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Draft Environmental Impact Statement

Renewal of the Federal Grant for the Trans-Alaska Pipeline System Right-of-Way

Volume 3: Sections 4.7 through 4.9 and Chapters 5 through 9

U.S. Department of the Interior
Bureau of Land Management

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Notation

The following is a list of acronyms and abbreviations (including units of measure) used in this document. Certain abbreviations used only in tables, equations, and as reference callouts are not included here but are defined in the respective tables, equations, and reference lists.

Acronyms and Abbreviations

AAAQS	Alaska Ambient Air Quality Standards
AAC	Alaska Administrative Code
AADT	annual average daily traffic
ACEC	areas of critical environmental concern
ACM	asbestos-containing materials
ACMA	Alaska Coastal Management Act
ACMP	Alaska Coastal Management Program
ACS	Alaska Clean Seas
ADEC	Alaska Department of Environmental Conservation
ADF&G	Alaska Department of Fish and Game
ADGC	Alaska Department of Government Coordination
ADNR	Alaska Department of Natural Resources
ADT	average daily traffic
AFB	Air Force Base
AFFF	aqueous film-forming foam
AFN	Alaska Federation of Natives
AK	Alaska
AKOSH	Alaska Occupational Safety and Health
ALOHA	Areal Locations of Hazardous Atmospheres
AMHS	Alaska Marine Highway System
AMM	asset maintenance management
ANCSA	Alaska Native Claims Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ANSI	American National Standards Institute
ANUA	Alaska Native Utilization Agreement
ANWR	Arctic National Wildlife Refuge
AO	Authorized Officer (Joint Pipeline Office)
AOGCC	Alaska Oil and Gas Conservation Commission
APHIS	Animal and Plant Health Inspection Service
API	American Petroleum Institute
APSC	Alyeska Pipeline Service Company
AQCR	Air Quality Control Region
AQRV	air-quality-related value
ARCO	Atlantic Richfield Company
ARRC	Alaska Railroad Corporation
ARRT	Alaska Regional Response Team
AS	Alaska Statute
ASME	American Society of Mechanical Engineers
ATV	all-terrain vehicle
BE	biological evaluation
BLM	Bureau of Land Management (U.S. Department of the Interior)
BLS	Bureau of Labor Statistics
BMP	best management practice
BOD	biochemical oxygen demand

BOD_5	biochemical oxygen demand measured over a five-day period
BP	British Petroleum
BPXA	British Petroleum Exploration (Alaska), Inc.
BS&W	basic sediments and water
BTEX	benzene, toluene, ethylbenzene, xylene
BTT	biological treatment tank
BWT	ballast water treatment
BWTF	Ballast Water Treatment Facility
BWTS	ballast water treatment system
CBR	Constitutional Budget Reserve
CBRF	Constitutional Budget Reserve Fund
CCP	Central Processing Plant
CDMS	Corrosion Data Management System
CEO	chief executive officer
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CMP	coastal management program
CNG	compressed natural gas
CO	carbon monoxide
CO_2	carbon dioxide
CP	Contingency Plan
CPF	Central Production Facility
CS	containment site
CSU	conservation system unit
CY	calendar year
CZ	coastal zone
CZM	coastal zone management
CZMA	Coastal Zone Management Act
DAF	dissolved air flotation
DBGC	designated big-game crossing
DCE	design contingency earthquake
DDT	dichloro-diphenyl-trichloro-ethane
DEIS	draft environmental impact statement
DHCMA	Dalton Highway Corridor Management Area
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
DOT	Department of Transportation
DOT/OPS	Department of Transportation, Office of Pipeline Safety
DRA	drag reducing agent
DRO	diesel-range organics
DS	drill site
DSMA	digital strong-motion accelerograph
EIA	Energy Information Administration
EFH	essential fish habitat
e.g.	exempli gratia (for example)
EGHP	exhaust-gas horsepower
EIA	Energy Information Administration
EIS	environmental impact statement
EMS	environmental monitoring system
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	environmental report
ERPG	emergency response planning guideline
ERV	Escort Response Vessel

ESA	Endangered Species Act
et al.	and others
FAA	Federal Aviation Administration
FACA	Federal Advisory Committee Act
FDA	U.S. Food and Drug Administration
FDS	Fire Dynamics Simulation (computer model)
Fe	iron
Fe_2O_3	ferric oxide
FEIS	final environmental impact statement
FR	Federal Register
FSIH	Fire Safety and Industrial Hygiene
FTE	full-time equivalent
GAO	General Accounting Office
GC	Gathering Center
GHG	greenhouse gas
GIS	geographic information system
GMU	Game Management Unit
GNOME	General NOAA Oil Modeling Environment
GRO	gasoline-range organics
GSP	gross state product
H_2O_2	hydrogen peroxide
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
HAZCORE	Hazardous Materials Consolidation and Redistribution
HAZMAT	hazardous material
HC	hydrocarbon
HCFC	hydrochlorofluorocarbon
HCl	hydrogen chloride
Hg	mercury
HRR	heat release rate
HVAC	heating, ventilation, and air conditioning
i.e.	that is (id est)
IMPROVE	Interagency Monitoring of Protected Visual Environments
IRIS	Integrated Risk Information System
IRT	Initial Response Team
ISC3	Industrial Source Complex Model (Version 3)
ISCST	Industrial Source Complex Short Term
IWSS	industrial wastewater sewer system
JPO	Joint Pipeline Office
L_{dn}	day-night average sound level
L_{eq}	equivalent steady sound level
LEFM	leading-edge flow meter
LNG	liquefied natural gas
LVB	line volume balance
MAP	Man in the Arctic Program
MCCF	mobile contingency camp facility
MCL	maximum contaminant level
MEI	maximally exposed individual
MEK	methyl ethyl ketone
MGV	manual gate valve
MLA	Mineral Leasing Act

MLR	Mainline Refrigeration
MMC	Marine Mammal Commission
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MOA	memorandum of agreement
MP	milepost
MSDS	Material Safety Data Sheets
MSFCMA	Magnuson-Stevens Fisheries Conservation and Management Act
MSGP	Multi-Sector General (NPDES) Permit
MSWLF	municipal solid waste landfill
N	nitrogen
NAAQS	National Ambient Air Quality Standards
NADP	National Atmospheric Deposition Program
NAICS	North American Industry Classification System
NANA	Northwest Alaska Native Association
NEPA	National Environmental Policy Act
NF	National Forest
NFRAP	no further remedial action planned
NGL	natural gas liquid
NH_3	ammonia
NHPA	National Historic Preservation Act
NMDS	National Missile Defense System
NMFS	National Marine Fisheries Service
no.	number
NO_x	nitrogen oxides
NO_2	nitrogen dioxide
NO_3^-	nitrate
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of Disposal
NOI	Notice of Intent
NORM	naturally occurring radioactive material
NP	national park
NPDES	National Pollutant Discharge Elimination System
NPP	national park and preserve
NPR	National Petroleum Reserve
NPR-A	National Petroleum Reserve-Alaska
NPS	National Park Service
NRA	national recreation area
NRHP	National Register of Historic Places
NS	North Slope
NSB	North Slope Borough
NSC	National Safety Council
NSPTS	North Slope Production and Transportation System
NWR	national wildlife refuge
NWS	National Weather Service
O_3	ozone
O&M	operation and maintenance
OCC	Operations Control Center
OCS	Outer Continental Shelf
ODC	ozone-depleting chemical
ODP	ozone-depleting potential
ODS	ozone-depleting substance
OMB	Office of Management and Budget
OMS	operational material site
OPA	Oil Pollution Act
OPS	Office of Pipeline Safety (U.S. Department of Transportation)

ORC	oxygen-releasing compound
ORV	off-road vehicle
OSHA	Occupational Safety and Health Administration
OSHTF	(Alaska) Oil Spill Health Task Force
OSPPR	Oil Spill Prevention, Preparedness, and Response
OSV	oil spill volume
P	phosphorus
PA	Programmatic Agreement
PAH	polycyclic aromatic hydrocarbon
PAI	Phillips Alaska, Inc.
Pb	lead
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PDF	pipeline design flood
PELs	permissible exposure limits
PF	Permanent Fund
PG	Pasquill-Gifford
pH	hydrogen ion concentration
P.L.	Public Law
PM	particulate matter
$PM_{2.5}$	particulate matter with a diameter less than or equal to 2.5 micrometers
PM_{10}	particulate matter with a diameter less than or equal to 10 micrometers
PMP	probable maximum precipitation
PO_4^{3-}	phosphate
POP	persistent organic pollutant
POTW	publicly owned treatment works
PPE	personal protective equipment
PPV	peak particle velocity
PRT	prevention and response tug
PS	pump station
PSD	Prevention of Significant Deterioration
PWS	Prince William Sound
QA	quality assurance
RCM	reliability-centered maintenance
RCRA	Resource Conservation and Recovery Act
REAA	Regional Educational Attendance Area
RGV	remote gate valve
RMP	Resource Management Plan
ROD	Record of Decision
ROS	recreation opportunity spectrum
ROW	right-of-way
RRO	residual-range organics
RSC	reduced sulfur compounds
SARA	Superfund Amendments and Reauthorization Act
SCADA	supervisory control and data acquisition
SD	standard deviation
SDWA	Safe Drinking Water Act
SERVS	Ship Escort/Response Vessel System
SHPO	State Historic Preservation Officer
Si	silicon
SIC	Standard Industrial Classification
SIP	state implementation plan
SO_2	sulfur dioxide
SO_x	sulfur oxides

SPC	State Pipeline Coordinator
spp.	species
SRS	state recreation site
Stat.	statute
SWDS	solid waste disposal site
SWPPP	Storm Water Pollution Prevention Plan
SWTP	sanitary waste treatment plant
TAPAA	Trans-Alaska Pipeline Authorization Act
TAPS	Trans-Alaska Pipeline System
TAGS	Trans-Alaska Gas System
TCA	1,1,1-trichloroethane
TCP	traditional cultural property
TEEL	temporary emergency exposure limit
TEF	toxic equivalency factor
TLV	threshold limit value
TPQs	Threshold Planning Quantities
TRI	Toxics Release Inventory
TSDF	treatment storage and disposal facility
TSP	total suspended particulates
TSS	total suspended solids
TVB	transient volume balance
TVR	tanker vapor recovery
UAA	University of Alaska-Anchorage
UIC	underground injection control
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	United States Coast Guard
USDA	U.S. Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UV	ultra-violet
VAHS	Valdez Air Health Study
VHF	very high frequency
VHS	viral hemorrhagic septicemia
VMT	Valdez Marine Terminal
VOC	volatile organic compound
VRM	visual resource management
VSM	vertical support member
VTS	Vessel Traffic Service
WSR	Wild and Scenic River
ZRAs	Zone of Restricted Activities

Units of Measure

acre-ft	acre-foot (feet)
bbl	barrel(s)
Btu	British thermal unit(s)
°C	degrees centigrade
cm	centimeter(s)
cm^3	cubic centimeters
cSt	centistoke(s)
d	day
dB	decibel(s)
dBA	A-weighted decibel(s)
°F	degrees Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
ft^3	cubic foot (feet)
g	gravitational acceleration
gal	gallon(s)
GW	gigawatt(s)
h	hour(s)
ha	hectare(s)
hp	horsepower
in.	inch(es)
$in.^2$	square inch(es)
j	joule(s)
K	kelvin degree(s)
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
knot	nautical mile(s) per hour
kW	kilowatt(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
mg	milligram(s)
mi	mile(s)
mi^2	square mile(s)
min	minute(s)
mL	milliliter(s)
mm	millimeter(s)
mmole	millimole(s)
mph	mile(s) per hour
MW	megawatt(s)
MYA	million years ago
ng	nanogram(s)
pCi	picocurie(s)
ppb	part(s) per billion
ppm	part(s) per million
psi	pound(s) per square inch
psig	pound(s) per square inch gauge
rpm	revolution(s) per minute
s	second(s)
scf	standard cubic foot (feet)
scfm	standard cubic foot (feet) per minute
wk	week(s)
YA	years ago
yd	yard(s)
yd^3	cubic yards
yr	year(s)
µg	microgram(s)
µg-atoms	microgram-atoms
µm	micrometer(s)
µmole	micromole(s)
µR	microroentgen(s)
$/bbl	dollar per barrel

4.7 Cumulative Effects

4.7.1 Introduction

4.7.1.1 Approach

Cumulative effects result from the incremental impact of the proposed action and alternatives when added to other past, present, and reasonably foreseeable future actions, regardless of what government agency or private entity undertakes such actions. Cumulative effects can result from individually minor impacts that when viewed collectively over space and time can produce significant impacts.

Cumulative Effects

These effects constitute the impact on the environment that results from the incremental impact of the action under consideration when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions (40 CFR 1508.7).

The approach used in this cumulative impact assessment is to first evaluate the cumulative impacts of all actions, including the proposed action and other reasonably foreseeable future actions. Then the degree to which the proposed action contributes to those impacts is presented. Finally, the cumulative impacts of the alternatives (less-than-30-year renewal and no action), together with other reasonably foreseeable actions, are discussed and compared with cumulative impacts of the proposed action of all other actions.

For this DEIS, the relationship of the proposed action to the no action alternative is reversed from the usual situation found in NEPA analyses of proposed actions for new facilities or new plans. For this DEIS, the proposed action is reauthorization, and the potential impacts would be largely related to forecasts of future continuing operations of an existing system. At the time of grant expiration, this system will have been in operation for 30 years, and its impacts have received continuous study. For this DEIS, the no-action alternative (the alternative in which the responsible agency takes no action) addresses a new action, which is to cease operating and remove the existing system. No action has not received engineering and environmental study and its description remains somewhat speculative. No action involves many major activities, including construction-like activities; removal of facilities would require a large workforce and generate large amounts of wastes, and other industries that depend upon the TAPS operation would be affected. The assessment of the no-action alternative in Section 4.6 concludes that in most cases, the environmental impacts of the no-action alternative would result in a greater change in impacts to the existing environment than the impacts of the proposed action. Where this cumulative impact assessment (Section 4.7) differs from the earlier impact sections, is that the resultant effect of no action on other reasonably foreseeable future actions is also considered in the impact assessment. The operation of the TAPS supports and is a requirement for other ongoing activities, and is an integral part of the Alaskan economy.

4.7.1.2 Method

The analysis of cumulative impacts focuses on specific human resources or environmental receptors that can be affected by the incremental impacts. Generally, the geographic area for a cumulative impact analysis is defined by the specific resource or receptor of concern and the spatial extent of the interacting (cumulative) impact generators. The temporal extent of the cumulative analysis extends from the past history of impacts to each receptor through the anticipated life of the project, including additional time necessary for decommissioning and restoration, if appropriate.

Cumulative impact analysis, by definition, incorporates an extensive range of potential stressors and thus provides a decision maker

and the public with an overview of the condition (past, present, future) of a receptor or resource within a regional or landscape context. A broader overview of the set of potential impacts to a resource allows the decision maker to place the direct and indirect impacts of the proposed action within the context of other potential stressors.

The Council on Environmental Quality discussed the assessment of cumulative effects in detail in its report entitled *Considering Cumulative Effects under the National Environmental Policy Act* (CEQ 1997). Although it is not formal guidance, the handbook provides assistance in developing an analysis. The handbook identifies 10 steps for assessing cumulative impacts prior to implementation of a proposal. In the words of the handbook, these steps are listed here and in Figure 4.7-1.

1. Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals.

2. Establish the geographic scope for the analysis.

3. Establish the time frame for the analysis.

4. Identify other actions affecting the resources, ecosystems, and human communities of concern.

5. Characterize the resources, ecosystems, and human communities identified during scoping in terms of their response to change and capacity to withstand stresses.

