshop on Nongame Bird Habitat Management in the Coniferous Forests of the Western United States. USDA Forest Service, General Technical Report PNW-64. Ketchikan, Alaska.

8.2.2.3 Rare and Endangered Species

Hansen, A. J., E. L. Bocher, J. I. Hodges and D. R. Cline. 1984. Bald Eagles of the Chilkat Valley, Alaska: Ecology, Behavior and Management. National Audubon Society, New York, New York.

Hehnke, M. F. 1973. "Nesting Ecology and Feeding Behavior of Bald Eagles on the Alaska Peninsula." M.S. Thesis, California State University, Humboldt, California.

Hodges, J. I. 1982. "Bald Eagle Nesting Studies in Seymour Canal, Southeast Alaska." Condor 84:125-127.

Hodges, J. I., J. G. King and F. C. Robards. 1979. "Resurvey of the Bald Eagle Breeding population in Southeast Alaska." J. Wildl. Manage. 43:219-221.

Hodges, J. I. 1982. "Observations of 3,850 Bald Eagle Nests in Southeast Alaska." In Proceedings of Raptor Manage. and Biol. Symp., eds. W. N. Ladd and P. F. Schempt, pp. 37-46, USDI Fish Wildl. Service, Alaska Regional Office, Anchorage, Alaska.

Imler, R. H. 1941. Alaskan Bald Eagle Studies. USDI Fish and Wildlife Service. Denver, Colorado.

King, J. G., F. C. Robards and C. J. Lensink. 1972. "Census of the Bald Eagle Breeding Population in Southeast Alaska." J. Wildl. Manage. 36:1292-1295.

Maser, C., J. M. Trappe and R. A. Nausbaum. 1978. "Fungal Small Mammal Interrelationships with Emphasis on Oregon Coniferous Forests." Ecology 59:799-809.

McKeever, S. 1960. "Food of the Northern Flying Squirrel in Northeastern California." J. Mammal. 41:270-271.

Mowrey, R. A., and J. C. Zasada. 1985. "Den Tree Use and Movements of Northern Flying Squirrels in Interior Alaska and Implications for Forest Management." In Fish and Wildlife Relationships in Old-growth Forests. Proceedings of a Symposium, eds., W.R. Meehan, T.R. Merrell, Jr., and T.A. Hanley, pp. 351-356, BookMasters, Ashland, Ohio.

Noble, R. E. 1978. Snag Characteristics in Old Growth Forests, Prince of Wales Island, Alaska. USDA Forest Service, Tongass National Forest, Ketchikan, Alaska.

- Noble, R. E., and P. Harrington. 1981. Snag Characteristics in Old-growth Forests, Prince of Wales Island, Alaska. USDA Forest Service Alaska Regional Report 125, Ketchikan, Alaska.
- Rice, K. 1979. 1979b. Habitat Management Guide for Bald Eagles on Ketchikan Area of Tongass National Forest. USDA Forest Service Ketchikan, Alaska.
- Robards, F. C., and J. I. Hodges. 1976. Observations from 2,760 Bald Eagle Nests in Southeast Alaska: Progress Report 1969-1976. USDI Fish and Wildlife Service, Juneau, Alaska.
- Robards, F. C., and J. G. King. 1966. Nesting and Productivity of Bald Eagles in Southeast Alaska. USDI Bureau of Sport Fisheries and Wildlife.
- Sherrod, S. K., C. M. White and F. S. L. Williamson. 1977. "Biology of the Bald Eagle on Amchitka Island, Alaska." Living Bird 15:143-182.
- Stalmaster, M. V., and J. R. Newman. 1978. "Behavioral Responses of Wintering Bald Eagles to Human Activity." J. Wildl. Manage. 42:50-6-513.
- Suring, L. H. 1985. A Preliminary Overview of Prince of Wales Island Flying Squirrel (Glaucomys sabrinus griseifrons). USDA Forest Service, Tongass National Forest, Ketchikan, Alaska.
- USFS. Undated. Bald Eagle Management Guidelines - Coastal Alaska.
- Wells-Gosling, N., and L. R. Heaney. 1984. "Glaucomys sabrinus." Mammalian Species 229:1-8.

B.3 SOCIOECONOMIC ENVIRONMENT

8.3.1 Regional Demography

- Department of Commerce and Economic Development. 1984. The Alaska Economic and Statistical Review. Economic Analyses Section.
- National Institute for Socioeconomic Research. 1983. An Analysis of the Social and Economic Effects Resulting from the Development and Operation of the Quartz Hill Molybdenum Project Executive Summary.

8.3.2 Labor Force and Housing

- Alaska Department of Commerce and Economic Development. 1985. Alaska Housing Report. Economic Analysis Section.
- Alaska Department of Labor (ADL). 1985. Alaska Economic Trends. January 1985-September 1985.

Alaska Department of Labor, 1985. Employment and Payroll Data, Ketchikan Gateway Borough.

