APPENDIX K

HYDROLOGY AND WATER QUALITY TECHNICAL REPORT

JUNEAU ACCESS IMPROVEMENTS
SUPPLEMENTAL DRAFT
ENVIRONMENTAL IMPACT STATEMENT

STATE PROJECT NUMBER: 71100
FEDERAL PROJECT NUMBER: STP-000S (131)

Prepared for

Alaska Department of Transportation and Public Facilities
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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLES

FIGURES

ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
AADT	annual average daily traffic
ADCED	Alaska Department of Community and Economic Development
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADNR	Alaska Department of Natural Resources
ADT	average daily traffic
AMHS	Alaska Marine Highway System
AWQS	Alaska Water Quality Standard
BMP	best management practice
°C	degrees centigrade
CFR	Code of Federal Regulations
cfs	cubic feet per second
cfs/mile2	cubic feet per second per square mile
CWA	Clean Water Act
DEIS	Draft Environmental Impact Statement
DO	dissolved oxygen
DOC	dissolved organic carbon
DOT&PF	(Alaska) Department of Transportation and Public Facilities
EIS	Environmental Impact Statement
FC	fecal coliform
FHWA	Federal Highway Administration
FVF	fast vehicle ferry
GIS	geographic information system
μeq	micro equivalent
μg/L	microgram per liter
m	meter
mg	milligram
mg/L	milligram per liter
ml	milliliter
mm	millimeter
MOA	Municipality of Anchorage
MPN	most probable number
NCHRP	National Cooperative Highway Research Program
NEPA	National Environmental Policy Act
nm	nautical mile
NPDES	National Pollutant Discharge Elimination System
OPA	Oil Pollution Control Act
PAH	polynuclear aromatic hydrocarbon
ppt	parts per thousand
SDEIS	Supplemental Draft Environmental Impact Statement
SEIS	Supplemental Environmental Impact Statement
SWPPP	Storm Water Pollution Prevention Plan
TDS	total dissolved solids
TSS	total suspended solids
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture

ACRONYMS AND ABBREVIATIONS (continued)

USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This report updates the hydrology and water quality technical report written for the 1997 Juneau Access Improvements Draft Environmental Impact Statement. Additional information from sources such as the Alaska Department of Environmental Conservation and the Municipality of Anchorage Wastewater Management Program has been incorporated. Revisions and updates to this technical report provide a more comprehensive discussion of the current condition of the affected environment and of potential impacts to hydrology and water quality from the proposed alternatives.

The proposed alternatives include construction of a highway and new ferry terminals, as well as changes in ferry vessel types and level of service. The East Lynn Canal highway alternatives cross up to approximately 64 streams, and the West Lynn Canal highway alternative crosses approximately 28 streams. Potential hydrologic impacts to these streams from the alternatives include channel disruption, flow diversion, and erosion.

Water quality can be affected during highway and ferry terminal construction and maintenance due to earth-moving activities, equipment leaks/spills, in-water work, and debris and waste generation. Highway operations can impact water quality by introducing contaminants to area water resources through rainfall and snowmelt runoff (or meltwater). Runoff from highways can transport accumulated pollutants to natural water bodies. Additionally, water quality can be impacted by ferry operations, particularly through wastewater discharges.

Evaluation of each of these potential impacts to hydrologic and water quality is detailed in this document. No irreversible, long-term impacts to hydrology or water quality are expected under any of the alternatives. Highway construction would alter surface water and groundwater flow in the alignment project area, but would result in only minor flow diversion. In-water work associated with both highway and ferry terminal construction would cause temporary and localized impacts to water quality.

Potential pollutants from increased vehicle traffic, transported to area water resources via runoff, would not result in long-term water quality impacts under any alternative. The potential exists, however, for the release of potential pollutants due to vehicle accidents. A major oil or hazardous substance release could occur and could result in long-term water quality impacts. The predicted relatively low highway traffic volume and the undeveloped character of the project area, however, minimize this potential.

Mainline ferry wastewater discharges would introduce concentrations of fecal coliform and total suspended solids, as well as some unregulated metals, above Alaska Water Quality Standards to Lynn Canal. Discharges would be diluted and, at most, would have localized adverse impacts to water quality. Shuttle ferries, including conventional monohull ferries and fast vehicle ferries, would not have on-board treatment facilities and would not discharge wastewater to Lynn Canal. Adverse impacts to water quality would not be likely from discharges from ferry terminal wastewater facilities. The proposed wastewater plants would use tertiary treatment with ultraviolet disinfection and discharge to an adequate mixing depth, similar to the current facility at the Auke Bay Ferry Terminal.

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1.0 INTRODUCTION

The Alaska Department of Transportation and Public Facilities (DOT&PF) is preparing a Supplemental Draft Environmental Impact Statement (SDEIS) in accordance with the National Environmental Policy Act (NEPA) process. The SDEIS will evaluate a range of reasonable alternatives. The SDEIS will describe the alternatives, evaluate their impacts to the natural and human environment, and discuss potential measures to avoid adverse impacts. This technical report describes the affected environment, with a focus on hydrology and water quality, and presents the results of an analysis of potential impacts to hydrology and water quality in the project area for each alternative.

1.1 Project Purpose And Need

The purpose of and need for the Juneau Access Improvements Project is to provide improved surface transportation to and from Juneau within the Lynn Canal corridor that will:

- Provide the capacity to meet the transportation demand in the corridor.
- Provide flexibility and improve opportunity for travel.
- Reduce travel time between Lynn Canal communities.
- Reduce state costs for transportation in the corridor.
- Reduce user costs for transportation in the corridor.

1.2 Project Description

Lynn Canal, located approximately 25 miles north of Juneau, is the waterway that connects Juneau with the cities of Haines and Skagway via the Alaska Marine Highway System (AMHS). At present there is no roadway connecting these three cities. The Glacier Highway originates in Juneau and ends at Echo Cove, approximately 40.5 miles to the northwest.

As required by the National Environmental Policy Act (NEPA), the SDEIS for the Juneau Access Improvements Project considers the following reasonable alternatives:

Alternative 1 – No Action Alternative – The No Action Alternative includes a continuation of mainline AMHS service in Lynn Canal as well as the operation of the fast vehicle ferry (FVF) *M/V Fairweather* between Auke Bay and Haines and Auke Bay and Skagway. The *M/V Aurora* would provide shuttle service between Haines and Skagway, beginning as early as 2005.

Alternative 2 (Preferred) – East Lynn Canal Highway with Katzehin Ferry Terminal – This alternative would construct a 68.5-mile-long highway from the end of Glacier Highway at the Echo Cove boat launch area around Berners Bay to Skagway. A ferry terminal would be constructed north of the Katzehin River delta, and operation of the *M/V Aurora* would change to shuttle service between Katzehin and the Lutak Ferry Terminal in Haines. Mainline ferry service would end at Auke Bay, and the existing Haines/Skagway shuttle service would be discontinued. The *M/V Fairweather* would be redeployed on other AMHS routes.

Alternative 2A – East Lynn Canal Highway with Berners Bay Shuttles – This alternative would construct a 5.2-mile highway from the end of Glacier Highway at Echo Cove to Sawmill Cove in Berners Bay. Ferry terminals would be constructed at both Sawmill Cove and Slate Cove, and shuttle ferries would operate between the two terminals. A 52.9-mile highway would be constructed between Slate Cove and Skagway. A ferry terminal would be constructed north of the Katzehin River delta, and the *M/V Aurora* would operate between the Katzehin and the

Lutak Ferry Terminals. Mainline ferry service would end at Auke Bay, and the existing Haines/Skagway shuttle service would be discontinued. The *M/V Fairweather* would be redeployed on other AMHS routes.

Alternative 2B – East Lynn Canal Highway to Katzehin with Shuttles to Haines and Skagway – This alternative would construct a 50.5-mile highway from the end of Glacier Highway at Echo Cove around Berners Bay to Katzehin, construct a ferry terminal at the end of the new highway, and run shuttle ferries to both Skagway and Haines from the Katzehin Ferry Terminal. The Haines to Skagway shuttle service would continue to operate, two new shuttle ferries would be constructed, and the *M/V Aurora* would be part of the three-vessel system. Mainline AMHS service would end at Auke Bay. The *M/V Fairweather* would be redeployed on other AMHS routes.

Alternative 2C – East Lynn Canal Highway with Haines/Skagway Shuttle – This alternative would construct a 68.5-mile highway from the end of Glacier Highway at Echo Cove around Berners Bay to Skagway with the same design features as Alternative 2. The *M/V Aurora* would continue to provide service to Haines. No ferry terminal would be constructed at Katzehin. Mainline ferry service would end at Auke Bay, and the *M/V Fairweather* would be redeployed on other AMHS routes.

Alternative 3 – West Lynn Canal Highway – This alternative would extend the Glacier Highway 5.2 miles from Echo Cove to Sawmill Cove in Berners Bay. Ferry terminals would be constructed at Sawmill Cove and William Henry Bay on the west shore of Lynn Canal, and shuttle ferries would operate between the two terminals. A 38.9-mile highway would be constructed between William Henry Bay and Haines with a bridge across the Chilkat River/Inlet connecting to Mud Bay Road. The *M/V Aurora* would continue to operate as a shuttle between Haines and Skagway. Mainline ferry service would end at Auke Bay, and the *M/V Fairweather* would be redeployed on other AMHS routes.

Alternatives 4A through 4D – Marine Options – The four marine alternatives would construct new shuttle ferries to operate in addition to continued mainline service in Lynn Canal. All of the alternatives would include a minimum of two mainline vessel round trips per week, year-round, and continuation of the Haines/Skagway shuttle service provided by the *M/V Aurora*. The *M/V Fairweather* would no longer operate in Lynn Canal. All of these alternatives would require construction of a new double stern berth at Auke Bay.

Alternative 4A – FVF Shuttle Service from Auke Bay – This alternative would construct two FVFs to provide daily summer service from Auke Bay to Haines/Skagway.

Alternative 4B – FVF Shuttle Service from Berners Bay – This alternative would extend the Glacier Highway 5.2 miles from Echo Cove to Sawmill Cove in Berners Bay, where a new ferry terminal would be constructed. Two FVFs would be constructed to provide daily service from Sawmill Cove to Haines/Skagway in the summer and from Auke Bay to Haines/Skagway in the winter.

Alternative 4C – Conventional Monohull Shuttle Service from Auke Bay – This alternative would construct two conventional monohull vessels to provide daily summer service from Auke Bay to Haines/Skagway. In winter, shuttle service to Haines and Skagway would be provided on alternate days.

Alternative 4D – Conventional Monohull Shuttle Service from Berners Bay – This alternative would extend the Glacier Highway 5.2 miles from Echo Cove to Sawmill Cove in Berners Bay, where a ferry terminal would be constructed. Two conventional monohull vessels would be constructed to provide daily service from Sawmill Cove to Haines/Skagway in the summer and alternating day service from Auke Bay to Haines/Skagway in the winter.

1.3 Regulatory Background

The Federal Highway Administration (FHWA), the United States Environmental Protection Agency (USEPA), DOT&PF, and the Alaska Department of Environmental Conservation (ADEC) require that any development of a transportation project in Alaska include evaluation of potential impacts to water quality according to regulatory requirements set in place to protect surface water and groundwater resources.

The Federal Water Pollution Control Act, as amended by the Clean Water Act (CWA) of 1977, Public Law 92-500, was the nation's first attempt at protecting water resources in the United States. The CWA gave USEPA the authority to implement pollution control programs such as setting water quality standards for all contaminants in surface waters, including those that may result from construction activities and/or highway runoff. The CWA also made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. These discharges are permitted under the National Pollutant Discharge Elimination System (NPDES) permit program.

There are multiple federal and state laws, regulations, and guidelines pertaining to water quality and relevant to the scope of this technical report.

Federal

- The Federal Water Pollution Control Act, as amended by the CWA of 1977, Public Law 92-500
- Oil Pollution Control Act (OPA) of 1990, 33 United States Code 2701 et seq.
- International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (Marine Pollution Convention 73/78)
- United States Department of Transportation (USDOT), FHWA, October 30, 1987. Guidance for Preparing and Processing Environmental and Section 4(f) Documents, FHWA Technical Advisory T6640.8A

State

- 18 Alaska Administrative Code (AAC) 70, ADEC Water Quality Standards as amended through June 26, 2003
- ADEC Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report (December 2003)
- ADEC Commercial Passenger Vessel Environmental Compliance Program (AS 46.03.460 – 46.03.490)
- ADEC Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances as amended through May 15, 2003
- ADEC 18 AAC 72 Wastewater Disposal as amended through July 11, 2002

1.4 Report Scope

The report incorporates and expands upon information presented in the *1994 Technical Report Hydrology and Water Quality*, completed for the Juneau Access Project 1997 Draft Environmental Impact Statement (DEIS). This report does not update affected environment hydrological information. The hydrology information presented in the 1994 technical report is accurate and remains relevant to the Juneau Access Improvements Project. This technical report provides the results of the water quality and hydrology analysis conducted for the proposed Juneau Access Improvement alternatives.

2.0 METHODOLOGY AND COORDINATION

2.1 Methods

The hydrology and water quality evaluation discussed in this report was conducted to achieve the following goals:

- Provide a description of the existing freshwater and marine environments within the project area;
- Provide a description of the ambient conditions of freshwater and marine environments within the project area; and
- Identify the potential impacts of each proposed alternative.

The methodology used to achieve these goals included a literature review, consultation with state agencies, including ADEC and AMHS, and consultation with representatives from Skagway Water and Wastewater Department and Haines Water and Sewer Department. The review concentrated on locating information to update the *1994 Technical Report Hydrology and Water Quality* (the 1994 technical report). The 1994 technical report consisted of a literature review that emphasized information from the *Juneau Access Improvement Reconnaissance Engineering Report, Appendix D, Hydraulics Report*.