6. Characterize the stresses affecting these resources, ecosystems, and human communities and their relation to regulatory thresholds.

7. Define baseline conditions for the resources, ecosystems, and human communities.

8. Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities.

9. Determine the magnitude and significance of cumulative effects.

10. Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects.

The approach used for the cumulative impact assessment discussed in this DEIS includes the 10 steps identified in the CEQ approach (Figure 4.7-1). Cumulative effect issues were initially identified during scoping and in consultations with Alaska Native groups (Step 1), as discussed in Chapters 1 and 2. Additional issues and actions were added later as they were identified. Next in the analysis, the region of interest (Step 2) and the time frame (Step 3) were established. Then other actions that previously had, now have, or would have similar impacts to those of the proposed action were identified (Step 4). The affected environment described in Chapter 3 was used to characterize the resources, ecosystems, and human communities of concern (Step 5); characterize the stresses affecting these elements (Step 6); and establish baseline conditions (Step 7). Both the proposed action and these other actions were found to generate factors that could cause impacts to the physical, ecological, human, and/or economic environment. These individual contributions were evaluated (Step 8) and aggregated, and it is this aggregate (the total contributions from all actions to the impacting factor) that was used to assess the cumulative effect (Step 9). In cases where the contributions of individual actions to an impacting factor were uncertain or not well known, a qualitative evaluation of cumulative impacts was necessary. A qualitative evaluation of cumulative effects covered the locations of actions, times they occurred, degrees to which the impacted resource is at risk, and potential for long-term or synergistic effects. Recommendations for future modifications to the alternatives and the means for future monitoring or mitigation of effects were identified if needed (Step 10). A further discussion of the approach used for cumulative effects analysis is found in Appendix A, Section A.16.

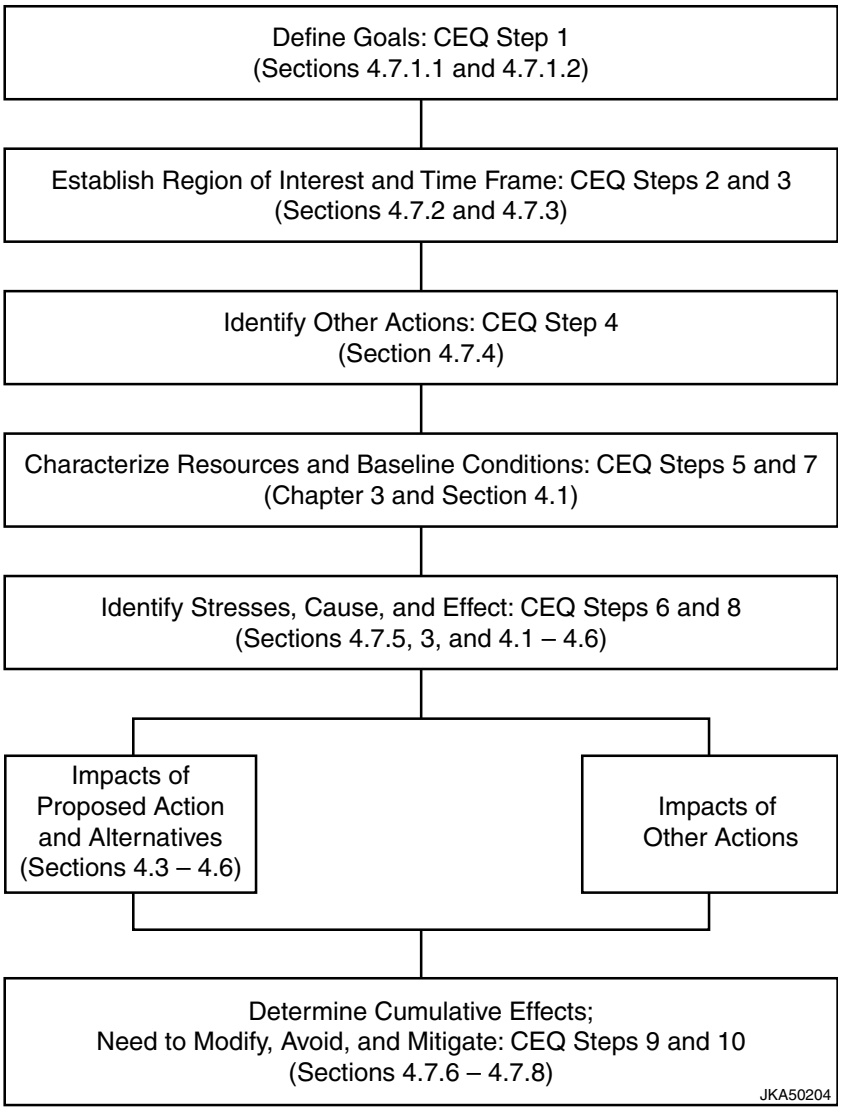

FIGURE 4.7-1 Cumulative Assessment Approach for This DEIS

4.7.2 Regions of Interest

In order to determine which actions should be included in a cumulative effects analysis in this DEIS, the region of interest must first be defined. This region should not be limited to just the location of the proposed action but should also take into account the distance that effects may travel and the regional characteristics of the affected resources.

The cumulative impact analysis in this DEIS considers past, present, and future actions that previously occurred, occur now, or are expected to occur near the TAPS or within the areas affected by the TAPS. Table 4.7-1 summarizes the regions of interest examined for cumulative effects for different subjects. For the purposes of the physical and ecological environment analyses in this DEIS, these areas include the (1) Beaufort Sea, (2) North Slope, (3) Interior Alaska, and (4) Prince William Sound regions (Figure 4.7-2). Actions and impacts in the Beaufort Sea and North Slope are described for an area extending from Barrow in the west to the U.S./Canadian border (east of the Arctic National

TABLE 4.7-1 Regions of Interest for the Cumulative Assessment

	Beaufort Sea/ Alaska North Slope	Interior/ TAPS ROW	Prince William Sound/Valdez	State of Alaska
Soils and permafrost	X	X		
Sand, gravel, and quarry resources	X	X		
Paleontology	X	X	X	
Surface water resources	X	X	X	
Groundwater resources	X	X	X	
Physical marine environment			X	
Air quality	X	X	X	
Noise	X	X	X	
Transportation	X	X		
Wastes	X	X	X	
Human health and safety	X	X	X	
Terrestrial vegetation and wetlands	X	X	X	
Fish	X	X	X	
Birds and mammals	X	X	X	
Threatened and endangered species	X	X	X	
Subsistence	X	X	X	
Sociocultural systems	X	X	X	
Economics				X
Cultural resources	X	X	X	
Land use and coastal zone management	X	X	X	
Recreation, wilderness, and northshore	X	X	X	
Environmental justice	X	X	X	

Wildlife Refuge [ANWR]) in the east and from the Beaufort Sea in the north to the crest of the Brooks Range in the south. This area includes the ranges of migratory mammal species that could be impacted by the TAPS and by North Slope petroleum development activities, and it also includes communities that would be affected by impacts to these important subsistence resources and by employment impacts (Figure 4.7-3). Interior Alaska includes areas adjacent to the TAPS, from the crest of the Brooks Range in the north to Thompson Pass near Valdez in the south. It also includes nearby portions of the Yukon River drainage west of the TAPS because they might be affected by a petroleum spill (Figure 4.7-4). With regard to the fourth area, Prince William Sound and land next to it, this area is affected by activities at the end of the TAPS, including activities associated with the Valdez Marine Terminal and tanker transport of oil through the sound. Tanker routes from Prince William Sound to the U.S. West Coast and to the Eastern Pacific are included for the purpose of addressing the potential impacts of oil transportation on marine resources (Figure 4.7-5).

For the purposes of the economic analysis in this DEIS, the region of interest for cumulative impact analysis is considered to be the entire State of Alaska. This is because the economic implications of the TAPS and North Slope petroleum development are statewide. In addition, a natural gas transportation pipeline would also have impacts on the state's economy through employment, expenditures, and fees.

Click here to view Figure 4.7-2

FIGURE 4.7-2 General Regions of Interest in Alaska for Cumulative Effects to Physical and Ecological Resources from the TAPS and Other Actions

Click here to view Figure 4.7-3

FIGURE 4.7-3 Areas and Locations in the Beaufort Sea and North Slope Regions

Click here to view Figure 4.7-4

FIGURE 4.7-4 Areas and Locations in Interior Alaska

Click here to view Figure 4.7-5

FIGURE 4.7-5 Areas and Locations in the Prince William Sound Region

4.7.3 Time Frames of Actions

4.7.3.1 Reasonably Foreseeable Future Actions

A cumulative impact analysis should incorporate the sum of the effects of past, present, and future actions, because the past influences the future, and impacts may accumulate or develop over time. The future actions specifically and generally described in this cumulative analysis are those that are "reasonably foreseeable." As a general rule, time frames for these actions fall within a planning horizon of less than the proposed action. These actions have either already occurred, are ongoing, are currently being implemented, are funded for future implementation, or are included in firm near-term plans. They are discussed further in Section 4.7.4. Types of proposals with firm near-term plans include these:

1. Proposals for which NEPA documents are in preparation or finalized;
2. Proposals in a detailed design phase;
3. Proposals listed in formal Notices of Intent published in the *Federal Register* or state publications;
4. Proposals that are funded;
5. Proposals for which enabling legislation has been passed; and
6. Proposals that have been submitted to federal and state regulators to begin the permitting process.

4.7.3.2 Proposals Considered but Excluded

Proposals that are in early stages of development and potential projects described in long-range planning documents are considered uncertain and speculative. These include the high-visibility and controversial proposal currently being discussed in Alaska and throughout North America for oil and gas production in the ANWR. The other proposal is for the construction and operation of a natural gas pipeline along a northern route through the Beaufort Sea into the Mackenzie Delta and from there to southern Canada and the United States. The proposal to develop oil and gas production in ANWR, while it has strong proponents, is currently not feasible under existing regulations and laws. This proposal has not reached a state of development where legislative approval, regulatory review, funding, or permitting has begun. The proposal for a natural gas pipeline from the North Slope oil fields into the Mackenzie Delta would not be permitted under existing Alaska regulations dealing with rights-of-way through state lands. Neither of these proposals is considered in this cumulative effects analysis.

One other proposal, which would otherwise have been included in this cumulative effect analysis because environmental analysis has been completed, is also considered uncertain and speculative at this time. This is the Liberty Project, designed to develop offshore oil reserves in the Beaufort Sea. It no longer has the support of its proponent.

4.7.4 Types of Actions

Table 4.7-2 lists the potential cumulative actions considered in this TAPS DEIS. In developing this list, descriptions and proposals prior to April 1, 2002 were used. These actions include those of various federal and state agencies, communities, and individuals. The actions listed in the table include past, present, and future actions in the region of interest. Both actions related to the TAPS and actions unrelated to TAPS are described. Uncertain or speculative actions are not required to be included. Cumulative effects are not limited to the actions of one agency, one type of organization, or individuals. Because several agencies or individuals can create a similar type of environmental effect, all agencies and individuals having the same effect are included.

The actions listed in Table 4.7-2 are listed by region. Because actions in the Beaufort Sea, on the shore, or in upland North Slope areas might affect more than one of these areas, they are

TABLE 4.7-2 Potential Contributions to Cumulative Effects in the Beaufort Sea, North Slope, Interior Alaska, and Prince William Sound

Type of Action	Beaufort Sea/North Slope	Interior	Prince William Sound
Oil and gas exploration, development, and production	• Locations (producing and undeveloped) - Alpine - Badami - Burger - Cascade - Colville Delta-North (Nanuq) - Colville Delta-South (fiord) - East Barrow - East Kurupa - East Umiat - Eider - Endicott - Fish Creek - Flaxman - Gubik - Gwydyr Bay - Hammerhead - Hemi Springs - Kavik - Kalubik - Kuvlum - Kuparuk River - Lisburne - Meade - Mikkelson - Midnight Sun - Milne Point - Niakuk - North Prudhoe Bay - Northstar - Prudhoe Bay - Pt. McIntyre - Pt. Thomson - Sag Delta - Sag Delta North - Sagavanirktok River - Sandpiper - Schrader Bluff - Sikulik - Simpson - South Barrow - Sourdough - Square Lake - Stinson - Tabasco - Tarn - Thetis Island - Ugnu - Umiat - Walakpa - West Beach - West Sak - Wolf Creek • Facilities and infrastructure - Central production facilities (CPFs) - Gas processing plants - Seawater treatment plants - Carrier pipelines - Power plants - Service industries at Deadhorse - Gravel sources - Roads - Landing strips - Waste treatment	• Locations (undeveloped) - Copper River - Mid-Tanana	• None

TABLE 4.7-2 (Cont.)

Type of Action	Beaufort Sea/North Slope	Interior	Prince William Sound
Oil refining	• Prudhoe Bay • Kuparuk	• Williams Alaska Petroleum (North Pole) • Petro Star (North Pole)	• Petro Star (Valdez)
Oil and refined product storage	• TAPS pump stations • Prudhoe Bay • Kuparuk • Communities	• Williams Terminal (Fairbanks International Airport) • TAPS Pump Stations • Communities	• Valdez Marine Terminal • Communities
Oil and gas transportation	• TAPS • Natural gas pipeline • Carrier pipelines • Fuel transfer from barges and other vessels	• TAPS • Natural gas pipeline • Interconnections of the TAPS to Williams and Petro Star Refineries (North Pole)	• TAPS • Interconnection of the TAPS to Petro Star Refinery • Valdez Marine Terminal • Oil tanker operations • Natural gas pipeline
Human habitation and development	• Towns and villages - Anaktuvuk Pass - Atqasuk - Barrow - Deadhorse - Kaktovik - Nuiqsut • North Slope Borough	• Cities, towns, villages - Arctic Village - Beaver - Chalkyitsik - Chicken - Chistochina - Chitina - Coldfoot and Wiseman - Copper Center - Delta Junction - Eagle - Evansville/Bettles - Fort Yukon - Gakona	• Cities, towns, villages - Chenega Bay - Cordova - Eyak - Tatitlek - Tonsina - Valdez - Whittier • Kenai Peninsula - Borough

TABLE 4.7-2 (Cont.)

Type of Action	Beaufort Sea/North Slope	Interior	Prince William Sound
Human habitation and development (Cont.)		- Glennallen - Gulkana - Livengood - Manley Hot Springs - McCarthy - Paxson - Rampart - Slana - Stevens Village - Tanana - Venetie • Fairbanks-North Star Borough	
Transportation	• Air fields and strips • Dalton Highway • Private and commercial watercraft	• Air fields and strips • Railroads • Alaska Highway • Dalton Highway • Richardson Highway • Other roads • Private and commercial watercraft	• Air fields and strips • Railroads • Roads • Marine Terminals • Alaska Marine Highway • Personal and commercial - Watercraft - Fishing vessels - Tour boats - Container and bulk carriers

TABLE 4.7-2 (Cont.)

Type of Action	Beaufort Sea/North Slope	Interior	Prince William Sound
Legislative actions related to land use	• Alaska Native Claims Settlement Act • Alaska National Interest Lands Conservation Act • Federal Coastal Zone Management Act • Alaska Coastal Zone Management Act	• Alaska Native Claims Settlement Act • Alaska National Interest Lands Conservation Act	• Alaska Native Claims Settlement Act • Alaska National Interest Lands Conservation Act • Federal Coastal Zone Management Act • Alaska Coastal Zone Management Act • Prince William Sound Regional Advisory Board
Land management	• U.S. Department of the Interior • North Slope Borough (Coastal Zone Management Program and Comprehensive Plan) • Native corporations	• U.S. Department of the Interior • U.S. Department of Agriculture • Alaska Department of Natural Resources • Dalton Highway Advisory Board • Military - Ft. Greely (Delta Junction) - Ft. Wainwright (Fairbanks) - Eielson Air Force Base (near Fairbanks) • North Star Borough • Native corporations	• U.S. Department of the Interior • U.S. Department of Agriculture • Alaska Department of Natural Resources • Military • City of Valdez • Native corporations

TABLE 4.7-2 (Cont.)