Economic Development Report for the City of Ketchikan. 1985. Draft Report. Ketchikan Gateway Borough Planning Department. Ketchikan, Alaska.

Ketchikan Area Port Commission. 1982. Ketchikan Gateway Borough Waterfront Development and Management Study. Phase one and Phase two Summary. Ketchikan, Alaska.

Ketchikan Gateway Borough Planning Department. 1982. Ketchikan District Coastal Management Program. Public Hearing Draft. Ketchikan, Alaska.

Martinson and Kuklock. 1979. Atlas of the Ketchikan Region. Prepared by: Dennis Kuklok and Charles Martinson, Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.

Morehouse & Associates. 1983. Managing Social Impacts in the Ketchikan Gateway Borough Resulting from the Proposed Quartz Hill Molybdenum Mine Project.

National Institute for Socioeconomic Research. 1983. An Analysis of the Social and Economic Effects Resulting from the Development and Operation of The Quartz Hill Molybdenum Project. Executive Summary.

State of Alaska Department of Commerce and Economic Development. 1984. The Alaska Economic and Statistical Review. Economic Analysis Section.

Statistical Quarterly by 1980 Census Area. 1984. State of Alaska, ADL Research and Analyses Section.

U.S. Borax. 1983. Development of Quartz Hill Molybdenum Project, Alaska. Draft Environmental Report. Vol. 1. United States Borax and Chemical Corp. on behalf of Pacific Coast Molybdenum Company.

8.3.3 Community Services

Ketchikan Gateway Borough Planning Department. 1984. Community Goals to 1990 Draft. The Comprehensive Plan Update, Ketchikan Gateway Borough. Ketchikan, Alaska.

Morehouse and Associates. 1983. Managing Social Impacts in the Ketchikan Gateway Borough Resulting from the Quartz Hill Molybdenum Mine Project.

National Institute for Socioeconomic Research. 1983. An Analysis of the Social and Economic Effects Resulting from the Development and Operation of the Quartz Hill Molybdenum Project. Executive Summary.

State of Alaska Department of Community and Regional Affairs. FY1984 and 1985 State Revenue Sharing Program Data for Ketchikan Gateway Borough.

State of Alaska Department of Revenue. FY1984 and 1985 Shared Revenue Data for Ketchikan Gateway Borough.

U.S. Borax. 1983. Development of Quartz Hill Molybdenum Project Alaska, Draft Environmental Report. Vol. 1. United States Borax and Chemical Corp. on behalf of Pacific Coast Molybdenum Company.

USDA Forest Service. 1984. Tongass Land Management Plan (TLMP) Evaluation Report. Alaska Region Admin. Doc. 139, Ketchikan, Alaska.

8.3.4 Public Institutions and Educational Facilities

Ketchikan Gateway Borough Planning Department. 1984. Community Goals to 1990 Draft. The Comprehensive Plan Update. Ketchikan Gateway Borough, Ketchikan, Alaska.

National Institute for Socioeconomic Research. 1983. An Analysis of the Social and Economic Effects Resulting from the Development and Operation of the Quartz Hill Molybdenum Project. Executive Summary.

U.S. Borax. 1983. Development of Quartz Hill Molybdenum Project Alaska. Draft Environmental Report. Vol. 1. United States Borax and Chemical Corp. on behalf of Pacific Coast Molybdenum Company.

USDA Forest Service. 1984. Tongass Land Management Plan (TLMP) Evaluation Report. Alaska Region Admin. Doc. 139. Ketchikan, Alaska.

8.3.5 Land Use

Fuel Wood Collection Sites (Map) Around Ketchikan. 1985.

Ketchikan Gateway Borough Planning Department. 1984. Community Goals to 1990 Draft. The Comprehensive Plan Update, July 1983 and October 1984, Ketchikan Gateway Borough. Ketchikan, Alaska.

Ketchikan Gateway Borough Planning Department. 1982. Economic Development Report for the City of Ketchikan. Draft Report. Ketchikan, Alaska.

Ketchikan Gateway Borough Planning Department. 1982. Ketchikan District Coastal Management Program, Public Hearing Draft. Ketchikan, Alaska.

Ketchikan Area Port Commission. 1982. Ketchikan Gateway Borough Waterfront Development and Management Study. Phase One and Phase Two Summary. Ketchikan, Alaska. 1982.

Managing Social Impacts in the Ketchikan Gateway Borough Resulting from the Proposed Quartz Hill Molybdenum Mine Project. By: Richard Morehouse and Associates. December 1983.

Martinson C. and D. Kuklock. 1979. Atlas of the Ketchikan Region. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.

National Institute for Socioeconomic Research. 1983. An Analysis of the Social and Economic Effects Resulting from the Development and Operation of the Quartz Hill Molybdenum Project. Executive Summary.

State of Alaska Department of Natural Resources. Permit Actions on State Lands in Vicinity of Back Island.

U.S. Army Corps of Engineers. Selected Army Corps of Engineers Permit Actions Near Back Island. Anchorage, Alaska.