Stream flow and water quality data for the project area are limited; however, there are multiple publications adressing water quality within the project area. Several of which include field data. Reviewed documents included the *Cascade Point Access Road Final Environmental Impact Statement (EIS)* (1998), the *Kensington Gold Project Final EIS* (1992) and the *Kensington Gold Project Final Supplemental Environmental Impact Statement (SEIS)* (1997). The United States Geological Survey (USGS) *Water Resources Data for Alaska, Water Years 1995 and 1997* was also reviewed for pertinent water quality data. The United States Department of Agriculture (USDA) Forest Service website provided additional information on topography of the project area. The ADEC Cruise Ship Program website presented valuable information on ferry wastewater discharge. Several Municipality of Anchorage (MOA) Watershed Management Program documents from 1999 and 2000 provided useful data on water quality impacts from storm water and meltwater runoff.

In addition to the literature review, the ADEC Water Quality Standards (under Title 18, Chapter 70 of the AAC), as amended through June 26, 2003, and the ADEC Alaska Water Quality Criteria Manual for Toxic and Other Deleterious Organic and Inorganic Substances, as amended through May 15, 2003, were used to evaluate water quality within the project area, when analytical results were available.

Potential secondary and cumulative effects of the proposed project alternatives on hydrology and water quality are defined and analyzed in the *Indirect and Cumulative Effects Analysis Report*, which is included as an attachment to the SDEIS. Mitigation measures included in the design of the project to alleviate potential project effects on hydrology and water quality are also addressed in the SDEIS in a separate *Project Mitigation Plan.*

2.2 Consultation

An agency scoping meeting was held in Juneau on April 14, 2003, to discuss general issues regarding the SDEIS for the Juneau Access Improvements project. In attendance, were representatives from multiple agencies: DOT&PF, FHWA, USEPA, United States Department of Agriculture (USDA) Forest Service, United States Fish and Wildlife Service (USFWS), United

States Army Corps of Engineers (USACE), Alaska Department of Fish and Game (ADF&G), Alaska Department of Natural Resources (ADNR), and the United States Coast Guard (USCG).

Additionally, in November and December of 2003, representatives from the AMHS, the ADEC Cruise Ship Program, City of Skagway Water and Wastewater, and the City of Haines Water and Sewer Department were consulted to obtain information pertinent to water quality for inclusion in this report.

3.0 AFFECTED ENVIRONMENT

3.1 Climate

Much of the information on the climate of the project area in the 1994 technical report remains accurate and is presented here.

> "The climate for most of the study area is considered maritime, characterized by mild winters and cool summers. Temperatures range from 7° to 18 degrees centigrade (°C) (45° to 65°F) in the summer and 8° to 1°C (18° to 34°F) in winter. The area between Juneau and Berners Bay has a climate that is influenced by the southeast Alaska rain forest. Storms and rain showers occur throughout the year but precipitation is generally heaviest and most frequent from November to January.
>
> The Aleutian low in the winter and the continental low in the summer cause inflows of relatively warm moist air. Orographic lifting of the airflows caused by the mountain ranges results in a precipitation pattern generally characterized by high annual amounts, and storms of long duration and low intensity. However, this pattern is subject to wide variations over short distances. Within watersheds in the project area, annual precipitation amounts can vary from less than 80 inches annually in areas affected by rain shadows behind ridgelines and mountains, to over 200 inches annually.
>
> In contrast, Haines and Skagway are considered to have a transitional climate, receiving less precipitation and somewhat more extreme temperatures than the southern part of the project area. The climate in Haines and Skagway is influenced by the drier weather of the interior of Alaska. Inland from the coastal range at higher elevations, precipitation decreases and temperatures decline significantly. Due to the decreased temperatures at higher elevations, permanent ice and snow and glaciers occur. These features generally occur at elevations above 3,000 feet above mean sea level; however, valley glaciers can occupy low-lying areas to near sea level where they have advanced. In these areas, the glaciers are in a state of ablation (i.e., retreating), whereas, at the higher elevations they are accumulating ice."

The Alaska Department of Community and Economic Development (ADCED) provides climate information specific to Juneau, Haines, and Skagway, as well as to other Alaska communities, on their website (ADCED, 2003). According to the website, Juneau has temperatures averaging 44°F to 65°F in the summer and 25°F to 35°F in the winter. Average annual precipitation in the community is 92 inches in the downtown area and 54 inches near the airport. Average annual snowfall is approximately 101 inches.

Haines has average annual summer temperatures of 46°F to 66°F. Winter temperatures are usually between 10°F and 36°F. Average annual precipitation is 52 inches, with 133 inches of snowfall annually.

Summer temperatures in Skagway average between 45°F and 67°F. Winter temperatures usually range from 18°F to 37°F. The driest of the three communities, Skagway receives an average of 26 inches of precipitation annually, and 39 inches of snowfall annually.

The Kensington Gold Project Final EIS identifies the average annual precipitation in the Sherman Creek, Sweeny Creek, and Slate Creek watersheds, which are near Berners Bay, to range from 60 to over 110 inches (USDA Forest Service, 1992).

3.2 Geologic Setting

A complex heterogeneous assemblage of rocks, including sedimentary, volcanic, metamorphic, and intrusive rocks of Paleozoic, Mesozoic, and Tertiary age, underlies the northern part of Southeast Alaska. These rocks were emplaced in the southeastern Alaska archipelago during a series of subductions and accretions by tectonic plates colliding obliquely with the ancient continental margin of western North America during Jurassic to early Tertiary time (Gehrels and Berg, 1992). Glaciers formed deeply carved valleys and fjords throughout Southeast Alaska. Alluvial, glacial, and tectonic processes have had a dominant role in forming the geomorphology of the project area. Underlying bedrock consists primarily of relatively impervious rock. A complex of gravels, sand, silts, marine deposits, peat, and clay are the result of glacial and corresponding sea-level activity. Regional uplift (shifting of the earth's surface) has a significant influence on the interaction between surface waters and ground waters.

3.3 Vegetation

Vegetative cover is important for stabilizing soil, especially on steep slopes, because the cover often reduces the amount of erosion in an area, which is an important contribution in promoting good water quality. Much of the vegetation in southeast Alaska is coastal temperate rainforest. The most common forest type found in this region is Coastal Spruce – Hemlock Forest (Viereck and Little, 1972).

Wetlands also play an important role in water quality by filtering out sediment, toxins, and excess nutrients. Large areas of forested wetlands exist within the project area, mostly of the needle-leaved evergreen subclass. Sub-classes describe the type of scrub/shrub (e.g., needle-leaved, broad-leaf, dead) (Cowardin *et al*., 1979). Forested wetlands also border emergent wetlands and many include a scrub/shrub component if there is an open canopy. Shrubs and/or trees that are less than 20 feet tall dominate scrub/shrub wetlands. The tree layer consists mainly of mountain hemlock (*Tsuga mertensiana*), western hemlock (*Tsuga heterophylla*), and the occasional Sitka spruce (*Picea sitchensis*) or shore pine.

Estuarine emergent wetlands are within the intertidal zone. Dominant vegetation in these project area wetlands consists of beach rye (*Leymus arenarius*), silverweed (*Argentina anserina*), beach pea (*Lathyrus japonicus*), and Lyngbye's sedge (*Carex lyngbyei*). The substrate is mostly gravel and sand. Other estuarine areas identified include estuarine beach bar, flats, and rocky shore.

3.4 Freshwater Environment

3.4.1 East Lynn Canal

According to the 1994 technical report,

> "The East Lynn Canal route would cross 62 streams, of which 4 drain watershed areas of greater than 100 square miles. These include the Antler/Gilkey River basin, the Lace River/Berners River Basin and the Katzehin River basin. All of these watersheds include large valley glaciers and large areal coverage by permanent ice and snow. These larger basins include areas behind the coastal ridge at high elevation. Several intermediate-sized drainages (between 5 and 20 square miles in area) also include relatively large area coverage by glaciers. The majority of streams are relatively small, draining steep watersheds of less than five square miles and are confined to the seaward coastal ridge along Lynn Canal."

In 2003, URS conducted a geographic information system (GIS) analysis of the proposed routes and found two additional streams (64 total) along the east side of Lynn Canal. Table 1 provides general information on the major tributaries, coves, and bays located on the east side of Lynn Canal.

3.4.2 West Lynn Canal

Although the 2003 GIS analysis identified 28 freshwater streams, instead of 27, the 1994 technical report provides an accurate description of the streams and drainage basins along the west side of Lynn Canal:

> "The West Lynn Canal route would cross [28] streams, of which four drain major watersheds with basin areas greater than 20 square miles. Only one of these watersheds, the Endicott River, drains an area greater than 100 square miles. All of these basins have relatively large areas covered by glaciers, except the Endicott River. The watersheds along this alignment all drain into Lynn Canal, and are generally less steep than on the east side of the canal. The terminus of Davidson Glacier is near the base of a watershed that occupies nearly the entire valley of the Glacier River. The larger drainages along this route all have deltas (alluvial fans) that have formed where the streams enter Lynn Canal."

Table 2 provides general information on the major tributaries, coves, and bays located on the west side of Lynn Canal.

3.4.3 Groundwater

The 1994 technical report provides an accurate discussion of general groundwater conditions in the project area:

> "Detailed hydrogeological information is not available for the [entire] project area; however, geologic considerations and baseflow data/observations provide sufficient information to understand the groundwater regime. Groundwater along the roadway alignments occur within the bedrock, shallow soils, and glacial till sediments overlying bedrock, and alluvial deposits within floodplains. There are no known groundwater wells along the proposed alignments.
>
> Groundwater within the bedrock formations generally does not constitute significant aquifers because of low yield resulting from low groundwater storage low bulk permeabilities. Because of this, groundwater seepage tends to be highly seasonal with large fluctuations in groundwater levels and generally does not supply large baseflows to streams. Exceptions to this general bedrock groundwater condition are in fractured and faulted zones, where permeability and storage are much higher due to large fracture porosity.
>
> Groundwater in shallow soils and glacial till sediments overlying bedrock in mountainous areas also would be expected to yield low quantities of groundwater because of low permeability and/or low storage potential. Groundwater levels in these materials are also highly seasonal because of low storage and do not provide significant baseflow to streams.
>
> Significant year-round groundwater resources are expected to occur primarily in alluvial and glacial outwash sediments within the valleys and floodplains associated with the larger streams and rivers. Groundwater levels in these valleys are controlled by water levels in the nearby river or surface water body. At the valley walls, groundwater levels are controlled by recharge from tributary streams and precipitation.

> Groundwater levels would be expected to be relatively shallow within the glacio-fluvial deposits in the alluvial valleys. Within these larger streams, including tributaries downgradient of the valley wall slope break, baseflows are sustained by groundwater seepage."

The Kensington Gold Project Final EIS provides additional groundwater information specific to the groundwater regime in the Sherman Creek watershed, near Berners Bay. The document identified five geologic units in the area, which were further characterized into three hydrogeologic units: alluvial and terrace sands and gravels, till, and phyllite bedrock. In general, alluvial sands and gravels were found along the banks of area creeks, whereas till was identified underlying most of the Sherman Creek drainage, and bedrock was most evident in the upper reaches of Sherman Creek.

Groundwater flow in the first two hydrogeologic units was found to occur in the lenses of gravels and sands and confined by silts and clays. As expected, groundwater flow in the bedrock generally occurred along fractures. The document attributed the majority of recharge into the groundwater system to the "direct infiltration of precipitation and snowmelt" and estimated it at "15 to 20 percent of the average annual precipitation" (USDA Forest Service, 1992).

3.5 Marine Environment

Lynn Canal and Chatham Strait, with a combined length of about 235 miles, comprise the longest and straightest fjord-like inlet in North America. Lynn Canal is the narrow northern segment of this inlet. The canal extends northward some 90 miles from its junction with Icy Strait, west of Juneau, between steep mountains to its trifurcation into Chilkat, Chilkoot, and Taiya Inlets at its north end.

The physical setting and oceanographic environment of Lynn Canal are indicative of a fjord-type estuary. Pritchard (1967) defined an estuary as "a semi-enclosed body of water which has a free connection with the open sea and within which sea water is measurably diluted with fresh water derived from land drainage." Estuary settings range from coastal plain to steep-sided fjords such as Lynn Canal, but all have the common feature of being a mixing region for fresh and salt water. Density differences between fresh and salt water can drive circulation, and hence can influence mixing and flushing in estuaries. The net circulation depends on the amount and timing of fresh and salt water input as well as other influences including winds, tides, topography, and continental shelf oceanic properties and processes. These influences can combine in various ways such that distinctly different circulations develop in otherwise similar estuaries.

Fjords are deep, narrow, and steep-sided estuaries that are peculiar to glacially carved coastlines, and have hydrodynamic characteristics that distinguish them from shallower embayments. Most fjords have at least one moraine or bedrock "sill" that affects, if not controls, hydraulic communication with the adjacent ocean. Several major rivers and numerous streams discharge into the northernmost reaches of Lynn Canal, which further justifies its classification as a fjord-type estuary and supports the presumption of "estuarine circulation" within it.

Studies of fjords show that deep or bottom water ranges from permanently anoxic, or oxygen-deficient, through intermittently anoxic to permanently oxic. Since the bottom water is not always anoxic in fjords that have sills at their entrances, there must be times when the deep waters undergo renewal, and hence reoxygenation. Advective bottom renewal with water of higher oxygen content (and higher density so that the water sinks within the basin behind the sill) and tidally driven mixing are probably the most effective mechanisms for reoxygenation.

Muench and Heggie (1978) studied the oceanographic conditions of deep-water renewal and flushing in six Alaskan fjords, for which substantial amounts of oceanographic data were available. Their work supports inferences on the mechanics of these processes in other fjords that have not been extensively studied, such as Lynn Canal. The six fjords were grouped according to their sill depths as "shallow" (<400 feet), "intermediate" (400 to 525 feet), and "deep" silled (>525 feet). Renewal of deep water was found to be dependent primarily upon the annual density variation of source (continental shelf) water outside the sill and upon vertical turbulent diffusion decreasing the density of the deep water inside the sill between renewal periods. Muench and Heggie concluded that deep-water renewal occurs at the following times for each fjord group:

- Shallow-silled fjords in late winter – early spring;
- Intermediate-silled fjords intermittently all year; and
- Deep-silled fjords in late summer – early fall.