Type of Action	Beaufort Sea/North Slope	Interior	Prince William Sound
Natural resource use	• Subsistence • Recreational development - Tourism - Hunting and fishing • Mining (gravel)	• Subsistence • Recreational development - Tourism - Hunting, fishing - Pipeline viewing areas - Campgrounds - Boat launches - Visitor centers • Commercial development • Commercial fishing • Mining (minerals, gravel) • Logging	• Subsistence • Recreational development - Tourism - Hunting, fishing - Pipeline viewing areas - Campgrounds - Boat launches, harbors - Visitor centers • Commercial development • Commercial fishing • Mining (minerals) • Logging
Petroleum spills	• Production and exploration • Transportation	• Transportation	• Transportation

listed together. However, when appropriate, certain cumulative impact analyses may consider impacts in the Beaufort Sea and the North Slope separately, depending on the distribution of the affected resources. Similar actions have been grouped together and listed by type in Table 4.7-2. Included are various actions associated with the petroleum industry, human habitation (these actions include various human and industrial activities), transportation, legislation affecting land control and use, land management activities and plans, natural resource use, and petroleum spills.

4.7.4.1 Oil and Gas Exploration, Development, and Production

4.7.4.1.1 Resources. Oil and gas exploration, development, and production have been ongoing for a number of years on the North Slope (see Figure 4.7-6). The state of Alaska currently estimates that the North Slope oil reserves contain 12.8 billion bbl (ADNR 2000). The federal government estimates that an additional 22.5 billion bbl of oil and 22.5 trillion ft^3 of natural gas are contained in the Arctic Outer Continental Shelf. An estimated 2.1 billion bbl of oil and 8.5 trillion ft^3 of gas are contained in NPR-A, and between 5.7 and 16 billion bbl of oil are contained in structures under the coastal plain of ANWR. While development within ANWR cannot be assumed, it is likely that oil and gas exploration, development, and production will continue on the North Slope, including NPR-A and offshore.

Current and projected oil and gas exploration, development and production are summarized in Table 4.7-3 (National Energy Policy Development Group 2001). In addition to the areas listed in the table, the Mid-Tanana and Copper River Basins in the Interior Alaska are being studied to determine their oil and gas potential, and lease sales are planned.

4.7.4.1.2 Facilities and Infrastructure. Petroleum production involves a number of ancillary facilities and supporting infrastructures, including well pads, gas processing plants, seawater treatment plants, carrier pipelines, power plants, gravel sources, roads, landing strips, and service industries. Oil development and production sites on the North Slope and in the Beaufort Sea use different technologies as a function of the time they were constructed and their remoteness from existing logistics sites. However, a generalized diagram is presented in Figure 4.7-7. Over the 35-year interval since the first wells were drilled at Prudhoe Bay, the technology and operating practices have changed considerably, resulting in a reduction in the size of the sites. Facilities enabled in remote locations, such as offshore, vary in configuration from those closer to principal infrastructure centers.

Future producing sites would be connected via a pipeline to the oil transfer network linked with the TAPS. The fields in the Prudhoe Bay area are serviced via the road network in that area. Nearshore operations, such as Endicott, are connected to the road network via causeways. Offshore operations, such as North Star, and potential new fields in the Beaufort Sea are or would be connected to shore only by air and marine transport. The newer onshore fields outside the existing road network, such as Alpine, are not connected to other oil fields by a permanent gravel road; instead, winter ice roads are used to move heavy equipment and materials. Aircraft and marine transport, where practical, are used to transport changing crews and lighter cargo items.

Well pads are gravel pads containing the wellheads and the equipment and personnel required to get oil out of the ground into gathering lines, to processing facilities, then into carrier pipelines. Drill sites (or production stations) are both individually smaller and fewer in number to produce a given deposit. Well spacing is tighter, both because drilling technology has improved and because earlier concerns about potential well damage caused by permafrost melting have been resolved. A wider subsurface area can now be reached from a single surface location through directional drilling, and multilateral and horizontal drilling techniques expand the oil reservoir that can be reached by a single well. Theoretically, a single drill site of 13 acres which is large even by

Prudhoe Bay standards could cover a subsurface area that is 8 mi in diameter (more than 32,000 acres) (National Energy Policy Development Group 2001). Drill sites today on the North Slope are much less than this hypothetical figure.

Site-specific conditions and available technology dictate the facilities' requirements and the size of the site footprint. Small fields with a single production pad and airstrip could have a footprint of approximately 50 acres. Larger fields with multiple pads and service roads could have footprints of up 200 acres. The newer production sites have well spacings of 10 to 20 ft on a pad (well spacings for older sites were 120 to 160 ft). Some of these wells are needed for reinjecting gas, water, or other fluids into the oil reservoir to improve oil recovery or for disposal of produced water into other authorized formations. The number of wellheads per production pad is determined by the economics and geology associated with developing the oil reservoir.

The number of pads needed depends on the methods of drilling and the depth to the oil reservoir. Conventional, vertically drilled wells have a horizontal distance (reach)-to-depth ratio of 1:1. Thus, for a reservoir at a depth of 8,000 ft, the reach for each pad would be 8,000 ft, so the production pads would be separated by roughly 16,000 ft. Currently, the greatest reach-to-depth ratio on the North Slope is 2:1. It occurs at a well in the Niakuk field (ratio of 18,098-ft reach to an oil reservoir depth of 9,445 ft) (BLM 1998).

A central production center (CPF) (also known as a flow station [Prudhoe Bay] or fathering center [western operating area]) manages well production and produces sales-quality crude oil by separating oil, water, and gas. In addition to oil production equipment, the CPF or nearby areas commonly include living quarters, eating and recreational areas, administrative areas, maintenance shops, vehicle parking, fuel and water storage tanks, power generators, wastewater management facilities, and a communications center. The types of services provided at a CPF, its crew size, and the size of its facilities depend on the size of the operations and the CPF's proximity to existing logistical support. Buildings are supported on pilings to mitigate ground settling or frost heaving. Production equipment includes oil, gas, and water separators and other equipment that condition and transport the oil and that manage the water and gas that have separated from the oil. Each oil-gas-water separation facility is equipped with gas detection, fire, and trouble alarm systems; several fire suppression systems; and fire water storage tanks. Each facility can also flare natural gas when the need arises to rapidly shut down a facility (BLM 1998; BP 2002a).

The maintenance of existing oil fields and the development of new fields require continued support activities, including the extraction of gravel from borrow areas and the use of local water supplies, except where salt water can be used. To maintain existing facilities, these resources would likely be used at the current rate. The pace of new development would determine if additional personnel and logistics support beyond the current levels would be needed on the North Slope. However, new development would require the transport of additional equipment and materials to, and within, the North Slope and Beaufort Sea areas.

It is possible that sources of gravel for the development of new fields in the NPR-A may be limited to existing sources, although gravel requirements for NPR-A development have not been established. Gravel might have to be transported from borrow pits used by the existing oil fields, roadways, and the TAPS. However, the gravel need within the NPR-A has not been quantified, and the possibility exists that locally generated crushed rock and other materials could substitute for gravel (BLM 1998). In the vicinity of Prudhoe Bay and along the TAPS, numerous material sites provide gravel. Gravel sources include state-permitted deposits near the rivers and stream that parallel the TAPS (e.g., Sagavanirktok River, Atigun River, and Kuparuk River.

The reservoirs tapped by the North Slope wells are under pressure. To increase the oil recovered, other wells are drilled to inject water or gas into the field to maintain the pressure within the reservoirs. Gas is produced from the well with the oil and is reinjected into the reservoir. Water is obtained from the water extracted with the oil and from water wells and surface sources. Seawater may be used as a

Click here to view Figure 4.7-6, page 1

FIGURE 4.7-6 Oil and Gas Development on the North Slope over Time

Click here to view Figure 4.7-6, page 2

FIGURE 4.7-6 (Cont.)

Click here to view Figure 4.7-6, page 3

FIGURE 4.7-6 (Cont.)

Click here to view Figure 4.7-6, page 4

FIGURE 4.7-6 (Cont.)

Click here to view Figure 4.7-6, page 5

FIGURE 4.7-6 (Cont.)

TABLE 4.7-3 Oil Fields Located in Alaska and the Arctic Outer Continental Shelf

Field	Unit	Product	Status	Operator	Began Production	Projected End of Production
Alpine	Colville River	Oil	Producing	Phillips Alaska, Inc.	2000	
Badami	Badami	Oil and gas	Producing	BP Exploration (Alaska), Inc.	1998	2008
Burger	Outer Continental Shelf	Oil and gas	Undeveloped	Shell		
Cascade	Milne Point	Oil	Producing	BP Exploration (Alaska), Inc.	1996	
Colville Delta	Colville	Oil	Undeveloped	Phillips Alaska, Inc.		
East Barrow		Gas	Producing	North Slope Borough	1981	
East Kurupa		Gas	Undeveloped			
East Umiat		Gas	Shut	UMC Petroleum		
Eider	Duck Island	Oil	Producing	BP Exploration (Alaska), Inc.	1998	
Endicott	Duck Island	Oil	Producing	BP Exploration (Alaska), Inc.	1987	
Fiord	Colville River	Oil	Undeveloped	Phillips Alaska, Inc.		
Fish Creek	NPR-A	Oil	Undeveloped			
Flaxman	Point Thomson	Oil	Undeveloped	ExxonMobil		
Gubik		Gas	Undeveloped			
Gwydyr Bay		Oil	Undeveloped	BP Exploration (Alaska), Inc.		
Hammerhead	Outer Continental Shelf	Oil	Undeveloped	Chevron		
Hemi Springs		Oil	Undeveloped			
Kalubik		Oil	Undeveloped	Phillips Alaska, Inc.		
Kavik		Gas	Undeveloped	Phillips Alaska, Inc.		
Kuparuk River	Kuparuk River (Greater Kurak Area) Kura	Oil and gas	Producing	Phillips Alaska, Inc.	1981	
Kuukpik	Kuukpik	Oil and gas	Exploration	Phillips Alaska, Inc.		
Kuvlum	Outer Continental Shelf	Oil	Undeveloped	Chevron		
Liberty	Outer Continental Shelf	Oil	Undeveloped	BP Exploration (Alaska), Inc.		
Lisburne	Prudhoe Bay	Oil and gas	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1986	
Meade	NPR-A	Gas	Undeveloped			
Midnight Sun	Prudhoe Bay	Oil	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.		
Mikkelson		Oil	Undeveloped	ExxonMobil; Phillips Alaska, Inc.		

TABLE 4.7-3 (Cont.)

Field	Unit	Product	Status	Operator	Began Production	Projected End of Production
Milne Point	Milne Point	Oil and gas	Producing	BP Exploration (Alaska), Inc;	1985	
Niakuk	Prudhoe Bay	Oil	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1994	
North Prudhoe Bay	Prudhoe Bay	Oil and gas	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1993	2006
Northstar	Northstar	Oil and gas	Producing	BP Exploration (Alaska), Inc;	2001	2015
Point McIntyre	Prudhoe Bay	Oil and gas	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1993	
Point Thomson		Oil and gas	Undeveloped	ExxonMobil		
Prudhoe Bay	Prudhoe Bay	Oil	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1977	
Sag Delta North	Duck Island	Oil	Producing	BP Exploration (Alaska), Inc.	1989	
Sagavanirktok River	Milne Point	Oil	Producing	BP Exploration (Alaska), Inc.	1994	
Sandpiper	Outer Continental Shelf	Oil	Undeveloped	Murphy		
Schrader Bluff	Milne Point	Oil and gas	Producing	BP Exploration (Alaska), Inc.	1991	
Sikulik		Gas	Undeveloped	North Slope Borough		
Simpson	NPR-A	Oil	Undeveloped			
Sourdough	Point Thomson	Oil	Undeveloped	BP Exploration (Alaska), Inc.		
South Barrow		Gas	Producing	North Slope Borough		
Square Lake	NPR-A	Gas	Undeveloped			
Stinson		Oil	Undeveloped	Phillips Alaska, Inc.		
Tabasco	Kaparuk River (Greater Kurak Area) Kura	Oil and gas	Producing	Phillips Alaska, Inc.	1999	
Tarn	Kaparuk River (Greater Kurak Area) Kura	Oil and gas	Producing	Phillips Alaska, Inc.	1999	
Thetis Island		Oil	Undeveloped	Anardarko		
Ugnu	Kaparuk River (Greater Kurak Area) Kura	Oil	Undeveloped	Phillips Alaska, Inc.		

TABLE 4.7-3 (Cont.)

Field	Unit	Product	Status	Operator	Began Production	Projected End of Production
Umiat		Oil	Producing	U.S. Department of the Interior		
Walakpa		Oil	Producing	North Slope Borough	1992	
West Beach	Prudhoe Bay	Oil and gas	Producing	BP Exploration (Alaska), Inc.; Phillips Alaska, Inc.	1994	2016
West Sak	Kuparuk River (Greater Kurak Area) Kura	Oil	Producing	Phillips Alaska, Inc.	1998	
Wolf Creek	NPR-A	Gas	Undeveloped			

Source: ADNR (2000).