U.S. Borax and Chemical Corporation. 1983. Development of Quartz Hill Molybdenum Project Alaska, Draft Environmental Report Vol. 1. on behalf of Pacific Coast Molybdenum Company.

USDA Forest Service. Final EIS: LPK Timber Plan Sale for 1984 through 1989 Operating Period. Tongass National Forest. Ketchikan, Alaska.

USDA Forest Service. 1985. USGS Maps of Behm Canal Areas, Highlighted by Land Use Activities.

USDA Forest Service. Tongass Land Management Plan (TLMP), Land-Type/Timber Task Force Working Report, Ketchikan, Alaska.

USDA Forest Service. Tongass Land Management Plan, Minerals Task Force.

USDA Forest Service. Tongass Land Management Plan, Recreation/Wilderness Task Force. Ketchikan, Alaska.

USDA Forest Service. Tongass Land Management Plan, Regional and Local Dimensions Socioeconomic Overview. Ketchikan, Alaska.

USDA Forest Service. 1983. An Alaska Regional Guide. Alaska Region Report #126a. Ketchikan, Alaska.

USDA Forest Service. 1984. Tongass Land Management Plan (TLMP) Evaluation Report. Alaska Region Admin. Doc. 139.

8.3.6 Water Use

Ketchikan Gateway Borough Planning Department. Community Goals to 1990 Draft. The Comprehensive Plan Update, Ketchikan Gateway Borough. Ketchikan, Alaska. July 1983 and October 1984.

Ketchikan Gateway Borough Planning Department. 1982. Ketchikan District Coastal Management Program, Public Hearing Draft. Ketchikan, Alaska.

- Ketchikan Area Port Commission. 1982. Ketchikan Gateway Borough Waterfront Development and Management Study. Phase One and Phase Two Summary. Ketchikan, Alaska.
- Martinson, C. and D. Kuklock. 1979. Atlas of the Ketchikan Region. Ketchikan Gateway Borough Planning Department, Ketchikan, Alaska.
- Ness, H. O. 1977. "Observations on the Birth of a Southeastern Alaska Fishery." Marine Fisheries Review, Paper 1241.
- Ness, H. O. 1977. "The Recent Development of the Southeastern Alaska Herring Fishery." Marine Fisheries Review, Paper 1240.
- Ness, H. O. 1977. "The Southeastern Alaska Herring Fishery." Marine Fisheries Review, Paper 1239.
- North Pacific Fishery Management Council. 1984. Fishery Management Plan for the Gulf of Alaska Ground Fish Fishery.
- Phase One and Phase Two Summary. 1982. Ketchikan Gateway Borough Waterfront Development and Management Study. Ketchikan Area Port Commission. Ketchikan, Alaska.
- State of Alaska Department of Fish and Game. 1985. Alaska Commercial Salmon Catches, 1878-1984. Division of Commercial Fisheries.
- State of Alaska, Department of Fish and Game. 1984. Commercial Fisheries Entry Commission Data for Ketchikan Census Area Permit and Fish Ticket Fisheries: Number of Permits, Earnings, Pounds, Species, Gear, Geographical, Area, Crew Sizes. 1976-1983 annual data.
- State of Alaska, Department of Fish and Game. 1984. Data for Six Fish Statistical Zones Around Back Island. Monthly data, 1978-1983.
- State of Alaska, Department of Fish and Game. Annual Performance Report for Harvest. Estimation of Selected Fisheries Throughout Southeast Alaska. Lee M. Neimark, Vol. 25. Study G-1.
- Troll. Salmon Fishery Management Plan. Federal Register. Vol. 44, Nos. 98 and 112; Vol. 45, Nos. 100, 138, 175, 187, 208, 129, etc. Vol. 46, Nos. 123, 131, etc., Vols. 47 and 48. 1979-1983.
- U.S. Army Corps of Engineers. Selected U.S. Army Corps of Engineers Permit Actions Near Back Island. Source: Jene Augustine, Anchorage, Alaska.
- U.S. Army Engineer District. 1983. Rivers and Harbors in Alaska. Draft Interim Feasibility Report and Environmental Impact Statement, Hydroelectric Power for Sitka, Petersburg/Wrangell and Ketchikan, Alaska.
- USDA Forest Service. Tongass Land Management Plan, Fisheries Task Force Working Report.

8.3.7 Prehistoric and Historic Resources

Ketchikan Gateway Borough Planning Department. 1982. Ketchikan District Coastal Management Program, Public Hearing Draft. Ketchikan, Alaska.

Native Cemetery and Historic Sites of Southeast Alaska. Preliminary Report), Prepared for: SEALASKA Corporation.

U.S. Borax and Chemical Corporation. 1983. Development of Quartz Hill Molybdenum Project Alaska, Draft Environmental Report. Vol. 1. United States Borax and Chemical Corporation on behalf of Pacific Coast Molybdenum Company.

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