To understand the scheme of Muench and Heggie and its application to Lynn Canal, it is necessary to understand the annual cycle of density variation in the source water for these Alaskan fjords, which is continental shelf water from the adjacent Gulf of Alaska. Wind stress over the northern Gulf of Alaska undergoes an order of magnitude reduction from winter to summer. In winter, the Aleutian Low (pressure center) dominates the atmospheric circulation with strong and generally westward winds along the northern Gulf of Alaska coast. This leads to onshore Ekman transport with coastal convergence and downwelling occurring from October through March (Royer, 1975). This is reflected by the highest density water being downwelled and pushed away from the coast and the mouths of the fjords.

In summer, the North Pacific High moves northward, displacing the weakened Aleutian Low. Coastal winds become weaker and more northeasterly, leading to a relaxation of the coastal downwelling and even promoting some upwelling. This is seen in the northern Gulf of Alaska as denser water rising to a depth of 500 to 600 feet in the water column from early summer to late autumn, usually peaking in October. However, the depth to which this renewal water rises depends on local factors such as coastal winds. For example, within the inland waterways of southeast Alaska, high-density renewal water has been observed as shallow as 100 to 150 feet deep (Nebert 1972, 1984).

With water depths exceeding 500 feet over most of its length, Lynn Canal probably also undergoes deep water renewal on the same schedule as that of other deep-silled fjords, namely from late summer to early fall.

3.6 Stream Flow and Flood Regime

Discussion of stream flow and flood regime was presented in the 1994 technical report:

> "The stream flow regime of the smaller coastal watersheds can generally be characterized as follows:

- Peak flow dominated by snowmelt in spring and rainfall runoff in fall;
- Rapid rise and fall of hydrograph in response to rainfall events;
- Glaciers comprising only a small portion of a basin, providing little or no sustained summer meltwater;
- Peak flows in summer and fall, sustained from glacier melt and rainfall runoff;

- Low flows occurring in winter, maintained by groundwater base flow; and
- High water velocities resulting from steep watersheds and high flow volume.

The stream flow regime of the larger watersheds includes the following:

- A large percentage of glaciation;
- Well-developed glacio-fluvial valleys and floodplains, braided channel networks;
- Peak flows in summer and fall, sustained from glacier melt and rainfall runoff;
- Low flows occurring in winter, maintained by groundwater baseflow; and
- High water velocities resulting from steep watersheds and high flow volume.

Based on a review of stream flow data for gauged streams outside the project area, the flow conditions can be assessed. In general, streams with glaciers in the basin (greater than five percent glaciation) show peak flows occurring from late spring to fall, sustained through the summer by meltwater, whereas streams with little or no glaciation in the basin show two peaks, one in spring from snowmelt and one in fall resulting from precipitation.

Daily stream flows are usually at a minimum from December through March or April. As spring temperatures rise, accumulated snow in the high basins starts to melt, and runoff increases accordingly. High rates of flow usually occur during July, August, and September for those streams fed by snowfields and glacial runoff. High water periods in the fall are influenced primarily by precipitation. By mid-November, flows begin to recede to the winter low flows (Selkregg, 1974).

Flow yield by basin in the project area is highly variable depending on the average precipitation, percent glaciation, and physiographic conditions for the basins. The larger basins typically show lower unit runoff (flow per unit area of watershed) because they encompass areas of lower precipitation behind the seaward mountain ridges. Low winter flows in the Juneau area typically fall to one to two [cubic feet per second per square mile] cfs/mile^2. Summer low flows, in small coastal basins with little or no glaciation fall as low as three to four cfs/mile^2.

Peak flows can be quite large for all streams within the project area. The 100-year floods range from approximately 100 to over 200 cfs/mile^2. USGS has developed a prediction method based on statistical analysis of stream flow records in the area. A review of predicted floods compared to actual measured floods for the gauged streams surrounding the project indicates that the USGS method over predicts flood flows except those in the Skagway area and for streams with greater than five percent glaciation, which are under predicted.

The proposed routes along both sides of the Lynn Canal cross complex river systems that have large glaciers at their headwaters. The Chilkat, Glacier, Sullivan, Endicott and Katzehin rivers, as well as the rivers draining into Berners Bay, are all potentially subject to periodic glacial outburst flooding. No significant historical records were found to address this type of flooding phenomena along the Lynn Canal. However, information provided by the local populace suggests that such events have occurred but their magnitude and frequency is not clearly known (Menzies, 1993). The USGS flood data include glacier dam floods, and therefore provide some representation of this phenomenon in the flood prediction method; however, glacier dam floods can be highly variable and not well anticipated by design."

Two sources provide stream flow information for the Berners Bay area. The surface water hydrology of Sherman, Sweeny, and Slate Creeks were studied for the Kensington Gold Project. The Final EIS (1992) identified the average annual stream flow at the mouth of both Sherman Creek and Sweeny Creek as 43 cubic feet per second (cfs). Average annual stream flow at the mouth of Slate Creek was determined to be 34 cfs. The 20-year, seven-day low flow results for the three respective streams were identified as 1.53 (Sherman), 0.86 (Sweeny), and 0.62 cfs (Slate).

The Cascade Point Access Road Final EIS (1998) estimated stream flow for Cascade Creek, which discharges into Berners Bay and is located south of Sawmill Creek. In the document, Cascade Creek was estimated to have a "mean annual flow of 5.5 cfs, with a mean annual flood of 280 cfs, a 10-year flood of approximately 470 cfs, and a winter seven-day, 10-year low flow of approximately 0.6 cfs."

3.7 Water Quality

This section and the following subsections identify factors that affect water quality and present water quality results from available and applicable studies. Limited detailed conclusions can be drawn regarding the current water quality of freshwater streams, rivers, and lakes and marine waters in the project area; however, because there is relatively little development in the project area, water quality is assumed to be unaltered by anthropogenic impacts.

The protection of Alaska's water bodies occurs primarily through implementation of ADEC Water Quality Standards. These standards designate specific uses for which water quality must be protected, including seven freshwater uses (drinking water; agriculture; aquaculture; industrial; contact recreation; non-contact recreation; and growth and propagation of fish, shellfish, other aquatic life, and wildlife) and seven marine water uses (aquaculture; seafood processing; industrial; contact recreation; non-contact recreation; growth and propagation of fish, shellfish, other aquatic life, and wildlife; and harvesting for consumption of raw mollusks or other raw aquatic life). For each of these uses, the pollutant parameters of fecal coliform (FC) bacteria, dissolved oxygen, pH, turbidity, temperature, dissolved inorganic substances, sediment, toxic substances, color, petroleum hydrocarbons, radioactivity, total residual chlorine, and residues have specified water quality criteria.

Alaska's Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report describes the status and health of Alaska's waters and lists water bodies that consistently exceed water quality criteria (ADEC, 2003b). The ADEC integrated water quality report combines the CWA Section 305(b) State Report on Water Quality and Section 303(d) Identification of Impaired Waters into a single report. All water bodies are grouped into five categories based on availability of information needed to categorize each water body and the degree to which the water body attains water quality standards. The water body categories are as follows:

- Category 1 – these waters attain all water quality standards for all designated uses. There are currently no water bodies in Alaska with sufficient water quality data to be placed in this category; however, most of Alaska's water bodies are not subject to anthropogenic impacts and would fall into this category.
- Category 2 – these waters attain water quality standards for some of the designated uses, and insufficient or no data are available to determine if the remaining uses are attained.
- Category 3 – these waters have insufficient or no data available to determine if water quality standards for any of the designated uses are attained.

- Category 4 – these waters are determined to be impaired but do not need a total maximum daily load (TMDL) because either the TMDL has already been completed, the water body is expected to meet water quality standards in a reasonable amount of time, or the impairment is not caused by a pollutant.
- Category 5 – these waters are determined to be impaired by one or more pollutants for one or more designated uses and require a TMDL. These waters do not attain ADEC Water Quality Standards and are CWA Section 303(d) listed.

Alaska's Final 2002/2003 Integrated Water Quality Monitoring and Assessment Report does not list any impaired water bodies within the project area. Impaired water bodies closest to the project area include five water bodies in Juneau (Jordan Creek, Pederson Hill Creek, Duck Creek, Lemon Creek, and Vanderbilt Creek), one in Haines (Sawmill Creek; note: this creek is not connected to Sawmill Creek located within the project area in Berners Bay), and one in Skagway (Pullen Creek).

Jordan, Pederson Hill, and Pullen creeks are identified as Category 5 water bodies, which are CWA Section 303(d) listed. These creeks require additional water quality assessment and development of TMDLs. Jordan Creek is listed for sediment, debris, and dissolved oxygen due to land development and road runoff. Pederson Hill Creek is listed for FC due to failing septic tanks. Pullen Creek, near the Skagway harbor, is listed for metals contamination from the nearby ore transfer facility.

Duck Creek, Lemon Creek, Vanderbilt Creek, and Sawmill Creek are listed as Category 4 water bodies. Duck, Lemon, and Vanderbilt creeks have completed TMDLs and implemented recovery plans, and Sawmill Creek is expected to meet water quality standards in a reasonable timeframe. Duck Creek is listed for dissolved gas, residues, metals, FC, and turbidity. Pollution sources for Duck Creek include urban runoff, landfill, road runoff, and land development. Lemon Creek is listed for turbidity and sediment with concerns for habitat modification due to urban runoff and gravel mining. Vanderbilt Creek is listed for turbidity, debris, and sediment with concerns for habitat modification due to urban runoff. Sawmill Creek is listed for debris due to urban runoff.

In general, water quality is affected by many factors including topography, bathymetry, runoff, sedimentation, tidal variations, large-scale mixing and upwelling, and anthropogenic activities (see Section 3.8), which can cause variability in sediment, temperature, salinity, turbidity, dissolved oxygen (DO), debris/residues, and toxic organic or inorganic compounds. Atmospheric deposition of chemicals through precipitation may also have a significant effect on water quality and can include dust, gases, volcanic emission, and salts (Water Resources Divisions, National Park Service, 1987).

Local geology can often present some basic information on water quality in a particular area. Most dissolved constituents in stream water initially come from the minerals in rocks and soils that streams pass over or through. Organic acids and carbon dioxide are often byproducts of respiration and decay occurring in soils. Metals and other toxics of concern may bind to organic matter in water at roughly 1 micro equivalent (μeq) of metal-binding capacity per milligram (mg) of dissolved organic carbon (DOC). Seawater usually has about 1 to 3 milligrams per liter (mg/L) DOC, whereas wetlands and marshes have the highest natural concentrations of 30 mg/L or more (Water Resources Divisions, National Park Service, 1987).

3.7.1 Freshwater

Although limited in scope, some information on the quality of freshwater resources within the project area is available. The following description of the water quality of area streams is taken from the 1994 technical report:

> "Streams in the project area originate in either undisturbed alpine areas or undisturbed river valleys. Consequently, the water quality is very good, although it becomes silty as it moves toward Lynn Canal. In general, Southeast Alaska surface water is of the calcium carbonate type. It is usually low in dissolved solids and, in some instances, high in iron. Concentration of dissolved solids from 38 sampling points throughout Southeast Alaska ranged from 10 mg/L, with an average of 32 mg/L (Selkregg, 1974). [The Alaska Water Quality Standard (AWQS) for total dissolved solids (TDS) in freshwater is 500 mg/L for drinking water, and 1,000 mg/L for the protection of aquatic life.]
>
> Suspended sediment concentrations and bedload are much higher in glacially fed streams compared to non-glacial streams in the project area and throughout Southeast Alaska. Summer suspended sediment concentrations for glacial streams range from 90 mg/L to 500 mg/L (or higher), with winter levels dropping to 10 mg/L. Forty to 100 percent of the summer suspended load is finer than 0.062 millimeters (mm), and is a steady supply derived from the glacier ablation process. Bedload in glacial streams consists of sand, silt, gravel, and cobbles entrained from glacially derived sediments during the ablation process. The high volume of flow and steep terrain with resultant high flow velocities enables the bedload transport. The coarser material is gradually transported downstream within the channel system; however, much of it will remain in the floodplains and alluvial fans for significant periods of time. In general, glacially fed streams have an excess sediment supply. More sediment is entrained in these glacially fed systems than is flushed out into the Lynn Canal. This results in aggradation of streambeds, particularly in the floodplains and alluvial fans.
>
> Suspended sediment concentrations in non-glacial streams typically range from 30 mg/L during normal high water to 10 mg/L or less in the winter. Suspended sediment loads vary directly with flow volumes, and would be expected to be high during flood events, and low during baseflow conditions. The particle size for non-glacial streams is usually about 40 percent finer than 0.062 mm (Selkregg, 1974). Much higher suspended sediment and bedload can occur in non-glacial streams resulting from events such as debris flows and bank failures. Coarser material entrained by these processes will be transported and deposited in the channel system, eventually reaching Lynn Canal. Fine materials would be flushed quickly from the system."

The Final EIS (1992) and the Final SEIS (1997) developed for the Kensington Gold Mine Project provide information on surface and ground water quality in the Sherman Creek watershed and its tributaries located on the east side of Lynn Canal.

3.7.1.1 Surface Water

As part of the studies for the Kensington EIS, surface water monitoring stations were set up on the south tributary of Ophir Creek, the main stem of Ophir Creek, lower Sherman Creek, upper Sherman Creek, and in the Sweeny Creek basin. The locations of both the Sweeny Creek basin and lower Sherman Creek monitoring stations are less than 500 feet west of the proposed highway corridor. The other monitoring stations, at the south tributary of Ophir Creek, the main stem of Ophir Creek, and upper Sherman Creek, are almost 1 to 1.5 miles west of the corridor.