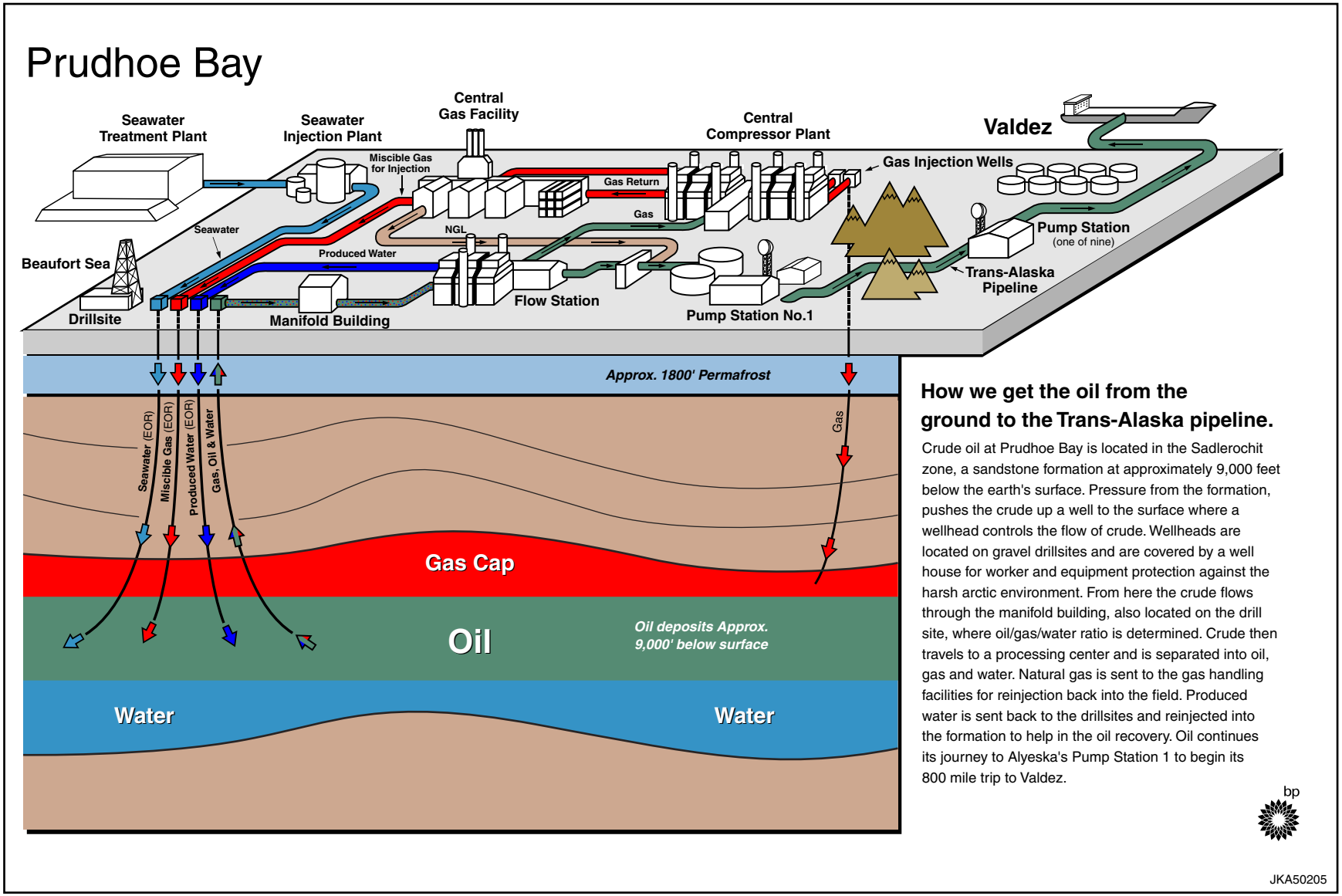

FIGURE 4.7-7 Generalized Schematic of Prudhoe Bay Oil Production (Source: BP 2002c)

water source for sites where it is practical to construct a seawater intake, treatment plant, and insulated pipeline delivery system. A Prudhoe Bay pressure maintenance program that included seawater injection into the reservoir was initiated in 1984. The scope of the $2 billion program includes a distribution system, seawater treatment plant, and pumping systems. Today, produced water has increased in volume and has largely replaced seawater as a secondary recovery fluid.

The need for water for new development and production would be met from local freshwater supplies or seawater. The water supplies currently used by the existing oil fields and TAPS would not be affected. However, wastewater would likely be placed in existing EPA-approved injection wells that are used by the existing oil fields and TAPS facilities.

Similarly, solid waste management facilities used by existing oil fields and TAPS would likely be used in new development and production (BLM 1998). Waste generation rates would likely be similar to the rates of existing facilities. Today, for existing fields as well as new development, grinding and subsurface injection are used to dispose of drilling muds and cuttings after sand and gravel have been reclaimed for reuse (BLM 1998). This practice reduces the amount of oil field waste. The total quantities of wastes generated from new oil fields cannot currently be predicted because the extent of the new development and production cannot be predicted.

BP operates a Central Compression Plant and Central Gas Facility on the North Slope. This facility is devoted primarily to processing and handling the enormous quantities of natural gas produced by oil wells in Prudhoe Bay. This gas is then reinjected into the reservoir. In addition, this facility provides compressed natural gas (CNG) for fueling trucks and other vehicles. The facility is designed to fuel 20 vehicles per hour. A total of 70 CNG vehicles have already been added to BP's Prudhoe Bay fleet, and plans are to convert the entire 450-vehicle fleet from diesel fuel to CNG over the next 3 years (BP 2002a).

Carrier pipelines are used to transfer oil from the production stations at the oil fields to the TAPS. Elevated pipelines are typically used in the North Slope oil fields to prevent heat transfer from the hot oil in the pipeline to frozen soils, since heat would degrade the permafrost. Carrier pipelines from offshore production facilities are on the sea floor. Elevated pipelines are relatively easy to maintain and are visually inspected for leaks. Because they can restrict the movements of caribou and other wildlife, both TAPS and North Slope producers have implemented resources to allow for safe passage of caribou and other large mammals. Buried pipelines are feasible in the Arctic provided that the integrity of the frozen soils is maintained. Such pipeline configurations have been used in the Milne Point area. Buried pipe is more difficult to monitor and maintain and must be insulated and operated so that the oil temperature will ensure that thaw settlement will be within tolerable limits. According to State of Alaska regulations, pipelines must be located to enable the containment and cleanup of spills, avoid significant changes in the migration patterns of herd animals, and allow fish passage (ADNR 1999).

Power is supplied to the oil fields by natural-gas-fueled turbines. Natural gas is obtained from the oil production wells. Diesel fuel is also used for some purposes and is supplied either by small refineries at the oil fields or by truck from Fairbanks.

Exploration is now generally limited to winter in order to minimize the impact of moving equipment over exposed tundra to avoid interference with animals, and avoid the need to build permanent roads. Ice roads and drilling pads spread the weight of the equipment over the ground surface and minimize the contact of the equipment with the soil surface. Their locations are almost undetectable when they melt. Production areas remote from permanent roads may be built and maintained by using only ice roads in the winter and access by air strip or water during the summer.

Major aviation facilities are located at Barrow, Deadhorse, and Kuparuk. In addition, there is a gravel airstrip at Nuiqsut. Smaller airstrips link remote oil sites with the larger aviation facilities. These airstrips are typically made of gravel, measure 150 to 200 ft wide and

5,000 to 6,000 ft long, and are built to serve the needs of the site and not the local area.

Deadhorse was established to support oil development at Prudhoe Bay and is not a community in the traditional sense. It is not controlled or managed by the North Slope producers. The private support companies are located on state-leased land. Services include three hotels that offer meals, a general store that doubles as a post office, and two gas stations. Tire and vehicle repair facilities are also available, as are an auto parts store and hardware store. The North Slope Borough operates a solid waste facility at Deadhorse.

Public access is restricted beyond Deadhorse. Areas to the north, including the Arctic Ocean, can only be accessed via commercial tours, which operate from the hotels (Morris Communications 2001).

4.7.4.2 Oil Refining

Alaska has four merchant refineries and two smaller crude oil tapping plants in North Slope fields dedicated to producing oil for field use. Three of the merchant refineries are in the region of interest: two are at North Pole (near Fairbanks), and one is at Valdez. Most of the petroleum products produced by these refineries are used within Alaska. Williams Alaska Petroleum, Inc., owns and operates one of the petroleum refineries at North Pole. The refinery produces approximately 62,000 bbl/d of various petroleum products, including motor gasoline, naphtha, jet fuel, heating fuels, diesel fuels, gas, oil, and asphalt for both local supply and export. Approximately 60% of the refinery's product is jet fuel, which is supplied to various domestic and international airlines as well as to the U.S. military (Williams Energy 2002).

Petro Star operates the other refinery at North Pole. It produces 3,750 bbl/d of product, including kerosene, diesel fuel, and jet fuel for use in interior and northern Alaska (Petro Star 2002a). Petro Star also operates a refinery at Valdez that produces 10,000 bbl/d of refined product (ADNR 2000). The refinery produces jet fuel, marine diesel and heating fuel for use in south-central and south coastal Alaska. The majority of the products are shipped out of the Valdez Petroleum Terminal, located approximately 6 mi from the refinery. The products are shipped to Anchorage, Kodiak, Dutch Harbor, and coastal Alaska by a leased barge (Petro Star 2002b).

These refineries obtain oil acquired by spur pipelines from the TAPS. Each extracts the lighter fractions from the crude oil to produce an array of refined products. The heavier fractions are returned to the TAPS via pipeline.

4.7.4.3 Oil Storage

Williams Energy operates a 20,000-bbl jet-fuel terminal at Fairbanks International Airport (Williams Energy 2002). Commercial fuel sales in Alaska increased from 1,507 million gal in 1995 to 1,788 million gal in 1999. Most of this increase was due to the increase in sales of jet fuel, which account for more than half of the total fuel sales in the state (900 million gal in 1999) (ADNR 2000). Other storage facilities exist at the TAPS pump stations at Kuparuk and Prudhoe Bay and in communities throughout the region of interest.

4.7.4.4 Oil and Natural Gas Transportation

In addition to the major systems described below, refined products are shipped by truck from the three refineries to various end points.

4.7.4.4.1 Trans-Alaska Pipeline System. The TAPS has been described in detail in the earlier sections of this DEIS. It is listed here for completeness. The TAPS system assessed here includes the pipeline, pump stations, access roads, and the Valdez Marine Terminal.

4.7.4.4.2 Alaska North Slope Natural Gas Commercialization. This DEIS assumes that it is reasonably foreseeable that sometime in the next 30 years natural gas will be transported from the North Slope to market in Canada and the United States. At this time, it is premature to guess which proposal would ultimately be selected and implemented.

There is a large quantity of natural gas within the Prudhoe Bay reservoir. In addition, there are undeveloped discoveries of natural gas in the area with projections for the discovery of substantially more gas if it were marketable. Since the discovery of the Prudhoe Bay field in 1968, planning for the commercialization of these gas deposits has been underway. A number of projects to market the gas have been proposed or conceptualized. These include several pipeline routes from the North Slope to the lower 48 states through Canada, a liquefied natural gas (LNG) project at Valdez, and a gas-to-liquids project on the North Slope. Although each of these projects has been studied, some extensively, none has been financed or built, principally because long-term natural gas prices in the target markets have not justified the cost and risk of the project. While it is not entirely clear that this gas will be commercialized, two possible gas commercialization projects are described in some detail below for purposes of this analysis to be the surrogate for whatever project might eventually be built.

A "southern" pipeline has been proposed to carry natural gas into Canada. One possible proposed route would parallel the TAPS until it reaches the Fairbanks vicinity, then it would run roughly parallel to the Alaska Highway through the Yukon Territory and British Columbia into Alberta (Figure 4.7-8). This proposal has been the subject of detailed study by the TAPS Owners, and legislation has been proposed for development of this proposal (BP 2002b). Another proposal is for a northern route from Prudhoe Bay through the Beaufort Sea to the MacKenzie Delta then south through Canada. As already discussed, this proposal was not considered reasonably foreseeable. A third proposal is for a pipeline parallel to the TAPS into Valdez, where the natural gas would be liquefied for shipment. Although it is not clear which proposal might eventually be developed, it was considered reasonably foreseeable that sometime in the next 30 years a natural gas pipeline might be constructed. For the sake of analysis a hypothetical description of such a system follows.

A natural gas pipeline could consist of a large-diameter, 735-mi-long buried pipeline. It would run parallel to the TAPS from Prudhoe Bay to the vicinity of Fairbanks near Delta Junction, and from there, it would turn east, and of the TAPS region of interest. Key elements of such a project would be (1) a large CO_2 treatment plant on the North Slope, (2) the pipeline itself, (3) valve stations and compressor stations along the route, and (4) a possible natural gas liquid (NGL) recovery plant.

The gas treatment facility would remove acid gases (CO_2, H_2S) and compress and chill the gas to make it ready for transport. The pipeline would be 48 in. in diameter and constructed of high-strength steel. Compressor stations, valve stations, and intermediate pigging facilities would maintain gas pressure (about 2,500 psi), allow maintenance and pigging of the line, and provide safety features. Because the gas would contain ethane, propane, and other gas liquids, a NGL recovery plant might be needed to remove the heavier hydrocarbons (C_2+) for sale.

Construction of a natural gas pipeline could involve about 600 mi of buried pipeline in Alaska. The total project cost could be approximately $10 billion, of which $1 billion could be for the gas treatment facility and $2.5 billion could be for actual pipeline construction. Construction of the gas treatment facility could require about 3,000 person-years of labor, while construction of the pipeline could require about 7,500 person-years of labor. It is anticipated that the main construction effort could occur over a period of 3 to 5 years. The facilities could be labor-efficient and capital-efficient to operate, and could create direct employment of 300 to 400 permanent jobs (Goldsmith 2001; McGraw 2002).

Alternatively, conditioned natural gas could be transported by pipeline from the North Slope to Valdez, where the gas would be liquefied by a cryogenic process. The LNG would then be transported to various countries in specially designed cryogenic LNG tankers. Likely markets would include Japan, Korea, Taiwan, and possibly Mainland China (TAPS Owners 2001).

This proposal could involve the construction of an 800-mi-long, 36- to 42-in. diameter, chilled pipeline, which could be buried adjacent to the TAPS. A 300-acre gas-conditioning facility could be built on the North Slope, and 10 main line compressor stations could be constructed along

the pipeline route to maintain required operating pressures. The gas could be liquefied for shipment at an LNG plant that could be constructed at Anderson Bay, 3.5 mi west of the Valdez Marine Terminal. Additional construction at Anderson Bay could include storage tanks for the LNG and a marine terminal with two berths and loading facilities to accommodate LNG tankers with a capacity of 165,000 m^3.

It is projected that the gas volume would be about 2 billion ft^3/d for both the LNG and the pipeline export project. The capacity of the liquefaction facilities could be compatible, at 14 million tons/yr (29.3 m^3/yr). Fifteen tankers, each with a capacity of 125,000 m^3, would make about 275 loaded voyages per year to the Pacific Rim.

It is estimated that construction of this system would cost $4 billion for the pipeline and $8–10 billion for the other elements, including the tanker fleet. The estimated construction period would be 10 years. Public revenue, including property taxes, severance taxes, and royalties, would amount to about $377 million annually, depending on future energy prices. The economic life of the project is estimated to be 30 years.

4.7.4.4.3 Valdez Container Terminal Dock.

The Valdez Container Terminal Dock is a 700-ft concrete floating dock, extending to 1,200 ft. The container dock is tied to a 21-acre marshalling yard by two 200-ft ramps. The dock is designed as a multipurpose berth to handle containerized, roll-on/roll-off and lift-on/lift-off operations. The marshalling yard contains a total area of 21 acres of land. A grain terminal consisting of nine concrete silos that are 112 ft tall and 33 ft in diameter and have a total capacity of 522,000 bushels is also located on the container terminal grounds (Valdez 2002).

4.7.4.4.4 Oil Tanker Operations.

Oil tankers with cargo capacities ranging from 660,000 to 2,000,000 bbl are loaded with North Slope crude oil at the Valdez Marine Terminal which is controlled by the U.S. Coast Guard. North Slope crude oil is transported primarily to the west coast of the United States, with other shipments to Kenai, Alaska; the Hawaiian Islands; and the Asia Pacific market (TAPS Owners 2001a). In 1999, an average of 37 tankers per month were loaded at the Valdez Marine Terminal.

Tankers approach the Valdez Marine Terminal from the Gulf of Alaska via Hinchinbrook Entrance, and they follow dedicated traffic lanes to Valdez Arm and Valdez Narrows. The Prince William Sound Vessel Traffic System (VTS) controls the movement of tanker traffic into and out of the area. VTS closes Valdez to tanker traffic if conditions are hazardous.

Currently, the fleet serving the Valdez Marine Terminal consists of 26 tankers, including three with double hulls and 13 with double sides. However, the composition of the fleet will change to comply with the Oil Pollution Act of 1990, which requires that all tankers calling on U.S. ports have double hulls (double bottoms and sides) by the year 2015. According to the planned phaseout schedule for Prince William Sound tankers, the fleet will consist exclusively of double-hulled tankers beginning in 2014. The number of tankers will be reduced to 8 to 10 by 2020 (TAPS Owners 2001a).

APSC's SERVS is responsible for the safe transit of oil tankers from the Valdez Marine Terminal to international waters. Nine SERVS vessels have escort, docking, and response duties. At least two escort vessels are required for each laden tanker exiting Prince William Sound, and an additional escort may be added in inclement weather (TAPS Owners 2001a).