Data collection at the two monitoring stations most relevant to the Juneau Access Improvements project occurred monthly between 1987 and 1995. Forty-one water quality parameters were monitored. Weak to moderate correlations were noted between stream flow at the lower Sherman Creek station and 14 parameters: conductivity, dissolved copper, dissolved lead, nitrite, sodium, calcium sulfate, carbonate, bicarbonate, total alkalinity, hardness, TDS, and sodium adsorption ratio. All of these parameters showed reduced concentrations as stream flow increased, with the exception of nitrite. Nitrite increased in concentration as stream flow increased. None of the other parameters showed any strong correlation between stream flow and parameter concentration.

All metal concentrations in lower Sherman Creek were below AWQS. Concentrations of total iron and total manganese were reported above the minimum detection limits, with relatively higher concentrations reported periodically. Other metals were typically either at concentrations below laboratory detection limits or near the minimum detection limits, as in the case of lead. Surface water in lower Sherman Creek was characterized as calcium bicarbonate-type water.

Sweeny Creek surface water quality was found to be similar to that of lower Sherman Creek. Based on monitoring beginning in 1988 and extending through 1990, both creeks had median pH levels of 7.3, which are within the pH range (6.5 to 8.5) determined by ADEC to be protective of aquatic life. Sweeny Creek had a lower concentration of dissolved solids, ranging from 20 to 106 mg/L, with a median value of 62 mg/L. The dissolved solids content in Sherman Creek ranged from 16 to 194 mg/L, with a median value of 55 mg/L. Iron was the only metal monitored in Sweeny Creek that was above the laboratory detection limits. Dissolved and total iron were reported at 0.07 and 0.09 mg/L, respectively, which fell below the AWQS of 1 mg/L for total iron. Like lower Sherman Creek, Sweeny Creek water was also characterized as calcium bicarbonate. (USDA Forest Service, 1992)

The contribution of Sherman Creek and Sweeny Creek to Lynn Canal is minimal compared to other, larger tributaries. The creeks are not expected to cause adverse impacts to Lynn Canal's water quality. TDS and metals concentrations detected in the surface water samples of lower Sherman Creek between 1988 and 1995 and of Sweeny Creek between 1988 and 1990 were below AWQS. Also, concentrations are likely to be diluted when entering Lynn Canal (USDA Forest Service, 1992 and 1997).

3.7.1.2 Groundwater

Groundwater monitoring stations were also established for the Kensington EIS. Data from 10 wells within the Sherman Creek drainage were collected between August 1989 and October 1995 (USDA Forest Service, 1997). The locations of the wells were between 0.75 mile and 1.5 miles west of the Juneau Access Improvements project corridor that is proposed for the east side of Lynn Canal.

The Kensington Final SEIS presents a detailed discussion of the sampling results. In general, wide-ranging values were measured for TDS (18 to 1,900 mg/L) and pH (5.7 to 12.0). Variance in total metals concentrations was also identified, but concentrations were typically at or near detection limits. However, the higher ends of the concentration ranges identified for some total metals exceeded AWQS. Metals with periodic total concentrations above AWQS included arsenic, barium, cadmium, chromium, copper, lead, mercury, and selenium (USDA Forest Service, 1997).

Additional groundwater sampling was conducted in 1996 in the area between Sherman Creek and Sweeny Creek, and within 800 feet west of the proposed highway corridor. The Kensington Final SEIS reported that the mean TDS value of these samples was 229 mg/L and that dissolved concentrations of arsenic, iron, manganese, and zinc were found in the majority of the samples. Total metals detected in most samples included aluminum, arsenic, cadmium, cooper, iron, lead, manganese, and zinc. The mean concentrations of aluminum, copper, iron, manganese, mercury, and zinc were above AWQS.

3.7.2 Marine Environment

Water quality in Lynn Canal is influenced by, but not limited to, topography, surrounding land use, tidal fluctuation, water circulation, quality of the freshwater entering the canal, vessel activity, permitted and accidental discharges from vessels and other point sources, and non-point sources of pollution such as vehicular activity or construction. Some information on Lynn Canal water quality exists and is provided in this section, but offers only a snapshot of the water quality of this expansive canal. ADEC expects to conduct studies to characterize the ambient water quality of the canal in the summer of 2004; however, ADEC currently has no water quality data for Lynn Canal (D. Koch, personal communication, 2003).

In their survey of Pacific fjords, Pickard and Stanton (1980) provided the following information:

> "Maximum salinity in Lynn Canal is only slightly less than that of the Northeast Pacific Ocean just outside (at 55 North Latitude). In most Alaskan fjords, DO levels are generally at or above saturation value (8 to 6.6 ml/L for salinities from 0 to 30 ppt [parts per thousand] at temperature of 10 °C), decreasing to 2-4 ml/L in deep water (>50 meters). Exceptions are in fjords with glacier ice where deep values are higher; e.g., 6 ml/L in Glacier Bay and 4-6 ml/L in Tracy and Endicott. At the head of Lynn Canal, where ice forms in some winters and deep mixing also occurs due to strong winds, values of 4-6 ml/L have been observed. The lowest values are generally in the deep water toward the mouth of the Lynn Canal/Chatham Strait where DO is closer to North Pacific values of 2 ml/L at sill depth (350 meters [m]). North Pacific DO values of Alaska typically decrease to a minimum of 0.5 ml/L at about 800 m depth."

In the Kensington Final EIS and SEIS, results from water sampling conducted in Lynn Canal near Point Sherman are presented. Below is the discussion on this localized area of Lynn Canal as presented in the 1997 document:

> "The water quality of Lynn Canal can be characterized by a number of physical and chemical properties. Parameters of primary concern include water temperature and salinity, which control the density and mixing of different water masses. The presence of suspended solids, metals, and nutrient concentrations is also important because they could be altered by effluent discharges. Changes to the water quality of Lynn Canal could, in turn, affect biological communities. Much of the information available for characterizing water quality conditions is based on data collected by Rescan (1990) during September 1988 and April and June 1989.
>
> Water temperatures and salinity in Lynn Canal are affected by freshwater discharges from rivers (i.e., the Chilkat, Chilkoot, Skagway, and Taiya) and creeks, solar heating, and estuarine circulation patterns. Seasonal differences in water temperature, salinity, and density stratification within the canal are described by Rescan (1991). During summer, a strong density gradient (i.e., pycnocline) forms in the upper portion of the water column due to solar heating and freshwater runoff. The density gradient separates a warmer, less saline surface layer from colder, higher salinity subsurface waters. The density layer is present from approximately June through September. During winter, the density gradients weaken, and the temperature, salinity, and density characteristics of the water column are relatively uniform with depth (Rescan, 1990).

During September, water temperatures decrease from 52 °F near the surface to 41°F at 200 ft. Salinity ranges from 21 to 32 ppt in the upper 65 ft. Within 65 feet of the surface, light transmittance ranges from 80 to 90 percent and remains uniform at approximately 90 percent below 65 ft. During April, temperature and salinity conditions do no vary appreciably with depth. Water temperatures range from 38 to 40°F, and salinity ranges from 29.5 to 30.5 ppt. The profile for light transmittance is similar to that observed during September, with approximately 90-percent transmittance throughout the water column, except for slightly lower (80 to 90-percent transmittance) values within the upper 82 feet (Rescan, 1990).

Concentrations of total suspended solids (TSS) in Lynn Canal waters range from less than 1.0 to 6.7 mg/L. Based on measurements at seven depths at each of seven locations near Point Sherman during three sampling periods, the mean TSS concentration was approximately 1 mg/L (Kessler & Associates and EVS, 1992). No appreciable differences with depth, location, or sampling period were evident. Nitrate concentrations range from nondetectable (<0.005 micrograms per liter [µg/L]) to 0.48 µg/L, with concentrations higher in summer than in spring. Chlorophyll concentrations are highest (≥4.5 µg/L) in June (Rescan, 1990).

Concentrations of dissolved metals in waters at various depths were measured at two locations offshore from the mouth of Sherman Creek. [All were measured below AWQS, per 18 AAC 70 as amended through June 26, 2003.] The following concentrations were reported: arsenic, 0.4 to 2.2 µg/L; cadmium, <0.05 to 0.30 µg/L; copper, 0.10 to 2.25 µg/L; lead, 0.05 to 0.80 µg/L; nickel, 0.29 to 0.54 µg/L; zinc, <1 to 53 µg/L; and iron, <0.5 to 20.4 µg/L. Mercury concentrations were consistently below method detection limits (0.05 µg/L). Concentrations for several metals, including cadmium, copper, lead, and zinc, appeared to be slightly higher during April than June or September, which is consistent with the seasonal differences in seawater nitrate concentrations (Rescan, 1990)."

3.8 Existing Potential Impacts to Water Quality

3.8.1 Vessels

Ferries, cruise ships, private boats, fishing boats and other commercial vessels are potential sources of pollution that can affect water quality. Potential pollutants may include but are not limited to fuels and oils, graywater (from bathing, showering, or washing), sewage waste disposal, and cleaning or painting products. Increased wave action from vessels can cause shoreline erosion and the use of bow thrusters in shallow bays can disturb the bottom by re-suspending sediments. The number of vessels and their movement patterns in Lynn Canal influence the spatial and temporal distribution of these potential pollutants in the water column. Although cruise ships and private boats likely play an important role in the water quality in the project area, for the purposes of this report only the ferries will be discussed further in this document. For more information on external factors such as other vessels, please refer to the *Indirect and Cumulative Effects Analysis Report*.

3.8.2 Point Source Discharges

As authorized by the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. USEPA defines the term "waters of the United States," to include:

- Navigable waters;
- Tributaries of navigable waters;
- Interstate waters; and
- Intrastate lakes, rivers, and streams, which are:
  - used by interstate travelers for recreation and other purposes;
  - sources of fish or shellfish sold in interstate commerce; or
  - utilized for industrial purposes by industries engaged in interstate commerce.

As NPDES program administrator in Alaska, USEPA handles all NPDES program components, although USEPA's primary focus is on the permitting and compliance of the relatively few larger facilities with "major" discharges greater than one million gallons per day. USEPA issues individual permits to 44 Alaska facilities with major discharges of greater than one million gallons per day, such as large municipal treatment facilities, seafood processors, oil and gas operations, mining operations, and some utilities. Since the late 1970s, USEPA also issued permits to 154 Alaska facilities with minor discharges of less than one million gallons per day, including small municipal and village sewage systems, subdivisions, schools, RV parks, and mining operations. However, USEPA generally defers enforcement and review of "minor" discharges of less than one million gallons per day, storm water discharges, federal facilities, and biosolids to ADEC. ADEC currently develops and administers state wastewater discharge permits for discharges outside the jurisdiction of the NPDES program (e.g., land, non-navigable water discharges, groundwater) and for discharges that USEPA is unable to permit due to lack of resources. ADEC also develops water quality standard-based limits to be included in NPDES permits and certifies NPDES permits issued by USEPA under Section 401 of the CWA (ADEC, 2003g).

USEPA has issued 14 NPDES permits for the Juneau vicinity including one NPDES permit for the Kensington Mine at Comet. The types of permitted effluent discharges include mining, seafood processing, and sewage treatment systems. For the Skagway vicinity, USEPA has issued two NPDES permits. The permits include the Skagway sewage treatment plant and the Gray Line of Alaska transportation facility. For the Haines vicinity, USEPA has issued three NPDES permits for effluent discharges from seafood processing, mining, and the Haines wastewater treatment plant, respectively (USEPA, 2004).

Both the Haines and the Skagway sewage treatment facilities are primary treatment plants that operate under USEPA 301(h) waivers from secondary treatment for ocean discharges. Primary treatment includes screening, settling, grit removal, and skimming. Haines' outfall extends 1,800 feet into Lynn Canal and discharges effluent at 70 feet below mean low low water (S. Bradford, personal communication, 2003). Skagway's outfall extends 85 feet into Taiya Inlet and discharges effluent at 60 feet below mean low low water (T. Gladden, personal communication, 2003).

The City of Juneau operates three wastewater treatment plants, all of which have NPDES permits (Juneau-Douglas, Mendenhall, and Auke Bay). The Auke Bay Wastewater Treatment Plant is the plant closest to the project area. Effluent is discharged to Auke Bay at 30 feet below mean low low water after secondary treatment (S. Jeffers, personal communication, 2004.)

Under 18 AAC 72.500, ADEC also requires a permit if a person disposes of nondomestic wastewater into or onto land, surface water, or groundwater. Nondomestic wastewater means liquid or water-carried wastes from a manufacturing, food processing, or production enterprise; an industrial establishment; the development of natural resources; the construction of a manufacturing, production, or industrial facility; and storm water runoff. Except for wastewater systems exempted from plan review under 18 AAC 72.200(a) or excluded from permitting requirements under 18 AAC 72.500, a person who disposes of domestic wastewater in this state must also have a permit issued by the department for that disposal. Domestic wastewater is defined by ADEC as waterborne human wastes or graywater derived from dwellings, commercial buildings, institutions, or similar structures. There are 11 active wastewater discharge permits that have been issued by ADEC for facilities within the Lynn Canal area from Juneau to Skagway. Discharges include effluent from sewage, mining, and seafood processing (ADEC, 2004).

Under 18 AAC 72.035 (d), ADEC plan approval and permitting is not required for a conventional on-site wastewater system that serves a single-family home, a duplex, or a small commercial facility. ADEC defines a small commercial facility as a commercial building with an expected peak design wastewater discharge flow of 500 gallons per day or less. The wastewater treatment facility at the Auke Bay Ferry Terminal falls under this category. The plant has a three-compartment aeration system that performs tertiary treatment on waste before it is discharged to Auke Bay at 20 feet below mean low low water.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE ALTERNATIVES

Ferry operations, construction of new ferry terminals, construction of a highway, and maintenance and operations of a highway and terminals would impact hydrology and water quality within the project area. The following sub-sections identify specific sources of potential impacts and explore how these impacts would likely manifest under each proposed alternative.

4.1 Potential Impacts to Hydrology

Sources of potential impacts to freshwater and marine hydrology are similar, and can be divided into construction sources and maintenance and operations sources. Construction impacts are characteristically short term, while potential longer-term impacts are associated with the maintenance and operations component of a project. Applicable to both freshwater and marine resources, the construction phase of the project can impact hydrology within the project area. Under the various proposed alternatives, the construction of bridges and associated in-water piers, ferry terminals and associated docks, and a highway are considered. These construction endeavors have the potential to cause the following hydrologic impacts:

- Channel disruption;
- Flow diversion or impedance; and
- Surface erosion.

Where possible, construction would not be conducted in water, thereby minimizing the potential for channel disruption. Single-span bridges would include no in-water pilings. Multi-span bridges and piers would require in-water pilings; however, techniques would be employed to minimize obstructions to flow during pile driving. In larger water bodies, such as the Chilkat River, pilings would be driven into sediment from machinery positioned on floating barges. In smaller water bodies where the use of barges would be prohibited by shallow depth, falsework (i.e., temporary bridges) would be constructed from which the permanent piles would be driven. The falsework would then be removed.

Ferry terminal construction would require the placement of fill (shot-rock generated during highway construction) at each proposed terminal site and dredging (to approximately 25 feet below mean low low water) at the Sawmill Cove and Katzehin ferry terminals. These slight encroachments into Lynn Canal and Berners Bay, respectively, would have negligible impacts on the hydrology of these two sizeable water resources.

Highway construction, as well as highway operation, would affect the flow of both shallow groundwater and slope runoff. Compacted highway embankment fill impedes groundwater flow. Much of this groundwater, in following the path of least resistance, would percolate to the surface. At the surface, the highway would act as a partial barrier to the flow of surface water, which includes slope runoff. To minimize impacts to the natural movement of surface water, roadside drainage ditches channel the flow through culverts to the downstream side of the highway. The size and location of culverts for non-fish passage would be determined during highway design, based on *Alaska Highway Drainage Manual* criteria.

Culverts can increase the velocity of water flow. Increased velocity can cause surface erosion at the culvert outfall. As standard practice and where applicable, culvert end sections or rock dissipaters would be used to immediately disperse the outfall, thus reducing the outfall velocity and the potential for surface erosion.

Potential hydrologic impacts during construction are further addressed by best management practices (BMPs). In 1992, DOT&PF developed a storm water manual for the construction and design of transportation facilities. The manual identified BMPs in an effort to avoid or minimize impacts to both hydrology and water quality. The use of these BMPs is standard practice in construction.

DOT&PF and ADEC review and approve a Storm Water Pollution Prevention Plan (SWPPP) that each construction contractor is required to submit prior to commencing work. Each SWPPP details what resources a contractor would have on-hand to address events that could arise unexpectedly during construction and jeopardize area hydrology or water quality. For example, a contractor may utilize silt fence to protect unvegetated slopes threatened by erosion due to an unexpected heavy rainfall.

Sources of potential impacts to hydrology (both freshwater and marine) that could occur during the maintenance and operations phase of the project are listed below:

- Presence of fixed structures (i.e., highway, ferry terminals and associated buildings and docks, and bridges);
- Sediment and debris buildup in the ditches and culverts flanking the highway; and
- Major re-build activities due to natural disasters, such as avalanches, landslides, or earthquakes.

Fixed structures can impede and divert the flow of shallow groundwater, surface water, and water bodies such as streams and rivers, and contribute to surface erosion. Designs of planned structures would address potential hydrologic impacts by minimizing the in-water footprint and by providing adequate redirection of flow around each structure.

Sediment and debris buildup in roadside ditches and related culverts and stream channels can impede flow. Sediment buildup would likely be most evident during spring thaw, due to highway sanding. Routine maintenance of the proposed highway would include removal of sediment and debris as necessary. Routine maintenance would also include keeping culverts free of ice blockage during winter.

Major re-build activities may be required due to unforeseen events, such as avalanches, landslides, or earthquakes. Impacts to hydrology from such activities would be similar in nature and consequence to those faced during initial construction activities. As such, the impacts are expected to be short term and localized.

4.2 Potential Impacts to Water Quality

Fresh and marine water quality throughout Alaska is protected by the AWQS (18 AAC 70), which includes criteria from the Alaska Water Quality Criteria Manual. This section discusses the potential impacts posed to area water quality by the proposed alternatives.

4.2.1 Construction

Water quality impacts from construction activities are anticipated. Construction of two of the proposed ferry terminals (Katzehin and Sawmill Cove) would require dredging to approximately 25 feet below mean low low water. All proposed terminals would require fill placement. Both of these activities would increase turbidity by disturbing bottom sediment. Increased turbidity, however, would be short term and localized. No impacts to water quality from potential pollutants would be expected from the fill placement; the fill would be the shot-rock generated during highway construction. Dredging and fill placement work would be performed during approved in-water work windows.

Construction equipment and highway vehicles can leak oil and fuels. These potential pollutants can flow directly to area water resources or be transported via storm water runoff. Leaks, as well as spills associated with refueling, are expected to be few and of minimal consequence. Containment devices, such as oil booms, absorbent pads, and straw bales are examples of items that contractors would be required to have on hand during construction.

Highway construction involves earth-moving activities, such as the development of borrow sources, excavation, and placement of fill. Exposed soils are susceptible to erosion and can be discharged to natural water bodies. Excess sediment in natural water bodies "can impede prey capture, impair respiration, reduce aquatic plant productivity, degrade spawning gravels, and bury substrate" (MOA, 1999a). Implementation of BMPs, identified in a contractor SWPPP, would minimize the potential for sediment transport. Implemented BMPs might include installing silt fences and/or pipe slope drains.

Debris and waste are generated during construction. Work sites would have site housekeeping plans that address the containment and disposal of potential pollutants for the protection of human and environmental health. These measures would be monitored for effectiveness; therefore, only minimal amounts of waste and debris are expected to enter area water resources. No long-term impacts to area water quality from normal waste and debris generation are anticipated.

4.2.2 Maintenance and Operations

4.2.2.1 Highway

Maintenance and operations of a highway can impact water quality by introducing contaminants to area water resources through rainfall and snowmelt runoff (or meltwater). Known as non-point source pollution, runoff from impervious surfaces, such as highways, can transport accumulated pollutants to natural water bodies. Highways accumulate pollutants from multiple sources: traction sand and deicers; vehicle-related emissions, depositions, and spills; fecal material; vegetation sources; and pavement wear and decomposition residue (MOA, 2000a). Table 3 identifies specific pollutant constituents associated with known contributors common to Alaska.

Predictions as to impacts from normal traffic volumes and associated effects can be made based on existing research. Results from storm water research by the FHA indicate storm water runoff from low to medium traffic volumes (under 30,000 vehicles per day) on rural highways exerts minimal to no impact on the aquatic components of most receiving waters (USDOT & FHWA, 1987). One study conducted in Anchorage, Alaska, under the MOA Watershed Management Program similarly concluded that street runoff has minimal impacts to the water quality of receiving waters from most potential pollutants (MOA, 2000b). Samples collected between March and September of 2000 from five streams that receive runoff from development and roadways within the Anchorage Bowl showed no concentrations of copper, lead, zinc, TSS, chloride, or pesticides above AWQS. Turbidity was also below the respective standard. FC was the only study parameter above AWQS, and was identified at elevated concentrations at each sampling location during multiple sampling events. The sources of FC were not identified in this report, but another MOA document on FC in swimming beaches in Anchorage attributes high FC concentrations to several potential sources: domestic pets, wild mammals, and waterfowl fecal material (MOA, 2000c).

In 1998 and 1999, meltwater runoff from Anchorage streets and snow disposal sites was studied to determine potential water quality impacts from chloride associated with sand and deicers used to enhance winter vehicle traction. Chloride can be toxic to aquatic life. It is not anticipated that deicers would be used on any of the proposed highway routes, sanding would be performed, as conditions require. Typically, up to 5 percent sodium chloride per total weight of sand is added to keep sand friable in winter. Study results showed that chloride from sand and deicer used in the Anchorage Bowl did not appear to adversely impact receiving waters (MOA, 2000d). Periodic high chloride levels (above the AWQS of 230 mg/L) were noted at snow disposal sites, which often preceded peak meltwater flows. Chloride levels, however, consistently decreased to below AWQS after the peak meltwater flows subsided. Also, a review of 1988 through 1992 chloride and conductivity data from seven Anchorage lakes within the bowl identified no trend pointing to chloride buildup in receiving waters over time (MOA, 1999b).

Anchorage Street Deicer and Snow Disposal: 2000 Best Management Practices Guidance (2000) was published after a review of the 1998 and 1999 studies and after analysis of meltwater from snow disposal sites in 2000. Results showed dissolved concentrations of calcium, chromium, magnesium, and zinc below AWQS. Only dissolved concentrations of copper and lead were noted above AWQS; however, modest dilution would likely reduce these concentrations below AWQS. Identified concentrations would not adversely impact streams with flow rates greater than 0.5 cfs (MOA, 2000e). Polynuclear aromatic hydrocarbons (PAH) were at concentrations below USEPA water quality criteria.

Because of the rural setting of the proposed highway alternatives and the predicted low annual average daily traffic (AADT), fewer impacts to water quality in the project area are expected than were found in the Anchorage studies. Studied runoff was collected from Anchorage roadways that ranged from residential (<2,000 average daily traffic [ADT]) to major arterial (>20,000 ADT). Studied meltwater was from snow collected from a mix of these types of roads. In comparison, predicted 2008 and 2038 AADTs for East Lynn Canal and West Lynn Canal build alternatives are much lower and the peak week predicted ADTs are at the lower end of the annual average traffic volumes for roads studied in Anchorage. East Lynn Canal build alternatives have maximum projected AADTs for 2008 and 2038 of 510 and 930, respectively (DOT&PF, 2003), while the maximum peak week ADT projected for 2008 and 2038 is 1,800 and 3,250, respectively. The maximum AADT projected at Berners Bay for an East Lynn Canal highway in 2008 and 2038 is 660 and 1,200, respectively. During the peak week, the maximum ADT for a highway in Berners Bay is projected to be 2,340 vehicles in 2008 and 4,220 in 2038. West Lynn Canal projected maximum AADTs for 2008 and 2038 are 310 and 530, respectively, while the maximum peak week ADT projected for 2008 and 2038 is 1,100 and 1,860, respectively.

Highway runoff and meltwater from the proposed highway alternatives would have lesser quantities of potential contaminants due to a lower traffic volume and less area development. Snow would be cleared from the highway and deposited along its length, instead of disposed in one location. Potential pollutants would not be concentrated in one area. Additionally, Anchorage roads have curb and gutter that increase the potential for pollutant accumulation and channel runoff into storm drainage systems that outfall directly into receiving waters. The design used in the proposed alternatives would include minimum curb and gutter except at ferry terminal locations.

Contamination from bridge deck runoff is also not expected to significantly impact receiving waters. According to the National Cooperative Highway Research Program (NCHRP), highways often "contribute a small fraction of the overall pollutant load to a given receiving water body, and bridges contribute even less" (NCHRP, 2002). To minimize potential impacts, bridge design would take into account the individual characteristics of the receiving water bodies, such as the flow rate and the aquatic biota.

Oil or hazardous substance spills along the highway route are possible and could impact area water quality. In Alaska between 1996 and 2002, vehicle spills were the most common spill reported to ADEC (ADEC, 2003f). A total of 3,969 spills were reported statewide during the seven-year period that included 1996 through 2002. ADEC attributed 1.6 spills per day and 130 gallons per day to vehicle spills. On average, each vehicle spill included a release of 86 gallons. As would be expected, more densely populated or industrialized areas experienced more spills than less populated or less developed areas.

4.2.2.2 Alaska Marine Highway System Ferry Service

AMHS provides year-round ferry service between Juneau, Haines, and Skagway within the project area. The distance from Juneau to Haines is 68 nautical miles (nm), Haines to Skagway is 13 nm, and Skagway to Juneau is 81 nm. AMHS operates seven ferries that carry passengers and vehicles between these cities via Lynn Canal. Table 4 presents information describing each of these vessels.

Operations of ferries has the potential to impact water quality, particularly marine waters, through the following means:

- Spills or leaks;
- Fuel transfers;
- Collisions;
- High-speed wave action;
- Permitted discharges;
- Accidental discharges; and
- Prop wash from propellers, jet wash from FVF jet engines, and bow thrusters.

As required by the Oil Pollution Prevention Program (40 Code of Federal Regulations [CFR], Part 112), AMHS has prepared Spill Prevention Control and Countermeasures Plans, which detail measures necessary to comply with the requirements of the program. Should an AMHS ferry have a collision resulting in a large oil spill, the detailed response procedures in this plan are intended to prevent significant impacts to waters of the United States. AMHS also has a contract with Juneau-based Alaska Steamship Response, a designated company responsible for responding to any such accident or event.

Since beginning operations in Lynn Canal, AMHS has had no fuel or oil spill in excess of approximately 1 cup (P. Johnson, personal communication, 2003). All ferries are refueled in accordance with standard industry spill prevention precautions at the Skagway terminal. Routine ferry maintenance is conducted in Ketchikan. Aside from an unforeseen catastrophic event, future impacts to marine water quality from fuel or oil spills/leaks would likely continue to be minimal.

Each mainline AMHS ferry discharges treated graywater (water from showers, sinks, and laundry) and treated blackwater (water from ship toilets) within Lynn Canal. Waste is treated by a macerator/chlorinator system. A macerator pump cuts and breaks up solids, then chlorine is added. After treatment is complete, the waste is automatically discharged. The largest ferry, the Kennicott, discharges up to 1,975 gallons of blackwater per day of operation, and as much as 7,900 gallons of graywater. ADEC has estimated that ferries and other small cruise ships account for 6 percent of the total wastewater discharge produced by large cruise ships, small cruise ships, and ferries. (ADEC, 2003e)

Since 2001, ADEC has required the periodic testing of treated wastewater from the mainline ferries. Testing has been based on 2001 legislation that established vessel effluent standards for FC (200 FC colonies [or most probable number {MPN}] / 100 milliliter {ml} of water) and TSS (150 mg/L). AMHS is required to test treated wastewater from each mainline ferry at least twice a year and provide ADEC with the analytical results. ADEC can also conduct sampling; however, this additional sampling is not required.