4.7.4.5 Habitation and Development

4.7.4.5.1 Beaufort Sea and North Slope.

The North Slope Borough is the largest borough in Alaska, making up more than 15% of the state's total land area. It consists primarily of the north and northeastern coast of Alaska, including the Brooks Range, north of the Arctic Circle. Communities or areas of development located within the Borough within the region of interest include Anaktuvuk Pass, Atqasuk, Deadhorse/Prudhoe Bay, Kaktovik, and Nuiqsut (Figure 4.7-3).

Click here to view Figure 4.7-8

FIGURE 4.7-8 Potential Routes for Natural Gas Transportation

With the exception of Deadhorse/Prudhoe Bay, these communities are composed of primarily Alaska Natives or part Natives, and most inhabitants maintain lifestyles that rely heavily on subsistence activities. The oil and gas industry is also an important source of employment. The populations within these communities range from 200 to 500 people. The Borough population is about 4,600.

Deadhorse at Prudhoe Bay is a town dedicated to supporting the oil industry. Although it has only six permanent residents, more than 5,000 oil petroleum industry workers pass through Deadhorse on rotating work shifts. Development in Deadhorse is almost entirely related to the petroleum industry.
See Section 4.7.4.1.2 for more information on Deadhorse.

4.7.4.5.2 Interior. Interior Alaska has a number of communities that could contribute to cumulative impacts (Figure 4.7-4). However, with the exception of Delta Junction/Big Delta, Fairbanks, and Glennallen/Copper Center, these communities are small, with populations of fewer than 200 people and no major industrial or commercial activities.

Delta Junction and Big Delta (no organized borough). Delta Junction is located at the convergence of the Richardson and Alaska Highways, approximately 95 mi southeast of Fairbanks. The city developed along the east bank of the Delta River, south of its junction with the Tanana River. Big Delta is located on the Richardson Highway at the junction of the Delta and Tanana Rivers. Delta Junction and Big Delta businesses provide services to traffic along the Richardson Highway. Fort Greely is located nearby. The surrounding area supports agriculture. The populations of Delta Junction and Big Delta in 2000 were 880 and 749, respectively.

Fairbanks North Star Borough. The Fairbanks North Star Borough is located in central Alaska and includes the cities of Fairbanks and North Pole. According to the 2000 census, the Borough's population was 82,840. The main campus of the University of Alaska is located at College in Fairbanks. Currently the Fort Knox and True North Gold Mines are expanding operations. The International Air Cargo landings at the Fairbanks International Airport have also expanded. The Fairbanks area serves as a regional service and supply center. The Alaska Railroad provides service to Fairbanks from Anchorage and Seward in the south and Eielson AFB in the east. The Borough is developing a plan for future growth and for an increase in population to 98,000 by 2018. Eielson AFB and Fort Wainwright are located nearby.

Glennallen/Copper Center. The communities of Glennallen and Copper Center are along the Richardson Highway, 189 mi (by road) east of Anchorage. The visitor's center and park headquarters for Wrangell-St. Elias NPP is located in Copper Center. Glennallen is the business hub of the Copper River region. Local businesses serve area communities and highway traffic, providing gasoline, supplies and services, schools, and medical care. State highway maintenance and federal offices are in Glennallen. The Wrangell-St. Elias Visitor Center and National Park Headquarters were recently completed (ADCED 2002).

4.7.4.5.3 Prince William Sound. Most of the communities bordering Prince William Sound are small (fewer than 200 people), with limited commercial and industrial activities (Figure 4.7-5). In general, people in these communities have lifestyles that rely on subsistence or commercial fishing. Cordova, Kenai Pennisula Borough, and Valdez are larger areas of human habitation and thus have the potential to make a greater contribution to cumulative impacts.

Cordova is located on the southeastern end of Prince William Sound and is readily accessible to other communities only by air and water routes. Cordova serves as a fishing port and a tourist and recreational sports center. The population of Cordova in 2001 was about 2,500, including Eyak, a federally recognized Native village within the City of Cordova.

The Kenai Peninsula Borough lies directly south of Anchorage and is bordered by the Gulf

of Alaska and Prince William Sound on the south and east. Cook Inlet divides the borough into two land masses. Cities within the Kenai Peninsula Borough include Homer, Kachemak, Kenai, Seldovia, Seward, and Soldotna. All communities are expanding in population and development. The population in 2000 was about 41,000.

Valdez is located on the north shore of Prince William Sound. In addition to being the southern terminus of the TAPS and Valdez Marine Terminal, the city is host to commercial fishing and shipping operations and is a port for commercial shipping, cruise ships, tour boat operations, and fishing. Valdez serves as a tourist and recreational sports center. Richardson Highway connects Valdez to Anchorage, Fairbanks, and Canada. The population in 2002 was estimated to be about 4,500 (Valdez 2002).

4.7.4.6 Transportation

4.7.4.6.1 Highways and Public Airstrips. In the areas traversed by the TAPS, the Richardson Highway connects Valdez with Fairbanks and the Dalton Highway connects Fairbanks with the North Slope. The Dalton Highway was formerly known as the "Haul Road" and was originally built and maintained by the TAPS Owners; it was closed to the public. It is now a state highway, is open to the public, and is maintained by Alaska's Department of Transportation and Public Facilities (Alaska Department of Transportation and Public Facilities 2002).

4.7.4.6.2 Railroads. The state-owned Alaska Railroad and ferry system transports passengers and freight between Anchorage, Seward, and Whittier and Interior Alaska. Future expansion will be made to link the existing lines to the Ted Stevens Anchorage International Airport. The Alaska Railroad is also constructing a new depot and passenger facilities in Fairbanks and Whittier; realigning its track in the Fairbanks and North Pole area to minimize the number of railroad crossings; repairing bridges in the Kenai Peninsula; and repairing maintenance facilities in Seward and Whittier. The railroad operations employ nearly 700 people (Alaska Railroad 2002).

4.7.4.6.3 Marine Terminals. Marine shipments to the North Slope are limited to the ice-free period between late July and early September. Dock facilities for unloading barges are located at Prudhoe Bay and Oliktok Point. One dock head, which is no longer used, is at East Dock of Prudhoe Bay. Two others are located at West Dock, with drafts ranging from 4 to 10 ft. The dock at Oliktok Point extends 750 ft from shore, with a depth of about 10 ft at the dock face. Because of the lack of deep-water ports, cargo is usually off-loaded to shallow- or medium-draft ships for transport to shore or for transport upriver to communities such as Nuiqsut.

No port facilities exist in Barrow. Cargo is transported to the area by barges and cargo ships and off-loaded to smaller vessels for transport to the shore north of Barrow.

On Prince William Sound, oil is shipped from the Valdez Marine Terminal at Port Valdez. Deep-water cargo ports are located at Valdez, Seward, and Whittier. Rail links exist at Seward and Whittier.

4.7.4.6.4 Alaska Marine Highway. The state-owned Alaska Railroad and ferry system is constructing two docks in Whittier to accommodate the unloading of barges. Seward and Valdez serve as cargo and cruise ship ports. The Alaska Railroad is also constructing a new freight dock and overhauling an existing dock to serve passengers in Seward (Alaska Railroad 2002). The Alaska Marine Highway System connects the communities of Cordova, Valdez, and Whittier along the Prince William Sound with ferry services.

4.7.4.6.5 Personal and Commercial Watercraft (fishing vessels, tour boats). Commercial fishing vessels use ports at Valdez and Cordova. Private and charter vessels also use the ports for recreational boating, which includes wildlife and sightseeing cruises and sport fishing excursions. Alaska state ferries stop at Valdez, Cordova,

Seward, and Whittier. Cruise ships use ports at Valdez and Seward (Morris Communications 2001). Section 4.7.4.9.2 on tourism and Section 4.7.4.9.4 on commercial fishing have more details.

4.7.4.7 Legislative Actions Related to Land Use

4.7.4.7.1 Alaska Native Claims Settlement Act. Shortly after its purchase of the territory of Alaska, the U.S. Congress abandoned its policy of establishing treaties with Native Americans (Alaska Commission on Rural Governance and Empowerment 1999). As a result, Alaska Native land claims were never resolved, and the status of Alaska Natives relative to the federal government was uncertain. The Alaska Native Claims Settlement Act (ANCSA) (PL 92-203; 43 USC 1601) was passed in 1971 to settle multiple Alaska Native land claims. The act extinguished all prior aboriginal land claims and conveyed 44 million acres to the 12 regional corporations established under the act.

The passage of ANCSA cleared land titles and facilitated granting of the TAPS ROW. It also established, through the for-profit regional corporations, the contemporary structure for Alaska Native economic and political affairs (Alaska Commission on Rural Governance and Empowerment 1999).

4.7.4.7.2 Alaska National Interest Lands Conservation Act. The Alaska National Interest Lands Conservation Act (ANILCA) (PL 96-487; 16 USC 3101) was passed in 1980 to provide for the designation and conservation of certain public lands in the State of Alaska. ANILCA establishes more than 100 million acres of federal land in Alaska as CSUs in order to preserve these lands and their resources for the national interest. The CSUs include National Parks, Preserves, Monuments, Wildlife Refuges, Wilderness Areas, and Wild and Scenic Rivers and are managed by federal agencies. Thirty-four CSUs are within a few miles of the TAPS ROW.

4.7.4.7.3 Federal and Alaska Coastal Zone Management Acts. The Federal Coastal Zone Management Act (CZMA) was enacted in 1972 and last amended in 2001. The Alaska Coastal Management Act (ACMA) was enacted in 1977 as Alaska's version of coastal zone management as envisioned in the national CZMA, and it was last amended in 1994. Both statutes guide land use in coastal zones to provide a balance between development and protection of coastal resources (BLM 1998; State of Alaska 2001).

ACMP, approved in 1979, was developed to implement the ACMA. The ACMP encourages coastal districts to develop and adopt district coastal management programs (CMPs) that become part of the ACMP once they are fully approved. CMPs include enforceable policies, and all activities that occur within a coastal zone or that may affect coastal resources must be consistent with an approved CMP. The Alaska Department of Governmental Coordination and State of Alaska resource agencies conduct consistency reviews on proposed and existing projects within coastal zones (BLM 1998; State of Alaska 2001).

4.7.4.7.4 Prince William Sound Regional Citizens' Advisory Council. The Prince William Sound Regional Citizens' Advisory Council is an independent, nonprofit corporation dedicated to the environmentally safe operation of the Valdez Marine Terminal and oil tankers within Prince William Sound. The council reviews and comments on APSC's operations, oil spill response and prevention plans and capabilities, and the design of mitigation measures. The advisory council helps monitor and assess the environmental impacts of terminal and tanker operations of oil-related accidents (Prince William Sound Regional Citizens' Advisory Council 2002b).

The council also works to increase the public's awareness of the actual and potential environmental impacts from terminal and tanker operations and of the APSC's environmental protection capabilities, which include oil spill prevention and response. Citizens organized the council after the Exxon Valdez oil spill in 1989 to increase public involvement in decision making in the Prince William Sound, Gulf of Alaska, and

Lower Cook Inlet regions of Alaska. The Oil Pollution Act of 1990 later required citizen oversight councils for Prince William Sound and Cook Inlet. Although APSC funds the advisory council, it has no control over its operation (Prince William Sound Regional Citizens' Advisory Council 2002a).

4.7.4.8 Land Management

4.7.4.8.1 National Parks, Preserves, Monuments, and Other Land Units

Arctic National Wildlife Refuge (ANWR). This refuge ranges from south of the Brooks Range to the Beaufort Sea. A small portion of the refuge comes within 1/4 mi of the TAPS, but the vast majority lies 60 mi or more east of TAPS. The ANWR encompasses more than 19 million acres and is the northernmost refuge in the United States. It contains the 8-million-acre federally designated Mollie Beattie Wilderness, which is the second largest Wilderness Area in the United States. The refuge contains part of the migration routes and calving grounds of the Porcupine caribou herds. Visitors are allowed in the refuge. Arctic Village – an Alaska Native community – is located on the south side of the refuge (Alaska Internet Travel Guide 2000a; Patterson 2001).

Chugach National Forest. The 5.5-million-acre Chugach NF occurs as two noncontiguous components. A portion of the forest is located south/southwest of the Valdez Marine Terminal and comes within 1/4 mi of the Valdez Marine Terminal at its closest point. Another portion is located on the Kenai Peninsula. The area near the Valdez Marine Terminal is used primarily for recreation and for subsistence hunting, fishing, and logging. Some commercial logging occurs on the Kenai. The Chugach NF is the northernmost national forest in the United States and is administered by the USDA Forest Service (Behrends 2002; Forest Service 2002).

Gates of the Arctic National Park and Preserve. Gates of the Arctic NPP is located in the Brooks Range west of the TAPS and comes within 2 to 3 mi of the pipeline at the closest point. It is composed primarily of federal lands and encompasses a 7.2-million-acre federally designated Wilderness Area — the third largest in the United States. The park is accessible by air and is open year round. There are no roads to or within the park, and it contains no established trails or facilities. Gates of the Arctic NPP receives about 4,000 visitors per year. A park ranger station is located in Coldfoot. No major construction is planned in the park (Uhler 2001a; Ulvi 2001).

Kanuti National Wildlife Refuge. The 1.6-million-acre Kanuti NWR is located about 150 mi northwest of Fairbanks. It is about 8 mi west of the TAPS at its closest point, but most of the refuge is more than 24 mi away. The refuge is undeveloped but contains no federally designated or proposed wilderness. Kanuti receives few visitors, and most visits are made by subsistence hunters and fisherman. Some river floating and hiking are done in the park (Alaska Internet Travel Guide 2000b; Schultz 2001).

White Mountains National Recreation Area (NRA). This NRA is administered by the BLM and is located about 30 mi north of Fairbanks between Elliott and Steese Highways. It encompasses about 1 million acres and is the largest NRA in the United States. The recreation area offers an abundance of year-round recreation opportunities (Great Outdoor Recreation Pages 2002).

Wrangell-St. Elias National Park and Preserve. This NPP reaches from the Copper Center and Glennallen area to the U.S./Canadian border and south to the Gulf of Alaska. The NPP headquarters and a point of access to the NPP are located near Copper Center and Glennallen. The NPP is 2 to 5 mi east of the TAPS at its closest point, but most of it is more than 26 mi away. At 13.2 million acres, Wrangell-St. Elias is the largest national park in the United States and is entirely

undeveloped. It encompasses the largest federally designated wilderness area in the United States: 8.9 million acres. The Ahtna Corporation, an Alaska Native Corporation, owns about 1 million acres of the NPP. Road access into the interior of the park is limited. Wrangell-St. Elias is open year round and averages 25,000 visitors a year, primarily in the summer. An abandoned mine site of Kennecott Mining Company is located within the park. No major construction is planned in the NPP (Uhler 2002; Ulvi 2001).

Yukon Flats National Wildlife Refuge. This 8.6-million-acre NWR is located east of the Dalton Highway and about 100 mi north of Fairbanks and is bisected by the Yukon River. The refuge is about 2 mi east of the TAPS at its closest point, but most of it is more than 6 mi away. Yukon Flats is undeveloped but contains no federally designated wilderness. A portion of the refuge has been proposed as a federal wilderness area. The refuge is visited primarily by subsistence hunters and fishermen. Summer use is mainly confined to the major waterways (Alaska Internet Travel Guide 2000c; Huer 2001).