Compliance with FC and TSS standards is not currently enforced for AMHS ferries. Beginning in 2004, however, ferries will have to meet the standards or apply for a 12-month extension by completing an ADEC-approved Interim Protective Measures Plan. Approved plans will have to include an outline of the changes and/or upgrades that will be completed to limit adverse impacts of wastewater discharges and a schedule for compliance with wastewater standards.

Table 5 presents the results for TSS and FC from samples of treated wastewater discharged by ferries between April 2001 and October 2003. Results ranged from 1 to 16,000,000 MPN/100 ml for FC and 1 to 314 mg/L for TSS. AMHS treatment systems appear to usually reduce TSS concentrations in effluent below AWQS, but are only sporadically successful at adequately reducing FC concentrations.

Although not regulated, metals in the same sampled effluent were noted above AWQS. Total and dissolved concentrations of certain metals including copper, lead, nickel, selenium, and zinc were consistently measured at concentrations above AWQS.

Dilution can reduce the impact from pollutants. ADEC has studied the effect of dilution on wastewater discharges and concluded that those that occur when vessels are traveling at a speed of at least six knots and are at least one mile from shore have little effect on water quality (ADEC, 2003e). The mixing action of the vessel propellers and the displacement of large volumes of water by the hull almost instantly dilute the discharges. AMHS vessel wastewater treatment systems automatically discharge when capacity is reached, whether a ferry is under way or docked.

High-speed wave action can cause bank and beach erosion. No-wake zones established near harbors, docks, and piers minimize these impacts.

Bow thrusters, prop wash from propellers, and jet wash from FVF jet engines can disturb bottom sediment during low tides. Greater water depths at higher tides buffer the degree of disturbance to bottom sediment. Although prop wash from propellers is generated downward toward bottom sediment, propulsion from bow thrusters and jet wash is generated sideways.

4.3 Hydrology and Water Quality Impacts by Alternative

4.3.1 Alternative 1 – No Action

Under this alternative, no highway would be built. Ferry service would include at least three mainline vessel round trips per week through Lynn Canal year-round. A conventional monohull ferry would operate year-round between Haines and Skagway. The FVF *M/V Fairweather* would operate between Juneau and Haines/Skagway five days per week in summer, two days per week in winter. No new ferry terminals would be constructed.

4.3.1.1 Impacts to Hydrology

Because no highway would be built, area hydrology would not be impacted by highway construction, operation, or maintenance activities. Higher operating speeds of the FVFs could cause localized increases in shoreline erosion. Long-term, irreversible consequences, however, are not likely.

4.3.1.2 Impacts to Water Quality

Treated wastewater is discharged from mainline vessels in Lynn Canal under this alternative. Based on ADEC data collected from 2001 through October 2003, AMHS wastewater treatment systems are not effective in consistently reducing FC concentrations below AWQS. The devices are more successful at reducing TSS concentrations below the threshold level, but are not 100 percent effective. Concentrations are diluted through discharge to ambient water. Dilution reduces the toxic effects of FC and TSS, as well as other pollutants. Discharges occurring while ferries are under way and away from shore will impact water quality the least. Because wastewater discharges from ferries are automatic and can happen while the vessels are near shore or docked, some short-term impacts to water quality from elevated levels of FC and TSS could be expected.

The frequency of elevated TSS and FC discharges could decrease substantially in the next few years. New ADEC compliance regulations go into effect in 2004 that will require wastewater discharges meet AWQS. A 12-month extension could be granted to AMHS to allow time for the necessary on-board modifications.

FVFs and the Haines-Skagway ferry shuttle would not discharge wastewater into Lynn Canal. Wastewater would be stored in on-board holding tanks and removed nightly by on-shore vacuum trucks. Wastewater would then be treated at a permitted sewage treatment facility; therefore, no impacts to water quality are expected. FVF operation could potentially increase the level of sediments in the water column near ferry terminals, where jet wash and higher speeds could re-suspend bottom sediment.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal, temporary impacts to water quality. This low level of impact would continue under this alternative.

4.3.2 Alternatives 2 and 2C – East Lynn Canal Highway (preferred) with Katzehin Ferry Terminal and East Lynn Canal Highway with Shuttle to Haines from Skagway

Alternatives 2 and 2C would include constructing a highway from Echo Cove around Berners Bay to Skagway. Alternative 2 would also include construction of a new ferry terminal north of the Katzehin Delta. A shuttle ferry would run between Katzehin Ferry Terminal and Haines. The Katzehin Ferry Terminal would have rubble mound breakwaters both north and south of the dock for wind and wave protection. Under Alternative 2C, no new ferry terminal would be built and shuttle ferry service would be provided to Haines from Skagway. Under both alternatives, mainline ferry service would end at Auke Bay.

4.3.2.1 Impacts to Hydrology

Under both alternatives, highway construction, maintenance, and operations activities would impact area hydrology. The highway would act as a partial barrier and alter the flow of shallow groundwater and surface water. Shallow groundwater blocked by the highway would eventually flow to the surface. Roadside drainage ditches would collect surface water on the upgradient side of the highway and channel it to the downstream side of the highway through culverts. This flow diversion would be minor and would adequately maintain water's natural downgradient flow. Culvert end sections or rock dissipaters would be used as necessary to disperse high volume/velocity outfall. By reducing the velocity, the end sections protect soils and vegetation below culvert outfalls from erosion.

The highway proposed in Alternatives 2 and 2C would cross 64 streams. Most of the streams are less than 50 feet wide. Bridges would be used to cross 27 streams, including all anadromous fish streams. Fourteen of the bridges would be single-span structures. The bridge and its piers would be located outside of the predicted 100-year flood elevation of the streams, as determined during the final engineering design of the preferred alternative. Multi-span bridges would be constructed at wide gorges and the crossings of the Katzehin, Lace, and Antler rivers. The bridges would require placement of supports in the river floodplain. These supports would be spaced and designed to accommodate the predicted 100-year flood volume with no more than a 1-foot rise in backwater. The remaining seven streams would be crossed with culverts. The culverts would vbe sized to pass the 100-year flood.

Alternative 2 would include construction of the Katzehin Ferry Terminal. This terminal would have little effect on the hydrology of the Katzehin River and Lynn Canal. The terminal would not obstruct discharge from the river to the canal, as it is sited at the northern-most extent of the river delta. Breakwaters north and south of the terminal would divert near-shore water flow farther into the canal, but this diversion would have a nominal effect on the canal's overall hydrology. Dredging to approximately 25 feet below mean low low water would be necessary for ships to use the terminal. Dredging would have no adverse impacts on area hydrology, nor would ferry operations under both alternatives.

4.3.2.2 Impacts to Water Quality

Highway construction, maintenance, and operations activities can affect water quality through earth-moving activities, equipment oil and fuel spills/leaks, debris generation, and vehicular traffic. Vehicular traffic can introduce heavy metals, fuel, and oil to vicinity water resources. Studies of roadway runoff in Anchorage, however, show that even with high urban traffic volumes, pollutants associated with vehicular traffic have little impact on the water quality of receiving streams (MOA, 2000b). Implementation of BMPs during design and in construction and the use of spill prevention and containment in addition to storm water pollution prevention measures during construction would minimize impacts to water quality.

Earth-moving activities and in-water work at stream and river crossings would likely cause temporary impacts to water quality, including increases in sedimentation and turbidity. Long-term effects in excess of water quality standards are not anticipated. Implementation of BMPs in design and in construction; the use of spill prevention and containment measures and storm water pollution prevention measures; and conducting in-water activities during the time of year with the least potential impact would minimize impacts to water quality.

Multi-span bridges would be required for crossings at the Katzehin, Berners/Lace, and Antler rivers. In-water work, such as pile driving, would be necessary. As detailed in the *Anadromous and Resident Fish Streams Technical Report* (appended to the SDEIS), in-water work would be restricted where necessary to protect vulnerable aquatic habitats and species from such impacts as poor water quality, particularly during important life-processes (e.g., spawning).

Highway operation would impact water quality. Pollutants that accumulate on the highway from routine traffic could affect water quality. These pollutants can dissolve in runoff or adsorb to sediment particles that are transported via runoff to nearby water resources. However, based on results from studies of runoff and receiving waters in Anchorage, it is not anticipated that runoff from the proposed highway would be above AWQS or adversely impact the water quality of receiving waters.

Oil or hazardous substance spills along the highway route are not anticipated, but are possible, and could impact area water quality. According to ADEC, more densely populated or industrialized areas experience more spills than less populated or less industrialized areas (ADEC, 2003f). The rural setting of the proposed highway and the predicted highway traffic volume create a low potential for large-scale oil or hazardous substance spills.

Ferry terminal construction under Alternative 2 would have little effect on area water quality. Terminal construction would include dredging the basin and adding fill to create the breakwaters and the foundation for the terminal building and parking area. Dredging would create short-term, localized increases in turbidity, but negligible long-term impacts to water quality. Shot-rock fill should introduce negligible concentrations of pollutants to Lynn Canal. In-water fill placement would disturb bottom sediment and cause a short-term increase in turbidity.

Ferry operations under both alternatives would also have little effect on area water quality. AMHS mainline ferry wastewater discharges in Lynn Canal would be eliminated under both alternatives, as mainline ferry service would end in Auke Bay. Under Alternative 2, the only AMHS ferry operating in Lynn Canal would be the Katzehin ferry shuttle. The Katzehin ferry shuttle would not discharge treated wastewater into the canal. Under Alternative 2C, the only AMHS ferry operating in Lynn Canal would be the Haines-Skagway ferry shuttle described in the No Action Alternative, which would also not discharge wastewater.

A sewage treatment facility with a permitted outfall would be installed at the Katzehin Ferry Terminal, under Alternative 2. Discharges from the Katzehin sewage treatment facility would operate within permit guidelines. The treatment plant would use tertiary treatment with ultraviolet disinfection and discharge to an adequate mixing depth, similar to the current facility at the Auke Bay Ferry Terminal. There would be no adverse impacts to water quality from the terminal treatment facility.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal and temporary impacts to water quality. This low level of impact likely would continue under these alternatives.

4.3.3 Alternative 2A – East Lynn Canal Highway with Berners Bay Shuttle

Alternative 2A is the same as Alternative 2 (East Lynn Canal Highway to Skagway) with the exception that shuttle ferries would cross Berners Bay from Sawmill Cove to Slate Cove rather than constructing a highway around the bay. Three new ferry terminals would be constructed. A shuttle ferry would operate from Katzehin to Haines. Mainline ferry service would end at Auke Bay.

4.3.3.1 Impacts to Hydrology

Highway construction, maintenance, and operations activities would affect area hydrology by impeding surface water and shallow groundwater flow within the alignment area. The use of bridges, roadside drainage ditches, and culverts would effectively maintain normal water flow, although some flow diversion would occur.

Most of the streams that would be crossed by the proposed highway are less than 50 feet wide. Single-span bridges or appropriately sized culverts would be used on these streams. These structures could result in minor modification of some stream profiles. A multi-span bridge would be constructed to cross the Katzehin River. This bridge would extend beyond the numerous outfall channels of the river to protect its natural, meandering flow, but minor modification of the river profile could occur. Because a highway would not be constructed around Berners Bay, there would be no hydrologic impacts to rivers at the head of the bay.

Ferry terminal construction, maintenance, and operations activities at Sawmill Cove and Slate Cove would not have long-term impacts on the hydrology of Berners Bay. Slate Cove terminal construction would not require dredging; Sawmill Cove would. Dredging at Sawmill Cove would be to approximately 25 feet below mean low low water and would cause no adverse hydrologic effects. Presence of the terminals would not obstruct water flow in the bay, but would cause minor near-shore flow diversions near the terminals. Terminals are sited such that they would not impede the flow of Sawmill Creek or Slate Creek into Berners Bay. Similarly, the Katzehin Ferry Terminal would have no long-term effects on the hydrology of Lynn Canal or the Katzehin River.

4.3.3.2 Impacts to Water Quality

The proposed highway would affect water quality during construction, operation, and maintenance activities. Earth-moving activities, debris and waste generation, increased vehicle traffic, winter sanding, and accidental fuel leaks and spills would impact area water quality, most likely through storm water and meltwater runoff. As detailed in Sections 4.1 and 4.2 and summarized in the discussion of Alternatives 2 and 2C, impacts are not expected to be severe enough to continuously elevate regulated parameters in receiving waters above their respective AWQS.

Because no highway would be built around Berners Bay, no associated adverse water quality impacts to the bay and nearby streams and rivers would occur.

Ferry terminal construction would affect area water quality by causing temporary levels of turbidity and suspended solids above AWQS near work zones. Activities such as driving piles, dredging (at Sawmill Cove and Katzehin), and fill placement would disturb bottom sediment temporarily, but have no lingering impact on water quality.

AMHS mainline ferry wastewater discharges in Lynn Canal would be eliminated under this alternative because mainline ferry service would end in Auke Bay. The only AMHS ferries in operation under this alternative are the Katzehin and Berners Bay ferry shuttles. These ferry shuttles would not discharge treated wastewater into Lynn Canal or Berners Bay. Sewage treatment facilities with permitted outfalls would be installed at the Katzehin and Sawmill Cove ferry terminals. Discharges from these sewage treatment facilities would operate within permit guidelines. Therefore, no impacts to water quality from vessel and treatment plant discharges would be expected.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal and temporary impacts to water quality. This low level of impact likely would continue under this alternative.

4.3.4 Alternative 2B – East Lynn Canal Highway to Katzehin, Shuttles to Haines and Skagway

Alternative 2B includes the construction of East Lynn Canal Highway from Echo Cove to the Katzehin Delta, with shuttle ferries providing service from Katzehin to both Haines and Skagway. A new ferry terminal would be built at Katzehin. Mainline ferry service would end at Auke Bay. The Haines-Skagway shuttle ferry described in the No Action Alternative would continue to operate.

4.3.4.1 Impacts to Hydrology

Highway construction, maintenance, and operations activities would impede surface water and shallow groundwater flow within the alignment area and cause some flow diversion. Surface water flow (including surfaced groundwater) would be able to maintain its natural down-gradient momentum through avenues created by bridges, roadside drainage ditches, and culverts.

Most of the streams along the proposed highway route are less than 50 feet wide and would be crossed by single-span bridges or culverts. Bridges would be used to cross all anadromous fish streams. Most of these bridges would be single-span structures, with the bridge and its piers located outside of the predicted 100-year flood elevation of the streams, as determined by hydraulic studies to be conducted during the final engineering design of the preferred alternative. Multi-span bridges would be constructed at the crossings of the Katzehin, Lace, and Antler rivers. These larger bridges would extend beyond the outfall channels at each river delta to protect their natural, meandering flow. The bridges would require placement of supports in the river floodplain. These supports would be spaced and designed to accommodate the predicted 100-year flood volume with no more than a 1-foot rise in backwater. Culverts would be sized to pass the 100-year flood.

The Katzehin Ferry Terminal would have little effect on the hydrology of the Katzehin River and Lynn Canal. The terminal's presence at the northern-most extent of the delta would not obstruct normal discharge from the river into the canal. Flow diversion created by the breakwaters north and south of the terminal would divert near-shore water flow farther into the canal, but would have a nominal effect on the canal's overall hydrology. Dredging would have no adverse impacts on area hydrology, nor would ferry operation.

4.3.4.2 Impacts to Water Quality

The proposed highway would affect water quality during construction, maintenance, and operations activities. Impacts from potential pollutant sources, including earth-moving activities, debris and waste generation, increased vehicle traffic, winter sanding, and accidental fuel leaks and spills are not expected to be severe enough to increase contaminant concentrations in receiving water above AWQS for the long term.

Multi-span bridges would be required for crossings at the Katzehin, Berners/Lace, and Antler rivers. In-water work, such as pile driving, would be necessary and would likely create temporary and isolated increases in turbidity and suspended sediments. Work would be conducted during in-water work windows for the protection of important aquatic habitat, species, and life-processes (e.g., spawning). These would be times when the affected aquatic environment is least susceptible to temporary disturbances, such as increased turbidity.

Construction of the Katzehin Ferry Terminal would cause temporary elevated levels of turbidity and suspended solids. Activities such as dredging and fill placement would disturb bottom sediment near the work, but would cause no lingering or widespread impacts to water quality.

AMHS mainline ferry wastewater discharges in Lynn Canal would be eliminated under this alternative because mainline ferry service would end in Auke Bay. The only AMHS ferries operating in Lynn Canal would be the Katzehin shuttle ferries and the Haines-Skagway shuttle ferry described in the No Action Alternative. As described in the Alternative 2 discussion on ferry impacts to water quality, the Katzehin ferry shuttle would not discharge treated wastewater into Lynn Canal.

4.3.5 Alternative 3 – West Lynn Canal Highway

Alternative 3 would extend Glacier Highway to Sawmill Cove, with shuttle ferry service to William Henry Bay. A highway would be constructed from William Henry Bay to Haines via Pyramid Island, connecting to Mud Bay Road. Mainline ferry service would end at Auke Bay. The Haines-Skagway shuttle ferry described in the No Action Alternative would continue to operate. This alternative includes the construction of two new ferry terminals: one at Sawmill Cove and one at William Henry Bay.

4.3.5.1 Impacts to Hydrology

Highway construction, maintenance, and operations activities would affect hydrology within the alignment area. Approximately 28 streams would be crossed. Most of the streams are less than 50 feet wide and would be crossed by single-span bridges. These structures could result in minimal modification of some stream profiles. Multi-span bridges would be constructed at the crossings of several large rivers: the Endicott, the Sullivan, and the Chilkat. Some channelization of meandering outfall channels would likely be needed in these larger river basins.

The highway (including the Glacier Bay Highway extension) would impede surface water and shallow groundwater flow within the alignment area and cause some flow diversion. Bridges, roadside drainage ditches, and culverts allow flow to reach the down-slope side of the highway. Sediment buildup from highway construction activities and operation would likely occur in concentrated areas, and in relation to spring thaw during highway operation, but should cause no long-term impacts to localized or overall area hydrology.

Ferry service would not impact area hydrology. Ferry terminal construction at William Henry Bay and Sawmill Cove would have minimal effect on the hydrology of Lynn Canal and Berners Bay, respectively. Tidal fill would be placed at both locations. Dredging would occur at Sawmill Cove. Terminals are sited to not obstruct discharge from nearby streams and creeks. Breakwaters are currently not planned for either terminal.

4.3.5.2 Impacts to Water Quality

Highway construction, maintenance, and operations activities would affect area water quality. Related activities increase the potential for pollutants to reach natural water bodies within the alignment area. The majority of pollutant concentrations would likely be from vehicle traffic. Other contributors would include earth-moving activities, fuel or oil leaks/spills, debris and waste, and highway sanding.

Major, direct depositions of pollutants (e.g., large oil or hazardous substance spill) to area water resources could have long-term effects on water quality, but are not probable. Statewide, Alaska reports approximately 1.6 spills per day, with an average spill volume of 86 gallons per incident. Spills are more prevalent in industrialized and populated areas. The area along the proposed West Lynn Canal highway is rural, sparsely populated, and largely undeveloped.

Runoff would likely introduce the greatest concentration of pollutants to natural water bodies. Studies of roadway runoff in Anchorage show that even with high urban traffic volumes, pollutants associated with vehicular traffic have little impact on the water quality of receiving streams (MOA, 2000b). Runoff studied in Anchorage was collected from roadways with traffic volumes ranging from less than 2,000 ADT to greater than 20,000 ADT. The predicted annual AADT for West Lynn Canal Highway in 2008 and in 2038 is 380 and 628 vehicles, respectively.

Impacts to the water quality of streams receiving runoff along the proposed highway route, therefore, would be minimal.

Multi-span bridges would be required for crossings at larger rivers. In-water work would be necessary, and would likely cause elevated levels of turbidity and suspended sediments. These impacts, however, would be localized and temporary. In-water work would be conducted during approved in-water work windows.

Ferry terminal construction at William Henry Bay would require hillside excavation and tidal fill placement. Both activities would affect water quality, but only temporarily and only around work zones. Hillside excavation can cause soil erosion. Eroded soil may be transported by storm water runoff to nearby natural water bodies, in this case, to Lynn Canal. Excess sediments can impair the functions and processes of aquatic life. Fill material would not introduce adsorbed pollutants to Lynn Canal. Placement of tidal fill, however, would disturb bottom sediment.

Dredging and tidal fill placement conducted for Sawmill Cove Ferry Terminal construction would also cause short-term and localized impacts to water quality.

AMHS mainline ferry wastewater discharges in Lynn Canal would be eliminated under this alternative because mainline ferry service ends in Auke Bay. The only AMHS ferries operating in Lynn Canal would be the Sawmill Cove ferry shuttle and the Haines-Skagway ferry shuttle described in the No Action Alternative. As described in Alternative 2A, the Sawmill Cove ferry would not discharge wastewater. Wastewater would be treated at an onshore facility at the Sawmill Cove Ferry Terminal. No impacts to water quality are expected.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal and temporary impacts to water quality. This level of impact likely would continue under this alternative.

4.3.6 Alternatives 4A and 4C – FVF and Conventional Monohull Shuttle Service from Auke Bay

Alternative 4A would provide daily summer FVF service from Auke Bay to Haines and Skagway. Alternative 4C would provide daily shuttle service with a conventional monohull ferry from Auke Bay to Haines and Skagway. Both alternatives would include a minimum of two mainline vessel round trips per week, year-round, and the continuation of the Haines-Skagway shuttle ferry service. No new ferry terminals would be constructed, but both alternatives would require construction of a new double stern berth at Auke Bay.

4.3.6.1 Impacts to Hydrology

Because no highway would be built, area hydrology would not be impacted by highway construction, operation, or maintenance activities. Construction of the double stern berth at Auke Bay would have negligible impacts to hydrology. Higher operating speeds of the FVFs could cause localized increases in shoreline erosion. Long-term, irreversible consequences, however, are not likely.

4.3.6.2 Impacts to Water Quality

No impacts to area water quality due to the construction, maintenance, and operations of a highway would occur. Construction of the double stern berth at Auke Bay would result in short-term and localized increases in turbidity, but no long-term impacts to water quality.

Wastewater from mainline ferry vessels would be discharged into Lynn Canal. Based on past sampling results, some wastewater discharges to Lynn Canal from mainline ferry vessels have concentrations of TSS and FC, as well as some unregulated metals, above AWQS. Dilution reduces the toxic effects of FC and TSS, as well as other pollutants. Discharges occurring while ferries are under way and away from shore would have the least impact on water quality. Because wastewater discharges from ferries are automatic and can occur while the vessels are near shore or docked, some impact to water quality from elevated levels of FC and TSS are anticipated. Elevated TSS and FC discharges may decrease substantially in the next few years. New compliance regulations are effective beginning in 2004 that would require wastewater discharges to meet water quality standards.

FVFs and conventional monohull shuttles would not discharge graywater or blackwater overboard. Waste would be stored in on-board holding tanks, and then removed for on-shore treatment. There would be negligible impacts to water quality from these wastewater discharges.

FVF and conventional monohull shuttle operation could potentially increase the level of sediments in the water column near ferry terminals, where prop wash, bow thrusters, and jet wash may re-suspend bottom sediment.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal, temporary impacts to water quality. This low level of impact would likely continue under these alternatives.

4.3.7 Alternatives 4B and 4D – FVF and Conventional Monohull Shuttle Service from Berners Bay

Alternatives 4B and 4D would extend Glacier Highway from Echo Cove to Sawmill Cove in Berners Bay. Under Alternative 4B, there would be daily FVF service from Sawmill Cove in Berners Bay to Haines and Skagway in the summer and from Auke Bay to Haines and Skagway in the winter. Under Alternative 4D, service would be the same, except conventional monohull ferries would be used instead of FVFs. Both alternatives would include a minimum of two mainline vessel round trips per week, year-round, and the continuation of the Haines-Skagway shuttle ferry service. One new ferry terminal would be constructed at Sawmill Cove. Both alternatives would require construction of a new double stern berth at Auke Bay.

4.3.7.1 Impacts to Hydrology

Highway construction, maintenance, and operations activities would affect hydrology by impeding surface water and shallow groundwater flow in the project area between Echo Cove and Sawmill Cove. The use of a bridge at Sawmill Creek, roadside drainage ditches, and culverts would effectively maintain natural water flow, although some flow diversion would occur.

Ferry terminal construction at Sawmill Cove would cause no long-term impacts to hydrology near Berners Bay. The terminal would not impact the hydrology of Sawmill Creek or obstruct water flow within the bay. Construction of the double stern berth at Auke Bay would have negligible impacts to hydrology. Higher operating speeds of the FVFs could cause localized increases in shoreline erosion. Long-term, irreversible consequences, however, are not likely.

4.3.7.2 Impacts to Water Quality

Highway construction, maintenance, and operations activities would increase the potential for pollutants to enter natural water bodies near the alignment. Pollutants can be deposited directly or indirectly, through runoff, into area water resources. Major direct depositions such as large oil spills that could have long-term effects on water quality are not probable. Runoff would likely introduce the greatest concentration of pollutants to area water resources. Results of runoff studies conducted in Anchorage indicate that concentrations of pollutants in runoff only temporarily increase contaminant concentrations in receiving streams above AWQS.

Sawmill Creek Ferry Terminal construction would cause temporary disturbances to bottom sediment and increased turbidity from dredging and fill placement. The increases would be short-term and only around the work zones. These activities would cause no measurable long-term impacts to water quality. Construction of the double stern berth at Auke Bay would result in short-term and localized increases in turbidity, but no long-term impacts to water quality.

No long-term impacts to water quality would result from operation of the ferry terminal wastewater treatment plant. The treatment plant would use tertiary treatment with ultraviolet disinfection and discharge to an adequate mixing depth, similar to the current facility at the Auke Bay Ferry Terminal.

Wastewater discharges from mainline vessels would periodically introduce concentrations of FC and TSS above AWQS into ambient water. Dilution after discharge would reduce the toxic effects of these pollutants. Discharges occurring while ferries are under way and away from shore would have the least impact on water quality. Because wastewater discharges from ferries are automatic and can happen while the vessels are near shore or docked, some impact to water quality from elevated levels of FC and TSS are anticipated. Elevated TSS and FC discharges may decrease substantially in the next few years. New compliance regulations would go into effect in 2004 that would require wastewater discharges meet water quality standards.

FVFs and conventional monohull shuttles would not discharge graywater or blackwater overboard. Wastewater would be stored in on-board holding tanks, and then removed for on-shore treatment. Therefore, no impacts to water quality would result from wastewater discharges.

FVF and conventional monohull shuttle operation could potentially increase the level of sediments in the water column near ferry terminals, where prop wash, bow thrusters, and jet wash may re-suspend bottom sediment.

Accidental discharges, spills, and leaks are possible during ferry operations. Historically, these have been minor with only minimal, temporary impacts to water quality. This low level of impact would likely continue under these alternatives.