4.7.4.8.2 Alaska Department of Natural Resources

Alaska Interior. Several small parks and recreation areas are in the Delta Junction and Fairbanks area. These parks provide access to lakes, rivers, and streams; camping; and limited facilities. No state-designated wilderness exists within 100 mi of the TAPS (ADNR 2001a). The Chena River State Recreation Area east of Fairbanks is a quarter of a million acres in size and draws more than 150,000 visitors a year. The park has limited facilities, and most of the area is closed to vehicles. The Chena River State Recreation Site is within the city of Fairbanks on the banks of the Chena River and is a popular recreation spot (ADNR 2001b).

Prince William Sound. There are several state marine parks in the Prince William Sound and Resurrection Bay area. Most of these parks can be accessed only by floatplane or boat, except for Shoup Bay, which can be entered by a foot trail. Seven parks are near Whittier, six are near Seward, three are near Valdez, and three are near Cordova. These parks are undeveloped but contain no state-designated wilderness (ADNR 2001c).

4.7.4.8.3 Military

Fort Greely. Fort Greely, near Delta Junction, is currently being closed and transferred to other uses by the Department of the Army under Base Realignment and Closure (BRAC). However, Fort Greely is the preferred alternative for the deployment of the ground-based interceptors and for deployment of the battle management, command, and control system of the National Defense Missile System. The former are guided missiles designed to intercept and destroy intercontinental ballistic missiles. The latter is the control and control system for the interceptors (U.S. Army Space and Missile Defense Command 2000).

Fort Wainwright. Fort Wainwright, located near Fairbanks, has nearly 4,600 soldiers and 6,100 family members. Its mission is to provide the services, facilities, and infrastructure needed to support the rapid deployment of the 172nd Separate Infantry Brigade and elements of the Arctic Support Brigade. These include field training exercises in Alaska, which involve the use of aviation, all-terrain, and winter vehicles and thus require facilities for refueling operations.

Eielson Air Force Base. This Air Force installation is located south of Fairbanks. The base mission includes support of combat aircraft, mid-air refueling, logistics support, and arctic survival training (Eielson AFB 2002).

Army Proposed Projects in the Region of Interest. Projects currently under construction at Fort Wainwright include central vehicle wash facilities, barracks renewals, central heat and power plant repairs, an ammunition surveillance facility, and a collective training facility for military operations in urban

terrain. Other Army projects that were recently built at Fort Wainwright include barracks upgrades, several phases of housing projects, a new ski chalet, a coal car preheat facility, and a missile test facility. A munitions storage facility was recently built at Fort Greely. The Alaska District Corps of Engineers solicited requests for proposals in October 2001 for a new hospital to replace the existing Bassett Army Community Hospital at Fort Wainwright. The proposed project is a 259,000-ft^2, 32-bed facility.

Air Force Proposed Projects in the Region of Interest. Eielson AFB (354th Wing) projects include a repair runway, a parking ramp, a weapons and release systems facility, consolidated munitions, and an A-10 squad/ops facility. Projects in design for fiscal year 2000 at Eielson AFB included a hazardous materials storage facility, dormitory, joint mobility complex, and utility upgrade Phase I and II (USACE 2001).

4.7.4.9 Natural Resource Use

4.7.4.9.1 Subsistence. Subsistence means the customary and traditional uses of fish and game in Alaska's rural areas. A person adopting a rural way of living in Alaska may legally fish and hunt for subsistence under federal law. In 1999, about 123,000 (21%) of Alaskans lived in rural areas. Since 1989, all Alaskan residents have qualified for subsistence under state law. While both Alaska Natives and non-Natives may subsistence hunt and fish, only Alaska Natives may hunt marine mammals, such as seals, whales, polar bears, and sea otters. Food is one of the most important subsistence uses of wild resources. Other subsistence uses include clothing, fuel, transportation (food for dogs), construction, home goods, sharing, customary trade, ceremony, and arts and crafts. In rural Alaska, about 75–98% of sampled rural households harvest fish and 48–70% harvest wildlife; actual use is probably higher, since harvested resources are often shared. Items harvested by weight included fish (60%), land mammals (20%), marine mammals (14%), birds (2%), shellfish (2%), and plants (2%). Although wild food harvests are high (up to 613 lb per person in the rural interior in the region of interest), subsistence harvest represents only 2% of the fish and game harvested annually in Alaska. Commercial fisheries harvest about 97%, while the sport harvest is only about 1%. In the region of interest, wild food harvests in 1999 were about 16 lb per person in the Fairbanks-Delta Area, 153 lb per person in the rural south central, 516 lb per person in the Arctic, and 613 lb per person in the rural Interior Alaska (ADF&G 2002c).

4.7.4.9.2 Tourism. Tourism is Alaska's second largest industry in terms of employment. The basis for much of Alaska's tourism industry is its natural resources. In 1999, more than 1.4 million people traveled to Alaska, and they spent about $1 billion in the state. Natural-resource-based tourism includes visits to national and state parks, viewing wildlife and scenery, back country travel, rafting and boating, skiing and winter sports, ship cruises, photography, fishing, and hunting. In addition, Alaska's cultural diversity and history help make it a major tourist attraction. In 1999, 53% of visitors to Alaska came by air, 31% came by cruise ship, and the balance came by highway, Alaska Marine Highway or international air (Alaska Travel Industry Association undated).

4.7.4.9.3 Hunting, Fishing, and Trapping. Hunting occurs for both subsistence and sport, while fishing and trapping occur for subsistence, sport, and commerce. In 2001, more than 565,000 sport fishing, hunting, and trapping licenses were sold. Of these, 51% were issued to nonresidents (ADF&G 2000a). Hunting, fishing, and trapping occur throughout the region of interest. Hunting seasons vary according to the region, species, sex of the animal, and classification of the hunter as resident or nonresident. In some cases, the issuance of a permit to hunt is based on a lottery. The situation for trapping is similar. The season and limits are adjusted by the ADF&G. In general, sport fishing is allowed year round in the Prince William Sound area and on the Tanana River, Yukon River drainage, and North Slope. Catch limits are placed on most species and typically do not exceed 10 per day. The season and limits are adjusted by the ADF&G. These regulations also apply on federal lands.

However, the federal government controls fishing and hunting on federal lands.

4.7.4.9.4 Commercial Fishing. In the Prince William Sound area, commercial fishing is mainly composed of sole operaters. In Prince William Sound and the Copper River District, the salmon season runs from mid-May to mid-October, and during this time, specific dates are set for each species and method of fishing. Herring season is in January for seine nets and from April into May for other methods. Shellfish season runs from April through December, with the specific dates set for each species and method of fishing. Groundfish, pollock, and cod fisheries operate year round. Six hatcheries operate in the area (ADF&G 2002b). Commercial fishing operations for salmon involve the use of purse seines, drift gillnets, and set gillnets. During the 1999 season, 523 drift gillnet permit holders, 21 set gillnet permit holders, and 139 seine permit holders participated in the fishery. However, three of the four seasons for herring and the fall season for food/bait fish were cancelled. Commercial fishing is a highly regulated industry; strict controls are placed on the days and hours fished, fishing locations, and methods.

4.7.4.9.5 Mining. Mining for gold and other minerals has been an important industry in Alaska, and this activity would continue throughout the period of TAPS operation. Mineral exploration, development, and production occur in a number of mining districts throughout the area traversed by the TAPS. In 1998, mining (except for oil and gas) was valued at about $900 million, with an annual employment of 3,452 (Szumigala and Swainbank 1999). The major new exploration activity was in the interior near Goodpasture and the Pogo Prospect, and exploration continued in the Fairbanks mining district. Exploration activities also concentrated on the north flank of the Alaska Range. During 1998, up to 12,000 new claims totaling 480,000 acres were staked on state land, while 5,800 claims were abandoned. The number of active claims on state land in 1998 was 41,157 on 1.65 million acres. Coal, copper, gemstones, gold, lead, sand and gravel, silver, stone, zinc, and other minerals were mined. The State of Alaska and several federal agencies regulate the mineral industry with regard to safety and environmental protection.

On the North Slope, mining of sand and gravel from river floodplains and stone from the Brooks Range support road construction and maintenance, river training, pipeline maintenance, and oil exploration and development. The Red Dog Mine (zinc, lead, and silver) in the Kotzebue area is several hundred miles from the TAPS and outside the region of interest for this cumulative assessment.

In Interior Alaska, coal is mined, and lode and placer are mined for gold and other metals and coal. In the Brooks Range, the Middle Fork Koyukuk River near Wiseman and Coldfoot was an important gold mining area, and mining still occurs there today. Numerous placer gold mining operations (i.e., the removal of gold from stream-bed gravel deposits) occur throughout the region around Fairbanks, and exploration is ongoing. The Fort Knox Mine, an open pit mine about 25 mi northeast of Fairbanks, is the largest operating gold mine in the state. The mine employs 260 people and produces 1,000 oz of gold per day. Probable reserves are estimated at 3,686,000 oz. In addition, gold-bearing sand and gravel are taken from the True North Mine, which is about 8 mi from the Fort Knox Mine and being developed. At the projected rate of production, this mine will be in operation for at least nine more years. The Teck-Sumitomo Pogo gold mine site is being developed northeast of Delta Junction. Once in production, it is estimated that the mine will operate for 12 years. Three medium-sized placer mines and about 50 smaller operations operate in the 10 interior mining districts. Small placer gold operations occur between Fairbanks and the North Slope and between Fairbanks and Valdez. These operations are widely scattered, and sites tend to shift depending on the potential for new discoveries of gold and the price of gold (Szumigala and Swainbank 1999).

In addition to gold mines, several small mining pits produce peat for local use in the Fairbanks and Palmer-Anchorage area. Several sand and gravel pits are located in the Fairbanks area, to the east of Delta Junction, in the Palmer area, and in the Kenai area. These materials are

primarily used for roadwork. About 100 mi south of Fairbanks, the Usibella Coal Mine in Healy produces about 1.5 million tons of coal per year. Coal mining operations are also expected to begin at a location just north of the existing mine site. A portion of the coal removed at the mine is exported out of Alaska. A portion was also used in the Healy Clean Coal Project; it was enough to potentially generate 50 MW of baseload electric power (Szumigala et al. 2000).

In the early 1900s, copper was mined near McCarthy and transported by railroad along the Chitina and Copper Rivers to ships at Cordova. During that period, gold was also extracted from the area. Today, mining still occurs on private lands within the region.

Mineral exploration and mining occurred historically in the Prince William Sound area. Mineral resources in the Prince William Sound area include placer and lode gold deposits, chromium, copper, oil, and coal.

4.7.4.9.6 Logging. Both commercial logging and harvesting for personal use occur in Alaskan forests. In the vicinity of the TAPS, most commercial logging occurs on state lands; minimal logging occurs on federal lands. Logging on state lands is regulated by the Alaska Division of Forestry, and logging on federal lands is regulated by the agency administering the land where the timber sale occurs. Both state and federal land management agencies develop forest/land management plans that (1) identify areas suitable for harvesting, (2) determine appropriate harvest levels, and (3) ensure that commercial operations comply with harvest management practices that protect resources, such as soils and surface water.

Commercial logging occurs throughout state lands near the TAPS. However, most logging occurs in Tanana Valley State Forest, which lies north, northeast, and southeast of Delta Junction in several separate parcels. Logging on federal lands occurs in the Chugach National Forest and in BLM lands in the Copper River Basin.

Harvesting for personal use occurs throughout forests on public lands in the vicinity of the TAPS. Wood is harvested for both fuel and housing.

4.7.4.10 Petroleum and Hazardous Materials Spills

For the purposes of this DEIS, petroleum spills are identified as an "action," although they do not occur independently of other actions. Petroleum spills can occur during any action involving petroleum and its products, including exploration and development, transportation, and refining. These actions can be the responsibility of any industry, agency, or individual that is carrying them out. Petroleum spills may be large, such as those resulting from a pipeline or tanker accident, or they may be very small, such as a diesel fuel or oil spill during refueling or equipment maintenance. Because of the nature of the proposed action addressed in this DEIS, this cumulative impact analysis emphasizes petroleum spills resulting from the exploration, development, and transportation of North Slope oil resources. The following text emphasizes spills on the North Slope and in Prince William Sound. Petroleum spills related to TAP operations are described elsewhere in this DEIS, as part of the assessment of the proposed action and no-action alternative.

4.7.4.10.1 North Slope Petroleum Spill Scenarios. Twelve crude oil, diesel fuel, and saltwater spill scenarios were developed for the North Slope (Table 4.7-4). The first seven spills would be similar to spills that have occurred historically over the 25 years of TAPS operations, as logged in the TAPS ROW Renewal Oil Spill Database (TAPS Owners 2001a). More than 1,500 North Slope crude oil spills, about 2,300 diesel fuel spills, and more than 70 saltwater spills are cataloged in the database. The "moderate" spill of saltwater (Scenario 6) occurred on March 17, 1997, at Arco's Drill Site 4 in East Prudhoe Bay. The cause of the spill is unknown. Between 750,000 and 1,000,000 gal of seawater were released from six to nine wellheads, each at 10 to 20 bbl/min (ADEC 1997). Information on saltwater spills on the North Slope is limited. Information is available from ADEC for the period from July 1995 to June 2001 (6 years). The largest recorded saltwater spill volume (on the order of 1 million gal) is used as a surrogate

TABLE 4.7-4 Spill Scenarios for the North Slope

No.	Description/Location[a]	Spill Material	Frequency (1/yr)	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Spill Volume Range (bbl)	Release Duration	Release Point	Does Spill Reach Water?
1	Small spill in the North Slope (NLS)	Crude oil	5.0E-01	X				~0 to 500	Short	Land	No
2	Small spill in the North Slope (NLS)	Diesel	5.0E-01	X				~0 to 170	Short	Land	No
3	Small spill in the North Slope (NLS)[b]	Saltwater	5.0E-01	X				~0 to 500	Short	Land (65–80% of crude oil spills on pad)	No
4	Moderate spill in the North Slope (NLS)	Crude oil	3.0E-02		X			501 to 925	Short	Land (65–80% of crude oil spills on pad)	No
5	Moderate spill in the North Slope (NLS)	Diesel	3.0E-02		X			171 to 450	Short	Land	No
6	Moderate spill in the North Slope (NLS)[b]	Saltwater	3.0E-02		X			501 to 23,810	Short	Land	No
7	Rupture of aboveground water-flood pipeline (saltwater spill)[b]	Saltwater	2.0E-01		X			2,400 to 82,000	Prolonged	Land	No

TABLE 4.7-4 (Cont.)

No.	Description/Location[a]	Spill Material	Frequency (1/yr)	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Spill Volume Range (bbl)	Release Duration	Release Point	Does Spill Reach Water?
8	Rupture of alpine pipeline near the Colville River	Crude oil	1.4E-03			X		50 to 2,800	Prolonged	Land, water	Yes
9	Platform spill in the Beaufort Sea (proposed Northstar field as a surrogate)	Crude oil	2.3–2.7E-02			X		1,500	Instantaneous	Water	Yes
10	Pipeline spill in the Beaufort Sea (proposed Northstar field as a surrogate)	Crude oil	2.3–2.7E-02			X		4,600	Instantaneous	Water	Yes
11	Well blowout at Phillips Alaska's Alpine Pad 1 during breakup	Crude oil	1.8–3.8E-03			X		3,000 to 34,000	Prolonged	Land, water	Yes
12	Rupture of Kuparuk pipeline over Kuparuk River to open water	Crude oil	1.0E-03			X		10,516	Instantaneous	Land, water	Yes

[a] NLS = scenario is not location-specific.

[b] There is limited information on saltwater spills in the North Slope. Because ADEC information covers only the period from July 1, 1995, to June 29, 2001 (6 years), extrapolation to a 30-year return period is highly uncertain. The largest recorded saltwater spill volume (on the order of 1 million gal) is used as a surrogate for the maximum spill that would be encountered during 30 years of operations in the North Slope.

for the maximum spill that could be encountered during 30 years of TAPS operations in the North Slope.