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TABLES

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Table 1
Major Tributaries, Coves, and Bays Located within the Project Area
(East Lynn Canal)

Name of Waterbody	General Description
Echo Cove	Lat N58°41'45"/Long W134°55'83"; Entrance has a strong current at max flood tide.
Berners Bay	Lat N58°44'/Long W134°59'; located north of Echo Cove at the southern end of the project area; convergence of the Berners/Lace and Antler rivers; largest bay within the project area.
Sawmill Creek	Lat N58°42'56"/Long W134°56'95"; located in Berners Bay; single meandering main channel with many small tributary streams running down the steep mountainsides that empty into the creek; originates from a glacier 3,000 feet in elevation and flows down a moderate gradient V-shaped valley; water is clear and has a low velocity; width ranges from 15-20 feet and the depth ranges from 1-2 feet; banks are 1-3 feet high with some erosion occurring towards the toe of the slopes; substrate consists of cobbles, gravel, and sand.
Gilkey River	Converges with Antler River
Antler River	Daily mean stream flow 18-700cfs (USGS, 2001); Lat N58°48'60"/Lon W134°56'45.2"; large braided river that is part of a classic glacial system that flows from the Antler Glacier; located at the north end of Berners Bay; very silty and has a low to moderate velocity with various flat channels; substrate is composed of gravel, sand, and silt.
Evelyn Lake	Empties into Berners Bay between the Antler and Lace rivers.
Lace River	Lat N58°49'52"/L W134°57'28" to Lat N58°49'36"/Long W134°59'41"; classic braided glacial river system located at the north end of Berners Bay; originates from an arm of the Meade Glacier, at approximately 800 feet in elevation and flows south for 20 miles into Berners Bay; deposits much sand and silt, creating many sand bars scattered throughout the channel; bottom strata are composed primarily of sand and silt; water is silty and flows at a moderate rate; gradient is less than 1 percent.
Berners River	Converges with Lace River
Slate Creek	Lat N58°47'26"/Long W135°01'54.4"; located at the northeast end of the cove in Berners Bay; main channel of the stream originates 1,500 feet in elevation, and is contained within a palustrine floodplain; a dry streambed parallels the main channels, and has a high probability of flooding during spring run-off; non-compacted substrate is composed of gravel, adequate for spawning and cobbles, composed of various flat shales; 40 percent of this substrate at the mouth is covered with intertidal algae.
Sweeny Creek	Lat N58°51'31"/Long W135°08'36.8"; flows approximately 1/4 a mile north of Point Sherman; originates at 1,600 feet, and flows through a moderate gradient valley; stream is contained within a single meandering channel with clear water that has a low velocity; gradient is 3 percent, the average width is 10 feet, and the depth is 1 foot; bottom stratum is uneven and consists of boulder and spawning gravel.
Sherman Creek	Lat N58°52'4.2"/Long W135°08'21"; located 1 mile north of Point Sherman; Kensington Mine is located at this creek which is contained in a single, meandering, classic V-shaped valley; flows at a moderate to high velocity; bottom strata is composed of cobble and boulders which forms and uneven bottom.
Yeldagalga Creek	Lat N59°06'13.3"/Long W135°13'17.5"; headwaters begin at a large, high velocity, vertical waterfall originating from a snow field 3,000 feet in elevation; flows through a V-shaped valley with large mountains on both sides; waterfall levels out at the 2,000 foot level and flows along a bench before emptying into another vertical waterfall that is 50 feet in height.

Table 1 (continued)
Major Tributaries, Coves and Bays Located within the Project Area
(East Lynn Canal)

Name of Waterbody	General Description
Katzehin River	Lat N59°12'0.30"/Long W135°17'17.5"; located approximately 6 miles southeast of Haines; large glacial stream that flows approximately 12 miles through a classic U-shaped valley, originating 500 feet in elevation from the Meade Glacier; active braided stream channel that meanders around high mountains; north bank expands into a large floodplain for 1 mile.
Chilkoot Inlet	Convergence of the Taiya Inlet, Lutak Inlet, and Ferebee River located east of Haines; converges with the Chilkat Inlet and empties into Lynn Canal.
Dayebas Creek	Daily mean stream flow ~35-450cfs (USGS, 1981); Lat N59°17'53"/ Long W135°21'56.4"; dry stream with an 85-degree talus slope.
Taiya Inlet	Located south of Skagway and is the convergence of the Taiya and Skagway Rivers.
Kasidaya Creek	Lat N59°24'15.8"/Long W135°20'20.6"; originates from a waterfall from a 4,000-foot snowfield, and flows through a 30-degree sloping gorge; cuts through a 20-foot steep rock wall before flowing onto a boulder beach.
Lower Dewey Lake	Located in the southern part of Skagway just east of the proposed alignment; part of a series of small freshwater lakes.

Notes: cfs – cubic feet per second
Lat – latitude
Long – longitude

Table 2
Major Tributaries, Coves, and Bays Located within the Project Area
(West Lynn Canal)

Name of Waterbody	General Description
Beardslee River	Lat N58°42'31"/Long W135°15'0.8"; located at the south end of William Henry Bay; main channel receives water from two tributary streams - one flows from a small lake located 500 feet in elevation and the other originates 2,500 feet in elevation; the two streams meet 1 mile up from the mouth and form the main channel, which meanders through a palustrine floodplain and into the bay; contained within a U-shaped valley; two dry channels parallel the main channel and have the potential to flood with seasonal water variations.
William Henry Bay	Located across from Berners Bay.
William Henry Creek	Lat N58°42'59.5"/Long W135°14'45.3"; located on the northwest side of William Henry Bay; flows through a moderate gradient V-shaped valley; and meanders through a forest, which provides a 40 percent vegetation canopy cover; gradient is 2 percent, width is 15 feet, depth is 1 to 2 feet; water is clear and has a medium velocity; flows in a single straight channel; bottom stratum is irregular and is composed of boulders and cobbles.
Endicott River	Total drainage area 100,500 acres; Lat N58°47'7.2"/ Long W135°16'1.7"; large glacial river system that is contained in a classic U-shaped valley; originates near the Glacier Bay National park boundary at Endicott Lake near the 1900-foot elevation; flows 21 miles east, through the valley and floodplain and terminates in Lynn Canal; gradient is 1 percent, width of the main channel is 60 feet, depth is 3 to 5 feet; water is glacial and has a low to medium velocity; total river span width is 300 feet; substrate composed gravel beds overlain by silt; water in clear in side sloughs, while the main channel is silty.
Davidson Glacier	Tidewater glacier with that terminates into Lynn Canal southwest of Haines.
Glacier River	Lat N59°04'28.7"/Long W 135°23'30.6"; flows from Davidson glacier; stream no longer exists and is evidenced by kettles, and a dry channel found in the previous stream's location; since the publishing of this quad map in 1954, the river has changed its course.
Chilkat Inlet	Converges with Chilkoot Inlet around Haines; Empties into Lynn Canal directly.
Chilkat River/ Lutak Inlet	Lat N59°12'9.7"/Long W135°30'44.9"; located northwest of Haines within the boundaries of the Haines State Forest and Resource Management Area; empties into Chilkoot Inlet.
Ferebee River	Tributary to Chilkoot Inlet; located within the boundaries of the Haines State Forest and Resource Management Area between the Chilkoot River and Taiya River.
Taiya River	Lat N59°27'9"/Long W135°21'3"; tributary to Chilkoot Inlet.
Skagway River	Lat N59°27'9"/Long W135°21'3"; converges with the Taiya River at Skagway where it empties into Chilkoot Inlet.

Notes: cfs – cubic feet per second
Lat – latitude
Long - longitude

Table 3
Potential Pollutants in Highway Runoff

Pollutant Category	Constituent	Source
Sediment	Particulates	Street sanding, pavement decomposition, atmosphere, maintenance
Salts	Sodium Chloride	Sanding, deicers* Sanding, deicers*
Polynuclear Aromatic Hydrocarbons	Chrysene Phenanthrene Pyrene	Gasoline, oil, grease Gasoline Gasoline, oil, grease
Heavy Metals	Cadmium Chromium Copper Iron Lead Manganese Nickel Zinc	- Tire wear - Metal corrosion - Metal corrosion - Auto body rust, steel highway structures, moving engine parts - Metal corrosion, gasoline, batteries, tire wear, lubricating oil - Metal corrosion - Diesel fuel and gasoline, lubricating oil, metal corrosion, brake lining wear, asphalt paving - Metal corrosion, tire wear, road salt, grease
Pathogens	Fecal Coliforms	Humans and animals, sewage
Organics	Total Organic Carbon	Vegetation decay, organic compounds

Notes: *It is not anticipated that deicers would be used on any of the Juneau Access Improvements highway alternatives.

Sources: *Street Sediments and Adsorbed Pollutants: Design Report,* December 2000, Municipality of Anchorage Watershed Program; North Central Texas Council of Governors, Department of Environmental Resources, 2003.

Table 4
Alaska Marine Highway System Selected Vessel Information

	Columbia	Matanuska	Malaspina	Taku	Aurora	LeConte	Kennicott	Fairweather*
Ferry Type	Mainline	Mainline	Mainline	Mainline	Mainline	Mainline	Mainline	Fast
Length (feet)	418	408	408	352	235	235	382	236
Speed (knots)	17.3	16.5	16.5	16.5	14.5	14.5	16.75	38
Fuel Consumption (GPH)	397	234	270	253	190	188	354	750
Diesel Fuel Carried (gallons)	309,766	106,334	134,978	76,178	52,217	50,470	211,258	Not Available
Lube Oil Carried (gallons)	19,661	5,000	4,361	3,250	1,891	1,880	9,183	Not Available
Waste Oil Carried (gallons)	2,681	1,800	1,800	1,800	1,200	1,210	5,335	Not Available

Notes: GPH – gallons per hour
* The Fairweather is a new fast ferry due to be in operation as part of the AMHS fleet by 2004.

Source: Information on oil storage came from the Geographic Response Plan – Northern Lynn Canal, Haines to Skagway (Shannon & Wilson, 1999)

Table 5
Ferry Wastewater Discharge Sampling Results

Ship Name	Sample Date	Total Suspended Solids (mg/L)	Fecal Coliform (mpn/100ml)
Columbia	August 2001	111	**1,100**
Columbia	August 2001	118	**1,300**
Columbia	August 2001	105	**500**
Malaspina	July 2001	40	**70,000**
Matanuska	April 2001	73	**2,200**
Matanuska	December 2001	70	2
Columbia	July 2002	74	22
Kennicott	June 2002	32	14
Kennicott	July 2002	23	1
Malaspina	June 2002	100	5
Malaspina	July 2002	23	1
Matanuska	July 2002	75	1
Columbia	August 2003	105	**9,000,000**
Columbia	September 2003	54	**160,000**
Kennicott	September 2003	**314**	**16,000,000**
Malaspina	August 2003	119	**3,000,000**
Malaspina	October 2003	72	0
Matanuska	August 2003	**154**	**90,000**
Taku	August 2003	1	0
Taku	September 2003	79	**300**

Notes: mg/L – milligrams per liter
mpn/100ml – most probable number per 100 milliliters
Bold Text – Result above AWQS

Sources: D. Koch, personal communication, 2003; ADEC Cruise Ship Program website, 2003c.

FIGURES

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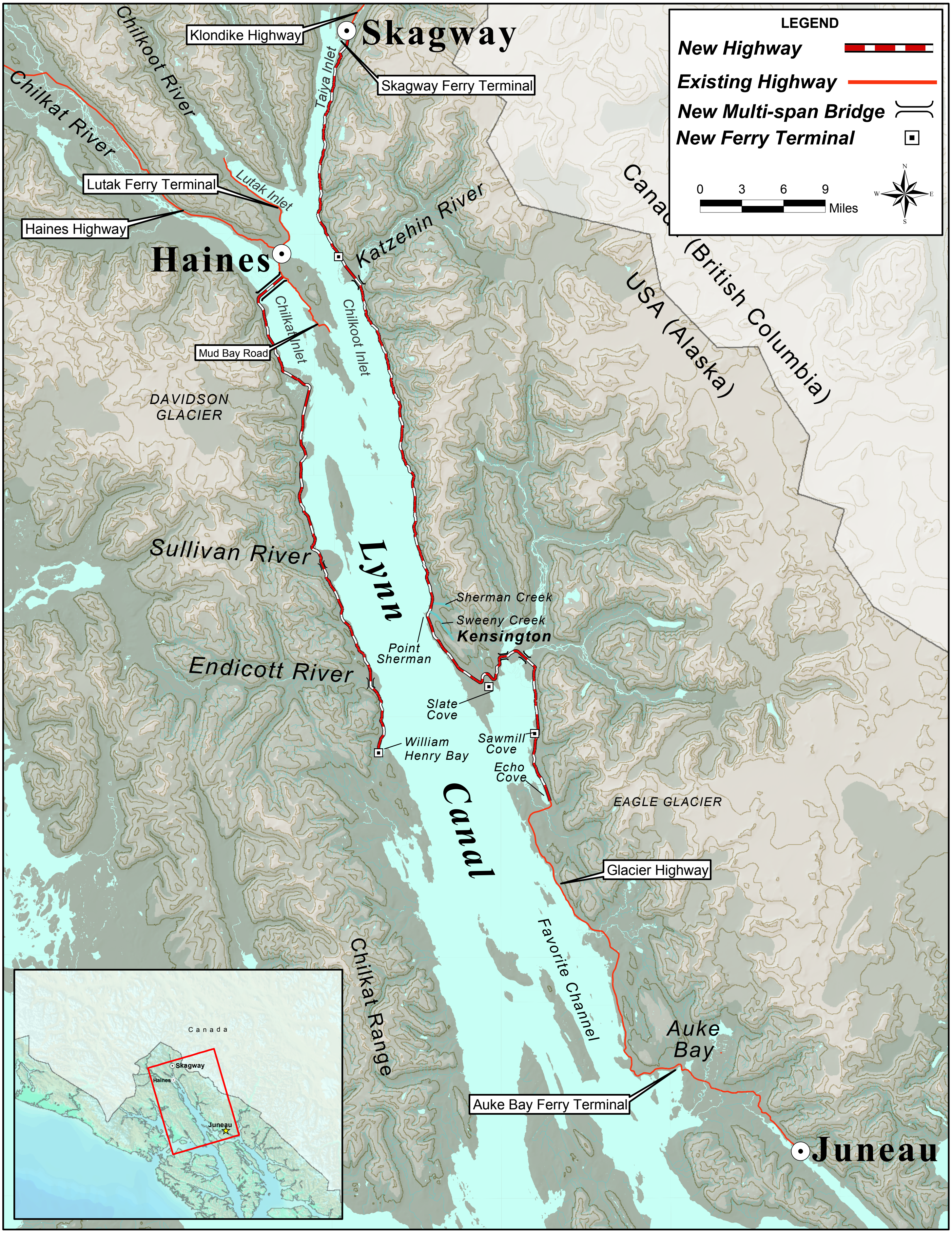

Figure 1. Location Map