The next three spills (Scenarios 8, 9, and 10) were taken from environmental assessments associated with the Alpine crude oil pipeline and the proposed Northstar well field. The Alpine crude oil field is located in the western Colville River Delta, about 34 mi west of the Kuparuk River oil field. The Alpine field is connected to the Kuparuk River delta via three 34-mi crude oil, diesel, and water transport pipelines. At the Colville River crossing, the depth of the pipeline is about 100 ft. The Alpine pipeline spill (Scenario 8) is an "extreme worst-case" scenario involving a rupture of the pipeline transporting crude oil. A fracture of the 14-in. Alpine pipeline is assumed to occur approximately 300 ft from the Colville River, causing crude oil to spill on the ground and then migrate into the river. The next two spills in the proposed Northstar Field (Scenarios 9 and 10) would result from a leak on the drilling well platform and in the pipeline that transports crude oil from the Beaufort Sea to shore terminal.

4.7.4.10.2 Catastrophic Events Considered in the North Slope Spill Analysis.

Two spill scenarios (a spill of crude oil due to a well blowout; a rupture of a pipeline over open water) have the potential to release catastrophic amounts of hazardous materials on the North Slope.

The first catastrophic scenario (Scenario 11; crude oil from a well blowout) was previously assessed as a "reasonable worst-case" spill at Alpine Pad 1 (Alpine 1997). It is assumed that the plume fallout and oil would spread from the wellhead and drill pad, flow over snow and ice surfaces that are breaking up, and deposit on them. Oil flowing from the drill pad would initially spread downslope following the terrain, then flow into adjacent lakes, the Sakoonang Channel, and eventually Harrison Bay. The frequency of this postulated spill scenario was estimated by using information from BLM (1998), which indicates that one well blowout occurred in the 9-year period from 1987 to 1996, a time when 2,933 wells were drilled. Ice breakup generally occurs on 10 to 21 days per year.

The last event in Table 4.7-4 (Scenario 12) is a crude oil pipeline rupture over Kuparuk River to open water. The rupture occurs where the Kuparuk 24-in. pipeline crosses the Kuparuk River. It instantaneously releases more than 10,000 bbl of crude oil into open water. The spilled oil moves downstream under the influence of the current and impacts the shoreline.

4.7.4.10.3 Transportation Spill Scenarios.

Cumulative impacts associated with transportation accidents involving spills of hazardous material were evaluated for truck shipments from the North Pole Refinery to the North Slope (Deadhorse) and for rail shipments from the North Pole Refinery to Stevens International Airport. Three scenarios were assessed; frequencies and spill volumes are summarized in Table 4.7-5. The frequencies of all three scenarios would be considered likely, except for Scenario 2b (a fire variant of 2a), which would be considered unlikely. All scenarios, including the variant, involve the shipment of refined petroleum products, except for Scenario 3, which involves of a shipment of hydrochloric acid (HCl). Acid stimulation is one of the primary methods for improving productivity of oil, gas, injection, and disposal wells in the North Slope. The HCl acid is pumped down the well and into the producing fields to increase oil flow.

Scenario 1. In this event, a tanker truck that is transporting an HCl solution (37% concentration of HCl) overturns on the Dalton Highway while en-route to Prudhoe Bay (Deadhorse). The tanker's liquid cargo tank (MC 312/412)[1] contains approximately 4,500 gal of HCl. The incident occurs near MP 280 on the

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[1] MC (motor carrier) 312 or 412 cargo tanks are cylindrical tanks designed to carry high-density corrosive liquids and are typically constructed of stainless steel or aluminum and lined with material to resist degradation or reaction with its contents.

TABLE 4.7-5 Transportation Spill Scenarios[a]

No.	Description/Location	Spill Material	Frequency (1/yr)	Frequency Range				Spill Volume (bbl)		Release Duration
				Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-3}/yr)	Low	High	
1	Rollover of tanker truck on the Dalton Highway	HCl (37%)	1.7E-01		X			17	17	Short
2a	Overturn of fuel truck between North Pole Refinery and Deadhorse (Prudhoe Bay)	Arctic grade diesel	2.2 to 3.9 E-02		X			119	190	Instantaneous
2b	Overturn of fuel truck *with subsequent fire* between North Pole Refinery and Deadhorse (Prudhoe Bay)	Arctic grade diesel	2.4 to 4.3 E-03			X		119	190	Instantaneous
3	Derailment of freight train between North Pole Refinery and Stevens International Airport	Aviation jet fuel A	1.3 to 1.6 E-01		X			195	488	Short (hours)

[a] All release points are aboveground, on land.

Dalton Highway. The TAPS pipeline is located less than 1/2 mi from the accident site. It is estimated that the accident would result in a spill of approximately 700 gal of HCl, released over a period of about 30 min.

This event is considered likely, with an occurrence frequency of once in every 6 years (0.17/yr). The accident frequency is based on a single event that occurred near Fairbanks on December 6, 1995, when 90 gal of 35%-HCl solution (muriatic acid) spilled when a drum fell off a truck and split because of the cold temperature (ADEC 2001a).

Scenarios 2a and 2b. A fuel truck carrying arctic-grade diesel from the Williams North Pole Refinery to Deadhorse leaves the highway and overturns on Dalton Highway. A large spill of diesel fuel (between 5,000 and 8,000 gal) (USDA-FS AND WEFSEC 1998) without a fire would be considered a likely event, occurring at a frequency of about 2.2 to 3.9×10^{-2}/yr. A variant of this scenario would involve a fire in addition to the spill and would have a probability of occurring about 2.4 to 4.3×10^{-3}/yr, based on adjustments to national HAZMAT transportation statistics (DOT 2001).

Scenario 3. A freight train towing an average of 50 loaded petroleum tank cars filled with aviation jet fuel A (turbine jet fuel) partially derails. Up to two railcars are damaged and leak aviation jet fuel at a rate of 2 to 3 gal/min. A large railcar spill ranging from about 200 to 500 bbl of jet fuel would be considered a likely event, with a frequency of occurrence of once in 6 to 8 years (based on frequencies taken from USDA-FS [1998]). The spill magnitude was estimated on the basis of 30,000-gal railcar spill size scenario (AIChE 1989), adjusted for frequency data based on railcar tanker capacities of 20,000 to 25,000 gal and Alaska railroad accident statistics that indicate that two hazardous material (HAZMAT) railcars are damaged for each train derailment over a 5-year period (ADEC 2001b).

4.7.4.10.4 Prince William Sound and North Slope Spill Scenarios

Prince William Sound Spill Scenarios. A total of 33 crude oil and diesel fuel spill scenarios were developed for the Prince William Sound (Table 4.7.4-6). They rely primarily on data from previous risk assessments prepared in support of crude oil spill emergency response planning in the sound (Det Norske Veritas et al. 1996; Merrick et al. 2000). It is expected that most pollution incidents in Prince William Sound would be minor, involving spills of diesel oil, lubricating oil, crude oil, and waste bilge oil. The probability of a hazardous substance discharge is low.

The first four spill scenarios listed in Table 4.7-6 represent small to moderate spills that are anticipated or likely to occur in Prince William Sound during the TAPS renewal period. The scenarios cover spills of North-Slope-produced crude oil and diesel fuel as a crude oil refined petroleum product. The scenarios were developed by considering more than 180 documented crude oil spills into the Prince William Sound during the first 25 years of operation of the pipeline (TAPS Spill Database 2001). In addition, 70 diesel fuel spills are also documented in the database for Prince William Sound for a similar period. Spill initiators or causes ranged from small fuel line ruptures to very large storage tank failures. The spill volumes for these scenarios ranged from less than 1 gal to 60 bbl of crude oil and 12 bbl of diesel fuel. All of these spills were of short duration (a few hours to about a day).

4.7.4.10.5 Catastrophic Events Considered in the Prince William Sound Spill Analysis.

The source of a medium or major oil spill would most likely be a tank vessel laden with crude oil. An incident involving a tank vessel has the most potential to be catastrophic (ARRT 1999). The last 29 scenarios (5 through 33) represent unlikely or

TABLE 4.7-6 Spill Scenarios for Tanker Accidents in the Prince William Sound[a]

No.	Spill Scenario	Material Spilled	Location	Frequency (1/yr) Low	Frequency (1/yr) High	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Very Unlikely (10^{-6} to 10^{-6}/yr)	Spill Volume (bbl) Low	Spill Volume (bbl) High	Release Duration
1	Small spill	Crude oil	NLS[b]	5.0E-01		X				~0	10	Short
2	Moderate spill	Crude oil	NLS	3.0E-02			X			11	60	Short
3	Small spill	Diesel	NLS	5.0E-01		X				~0	1	Short
4	Moderate spill	Diesel	NLS	3.0E-02			X			2	12	Short
5	Collision	Crude oil	Arm	4.E-04	8.E-03			X		110,000	170,000	Prolonged
6	Drift grounding	Crude oil	Arm	2.E-05	1.E-03			X		50,000	190,000	Prolonged
7	Fire and explosion	Crude oil	Arm	2.E-05	1.E-04				X	270,000	320,000	Prolonged
8	Powered grounding	Crude oil	Arm	1.E-04	9.E-04			X		80,000	200,000	Prolonged
9	Structural and foundering	Crude oil	Arm	3.E-05	2.E-04			X		100,000	260,000	Prolonged
10	Collision	Crude oil	Central Sound	4.E-04	3.E-03			X		110,000	180,000	Prolonged
11	Drift grounding	Crude oil	Central Sound	6.E-06	6.E-04			X		0	190,000	Prolonged
12	Fire and explosion	Crude oil	Central Sound	4.E-05	2.E-04			X		250,000	300,000	Prolonged
13	Powered grounding	Crude oil	Central Sound	1.E-08	7.E-04			X		0	190,000	Prolonged
14	Structural and foundering	Crude oil	Central Sound	5.E-05	4.E-04			X		130,000	210,000	Prolonged
15	Collision	Crude oil	Gulf	6.E-05	5.E-04			X		170,000	190,000	Prolonged
16	Drift grounding	Crude oil	Gulf	2.E-05	6.E-04			X		150,000	320,000	Prolonged
17	Fire and explosion	Crude oil	Gulf	2.E-05	1.E-04				X	230,000	280,000	Prolonged
18	Structural and foundering	Crude oil	Gulf	4.E-05	2.E-04			X		100,000	210,000	Prolonged
19	Collision	Crude oil	Hinchinbrook	1.E-04	1.E-03			X		100,000	270,000	Prolonged
20	Drift grounding	Crude oil	Hinchinbrook	3.E-04	3.E-03			X		150,000	180,000	Prolonged
21	Fire and explosion	Crude oil	Hinchinbrook	2.E-05	1.E-04				X	280,000	330,000	Prolonged
22	Powered grounding	Crude oil	Hinchinbrook	1.E-04	1.E-03			X		190,000	160,000	Prolonged
23	Structural and foundering	Crude oil	Hinchinbrook	3.E-05	2.E-04			X		130,000	200,000	Prolonged
24	Collision	Crude oil	Narrows	3.E-04	8.E-03			X		120,000	80,000	Prolonged
25	Drift grounding	Crude oil	Narrows	1.E-08	2.E-06					0	0	Prolonged
26	Fire and explosion	Crude oil	Narrows	1.E-05	6.E-05				X	290,000	340,000	Prolonged
27	Powered grounding	Crude oil	Narrows	2.E-04	2.E-03			X		70,000	180,000	Prolonged
28	Structural and foundering	Crude oil	Narrows	1.E-05	8.E-05				X	110,000	280,000	Prolonged
29	Collision	Crude oil	Port	6.E-04	9.E-03			X		110,000	90,000	Prolonged

TABLE 4.7.4-6 (Cont.)

No.	Spill Scenario	Material Spilled	Location	(1/yr) Low	(1/yr) High	Frequency Range: Anticipated (> 0.5/yr)	Likely (0.03 to 0.5/yr)	Unlikely (10^{-3} to 0.03/yr)	Unlikely (10^{-6} to 10^{-6}/yr)	Spill Volume (bbl) Low	Spill Volume (bbl) High	Release Duration
30	Drift grounding	Crude oil	Port	9.E-05	7.E-04			X		70,000	180,000	Prolonged
31	Fire and explosion	Crude oil	Port	1.E-05	7.E-05				X	250,000	300,000	Prolonged
32	Powered grounding	Crude oil	Port	1.E-08	7.E-04			X		0	190,000	Prolonged
33	Structural and foundering	Crude oil	Port	2.E-05	2.E-04				X	100,000	240,000	Prolonged

[a] All release points are on the water, and all spills reach the water.

[b] NLS = scenario is not location specific; it could occur anywhere in Prince William Sound.

very unlikely spill events. The analysis considers possible occurrences in seven different locations in Prince William Sound (or designated subareas) caused by five different tanker vessel accident types or initiators. The Prince William Sound subareas, identified in a risk assessment study by Merrick et al. (2000), are as follows:[2]

- Port of Valdez,
- Valdez Narrows,
- Valdez Arm,
- Central Sound,
- Anchorage,
- Hinchinbrook Entrance, and
- Gulf of Alaska.

The five types of tanker accidents considered are: (1) collision, (2) drift grounding, (3) fire and explosion, (4) powered grounding, and (5) structural and foundering. The potential for a catastrophic release of crude oil is identified with regard to the spill scenario initiators as follows (Det Norske Veritas et al. 1996):

- Collision occurs when an underway tanker and another underway vessel collide into each other or strike each other as a result of human error or mechanical failure and lack of vigilance (intervessel collision) or when a floating object is struck by an underway tanker (e.g., ice collision).
- Drift grounding occurs when a drifting tanker contacts the shore or bottom because it is not under control as the result of a propulsion or steering failure.
- Fire and explosion occurs either when there is a fire in the machinery, hotel, navigational, or cargo space of a tanker or when there is an explosion in the machinery or cargo spaces.
- Powered grounding occurs when an underway tanker contacts the shore or bottom because of navigational error or steering failure and lack of vigilance.
- Structural failure and foundering occurs when a structural failure due to the hull or frame cracking or erosion is serious enough to affect the structural integrity of the tanker. It is then assumed that the tanker will founder or sink as a result of water ingress or loss of stability.

As Garrick (1984) notes, an accident is not a single event, but the culmination of a series of events. A triggering incident is defined to be the immediate precursor of an accident. In the Prince William Sound Risk Assessment (Det Norske Veritas et al. 1996), triggering incidents were separated into mechanical failures and human errors. The mechanical failures that were considered to be triggering incidents were propulsion failures, steering failures, electrical power failures, and hull failures. Human errors were classified as diminished ability; hazardous shipboard environment; lack of knowledge, skills or experience; poor management practices; or faulty perceptions or understanding.

The volume of crude oil spilled for a given scenario identified in Table 4.7-6 was estimated on the basis of the methodology in DNV (1996) and by taking into account the decreasing number of crude oil tanker shipments due to depletion of North Slope crude oil and the mandatory phase-out of single hull tankers on or before 2015 (FR 1998).

4.7.5 Impacting Factors of Reasonably Foreseeable Actions

Section 4.7.4 describes past, present, and reasonably foreseeable actions for each of the regions of interest (Beaufort Sea and the North Slope, Interior Alaska, and Prince William

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2 This Prince William Sound risk assessment study had three primary objectives: to (1) identify and evaluate the risks of oil transportation in Prince William Sound; (2) identify, evaluate, and rank proposed risk reduction measures; and (3) develop a risk management plan and tools that could be used to support a risk management program.

TABLE 4.7-7 Activities and Impacting Factors Associated with the Reasonably Foreseeable Actions That Would Contribute to a Cumulative Effect

Key to actions: A = Oil and gas exploration, development, and production; B = Oil refining; C = Oil and refined product storage; D = Oil and gas transportation; E = Human habitation and development; F = Transportation (other than oil and gas); G = Legislative actions; H = Land management; I= Natural resource use; and J = Petroleum spills.

Environmental Attribute and Associated Activities	Impacting Factor	Major Contributing Actions, by Region[a]		
		Beaufort Sea and North Slope	Interior Alaska	Prince William Sound
PHYSICAL				
Soils and Permafrost				
Construction	Disturbance	A, D	A, D, E, F, I	E, F, I
Spill/site cleanup	Disturbance	J	J	J
Vehicular traffic	Dusts	A, D	A, D, E, F, I	--
Sand, Gravel, and Stone				
Construction	Resource use	A, D, E	A, D, E, F	--
Paleontology				
Excavation	Disturbance	--	--	--
Collecting	Removal	E	E	E
Surface Water Resources				
Permitted discharges	Pollutants	A	A, B, E	B, D, E
Construction	Sedimentation	A, D, E, F	A, D, E, F	D, E, F
Land disturbance	Sedimentation	--	E, I	E, I
Bank/shore modification	Sedimentation; channel/flow changes	A, D, F	D, E, F, I	D, E, I
Water use	Reduced flow	A	A, E, I	A, E, I
Site remediation	Sedimentation; elimination or reduction of pollution source	J	I, J	I, J
Petroleum spills	Pollutants	A, D, F	A, B, C, D, E, F, I	B, C, D, E, F, I, J

TABLE 4.7-7 (Cont.)

Environmental Attribute and Associated Activities	Impacting Factor	Major Contributing Actions, by Region[a]		
		Beaufort Sea and North Slope	Interior Alaska	Prince William Sound
Groundwater Resources				
Permitted discharges	Pollutants	A	--	--
Site remediation	Elimination or reduction of pollution source	J	I, J	I, J
Petroleum spills	Pollutants	A, D, F	A, B, C, D, E, F, I	B, C, D, E, F, I, J
Marine Environment				
Noise		--	--	E, F, I, J
Oil/fuel spills		--	--	E, F, I, J
Air Quality				
Facility and equipment operations	Emissions from fuel combustion	A, D, E	A, B, D, E, I	B, C, D, E
	Fugitive emissions	A, C, F	A, C, F	C, F
Construction	Exhaust emissions	A, D, E	A, D, E, I	D, E, I
	Fugitive dust	A, D, E	A, D, E, I	D, E, I
Vehicles	Exhaust emissions	D, F	D, F	D, F
	Fugitive dust	D, F	D, F	D, F
Accidental spills	Evaporative emissions from crude oil, petroleum products, hazardous chemicals	J	J	J
Noise				
Construction activities	Equipment, blasting	A, D, E, F	A, D, E, F, I	D, E, F, I
Operations	Equipment, blasting	A, D, E, F	A, D, E, F, I	D, E, F, I
Transportation				
Marine railway	Materials, equipment, supplies	A, D	A, D, E, I	E, I
Dalton/Alaska highways	Materials, equipment, supplies	A, D	A, B, D, E, H, I	B, D, E, I
	Workers	--	A, D, E, H, I	B, C, D, E, H, I
	Residents	--	E	E
	Tourists	E, H, I	E, H, I	E, H, I

TABLE 4.7-7 (Cont.)

Environmental Attribute and Associated Activities	Impacting Factor	Major Contributing Actions, by Region[a]		
		Beaufort Sea and North Slope	Interior Alaska	Prince William Sound
Airports/airstrips	Workers, supplies	A, H	E, H, I	E, H, I
	Residents	E	E	E
	Tourists	E, H, I	E, H, I	E, H, I
Permanent/seasonal roads	Materials, equipment, supplies, workers	A	A, D, E, H, I	E, H, I
Ice/winter roads	Materials, equipment, supplies	A	A, D, E, H, I	--
Human Health and Safety				
Exploration	Occupational hazards	A	A	--
Construction	Occupational hazards	A, D, E, I,	D, E, I	E
Operations	Occupational hazards	A, D, H, J	B, C, D, E, H, I	B, C, D, E, H, I
	Toxic releases	A, D	B, C, D, E, I	B, C, D, E, I
Transportation	Vehicle emissions	F	F	F
	Accidents	F	F	F
Persistent environmental contaminants	Persistent organic pollutants (POPs)	A, D, E, F, H, I, global sources	B, C, D, E, F H, I, global sources	B, C, D, E, F H, I, global sources
	Heavy metals	A, E, F, J, natural sources	E, F, I, natural sources	E, F, I, natural sources
	Radionuclides	A, natural sources	B, E, I, natural sources	B, E, I, natural sources
BIOLOGICAL				
Vegetation and Wetlands				
Construction	Disturbance	A, D, E	D, E, F, I	E, I
	Dusts	A, D, F	D, E, F, I	E, I
	Erosion	A, D, E	D, E, F, I	E, I
Transportation	Dusts	A, D, F	B, C, D, E, F, I	C, E, F, H, I
Restoration	Disturbance	A, D	B, C, D, I	B, C, D, I
	Nonnative species	A, D	B, C, D, I	B, C, D, I

TABLE 4.7-7 (Cont.)

Environmental Attribute and Associated Activities	Impacting Factor	Major Contributing Actions, by Region[a]		
		Beaufort Sea and North Slope	Interior Alaska	Prince William Sound
Petroleum spills	Spills	A, D, F	B, C, D, E, F, I	B, C, D, E, F, I
Permafrost changes	Habitat loss/alteration	F	F	-.-
Fish				
Construction	Habitat loss/alternation	A, D, E	D, E, F, I	E, I
	Obstruction	A, D, F	D, F	I
Transportation	Harvest	A, D, F	D, E, F, H, I	D, E, F, H, I
Petroleum spills	Habitat loss/alteration	A, D, E	B, C, D, E, F, I	B, C, D, E, I
Birds and Mammals				
Construction	Habitat loss/alteration	A, D, `E	D, E, F, I	E, I
	Displacement	A, D, E	D, E, F, I	E, I
Operations	Obstruction	A, D	D, E, F, I	I
	Disturbance	A, D, E	D, E, F, H, I	B, C, D, E, I
Petroleum spills	Habitat loss/alteration	A, D, E	B, C, D, E, F, I	B, C, D, E, F, I
	Mortality	A, D, E	B, C, D, E, F, I	B, C, D, E, F, I
Transportation	Mortality	A, D, F	B, C, D, E, F, I	B, C, D, E, I
HUMAN				
Subsistence				
Construction/operation	Employment	A, D, E, H	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Permanent Fund Dividend	A, D	D	D
	Effects on resources	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Nonsubsistence use	H, I	E, H, I	E, H, I
Petroleum spills	Effects on resources	A, D, F	J	J
Sociocultural Systems				
Taxes and revenues	Public services and education	All actions	All actions	All actions
	Roads, airports, infrastructure	All actions	All actions	All actions

TABLE 4.7-7 (Cont.)

Environmental Attribute and Associated Activities	Impacting Factor	Major Contributing Actions, by Region[a]		
		Beaufort Sea and North Slope	Interior Alaska	Prince William Sound
Employment	Cash economy	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Acculturation	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Fragmentation	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
Economics				
Construction/operations	Expenditures	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Employment	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
	Taxes/revenues	A, D, E, H, I	B, C, D, E, F, H, I	B, C, D, E, F, H, I
Petroleum spills	Expenditures	A, D, F	B, C, D, E, F, I	B, C, D, E, F, I
	Employment	A, D, F	B, C, D, E, F, I	B, C, D, E, F, I
Land Use				
Construction/operations	Use conflicts	A, D, G, H	D, G, H	G, H
Petroleum spills	Fire	A, D	B, C, D	B, C, D
Coastal Zone Management				
Construction/operations	Visual changes	A, D	--	B, C, D
	Use conflicts	A, D, G, H	--	B, C, D, E, F, G, H, I
	Subsistence impacts	A, D, G, H	--	B, C, D, E, F, G, H, I
Recreation				
Construction/operations	Increased demand	--	D, E, I	--
	Conflict with use	--	D, E, I	--
Aesthetics				
Construction/operations	Visible effects	A, D	B, C, D, E, F, I	B, C, D, E, F, I
	Noise	A, D	B, C, D, E, F, I	B, C, D, E, F, I
Petroleum spills	Fire	A, D	B, C, D	B, C, D

[a] See Table 4.7.5-1 for further details.

[b] A hyphen indicates not applicable.

Sound) that are the focus of the cumulative analysis (see Table 4.7-2). Table 4.7-7 translates these major actions in each region of interest into sets of activities relevant to each environmental attribute considered in the cumulative impact analysis. For example, surface water resources (an environmental attribute) could be affected by oil development (an action) through permitted discharges, construction, land disturbance, water use, or spills (the activities). The activities, in turn, can be further translated into impacting factors (e.g., chemical pollutants, sedimentation, reduced flow) that can be used to evaluate the impacts of the action on the environmental attribute. The sum of these effects, then, represents the cumulative impacts on the specific environmental attribute in the region. Thus, impacting factors constitute the mechanism by which cumulative effects are analyzed and presented. While each activity in Table 4.7-7 has one or more corresponding impacting factors, each impacting factor can also be a component of more than one activity. For example, sedimentation can be an impacting factor for surface water resources for both construction and land disturbance.

4.7.6 Physical Environment

4.7.6.1 Soil and Permafrost

Activities associated with oil and gas exploration, development, and production and the construction of a natural gas pipeline could disturb vegetative cover and affect soils and permafrost in the North Slope and Beaufort Sea areas and Interior Alaska. These activities could include constructing roads, drilling pads, and pipeline; delivering heavy equipment; logging; and building support facilities. As the vegetative cover would be disturbed, the permafrost below the ground surface could be degraded, causing changes in the local hydrology, slope stability problems, and surface subsidence (see Section 4.3.2 on soils and permafrost).

The impacts would vary by location, since they would depend on the local geology, hydrology, and permafrost conditions. The impacts on the soil and permafrost would primarily occur in the local areas where the activities occurred. Therefore, since other activities in the Beaufort Sea and North Slope areas would affect local areas, there would be a negligible cumulative impact with any similar localized impacts of TAPS operations.

Construction of a gas pipeline from the North Slope either to Delta Junction in Interior Alaska or on to Valdez would require excavation in the vicinity of the TAPS ROW. Activities associated with TAPS and natural gas pipeline construction and operation would therefore act cumulatively to disturb vegetative cover and affect soils and permafrost. The disturbance caused by construction of the natural gas pipeline would be substantially larger than that caused by maintaining the TAPS; the contribution of the TAPS to cumulative impacts of soil disturbance in the region is expected to be small.

Under the less-than-30 year renewal alternative, cumulative impacts would be as stated for the proposed action. For the no-action alternative, the cumulative impacts on soil disturbance from oil exploration and development on the North Slope would decline as these activities declined, pending development of an alternative means of oil transportation. However, the combined effects of shutting down TAPS operations, removing facilities, and construction of a natural gas pipeline would have cumulative effects greater than those for the proposed action. This is because the activities involve extensive excavation and movement of heavy equipment. In summary, the cumulative impact on soil and permafrost caused by physical disturbance on the ground surface would be smaller under the proposed action than under the no-action alternative.

Permafrost is affected by road dust generated by traffic on unpaved roads; snow melt due to dust deposition can lead to flooding, ponding, and hydrological changes in soil (see Section 3.3.2.2 on permafrost degradation and aggradation). Because the Dalton Highway and other roads on the North Slope and in Interior Alaska are not paved, all activities that generate vehicle traffic on roadways generate dust. Thus, continuing oil and gas exploration, development, and production; construction of a natural gas pipeline; the operation of the TAPS; and other activities requiring road travel would

add cumulatively to the volume of road dust generated. The quantitative increase in the settled dust layer, as well as increases in the frequency of dusting may increase effects on vegetation and snow cover, thus ultimately affecting soils and permafrost.

The road dust generated from TAPS activities would be about the same or larger under the proposed action than under the no-action alternative because expected traffic volumes would be less under no action (Section 4.6.2.11). Under the no-action cumulative case, the amount of traffic due to oil exploration, development, and production would also decline. Depending on the balance of the transportation effects of these changes, the cumulative impact of road dust on soil and permafrost could be smaller, the same, or larger in the proposed action case than in the no-action case, while the contribution of the gas line construction to the total impact caused by the road dust in both alternatives would be the same.

If oil and gas exploration, development, and production in the North Slope and Beaufort Sea areas were expanded, or a gas pipeline parallel to the TAPS is constructed, the amount of road traffic caused by these activities would increase greatly over the traffic caused by regular maintenance operations for the TAPS. The cumulative impact of road dust on soil and permafrost would be smaller in the proposed action case than in the no-action case. Similarly, the cumulative impact on soil and permafrost caused by physical disturbance on the ground surface would be smaller under the proposed action than under the no-action alternative.

In summary, if oil and gas exploration, development, and production in the North Slope and Beaufort Sea areas continued and if the natural gas pipeline were constructed, the amount of road traffic caused by these activities could be greater than the traffic caused by regular maintenance operations for the TAPS. It is likely that the TAPS contribution to the total dust load would be smaller than that from the other activities in the North Slope area.

4.7.6.2 Sand, Gravel, and Quarry Resources

Sand, gravel, and quarry stones are needed to build the access roads, air strips, workpads, drilling pads, and gravel islands needed for oil and gas exploration, development, and production. These materials are mined in quarries in the Brooks Range and in floodplains throughout the region.

To reduce construction costs, most of the mining sites, to the maximum extent possible, would be located near areas where the materials would be needed. With continuing oil and gas exploration, development and production in the Beaufort Sea, North Slope, and Interior Alaska, and with development of the natural gas pipeline and with other industrial and community development, additional quantities of sands, gravels, and quarry stones would be needed. Other actions in Interior Alaska, such as mineral development, logging, and urban development, would require roads and other facilities, which, in turn, would require sand and gravel. The sand and gravel requirements for the natural gas pipeline on the North Slope and in the Interior Alaska are not known, but these resources might be required along the ROWs and access points. Rip rap might be needed at river crossings. The majority of these materials would be mined and impact areas would be outside the areas where the TAPS is located. However, some of the materials could be extracted in areas near the TAPS or from the same quarries or gravel pits as those used by the TAPS. The latter actions would contribute to a cumulative impact. However, taken as a whole, sand, gravel, and stone resources are abundant, and all requirements are unlikely to deplete these resources.

The requirement designed to protect the tundra environment — to use ice roads in winter and ice pads in exploratory drilling pads — reduces the quantity of gravel that would otherwise be used for roads to reach remote areas. However, ice roads or ice pads might not be used in places where continued access during summer (for maintenance) or operational access is required. Sands and gravels would be required at remote locations for pad construction, production facilities, and

associated infrastructure. On the North Slope, the source for rock for rip rap and river framing is limited to quarries in the Brooks Range. The contribution of the TAPS to the total impact would likely be much smaller than that of the other continuing and new activities in the North Slope area.

Under the less-than-30-year renewal alternative, cumulative impacts would be as stated for the proposed action. Under the no-action alternative, sand, gravel, and quarry stone requirements might increase while TAPS facilities were dismantled and removed. However, sand, gravel, and quarry stones would no longer be needed for the TAPS after early phases of the termination activities were completed, and requirements for oil exploration, development, and production would decline. However, the gas pipeline would require sand, gravel, and quarry stone resources. Therefore, the cumulative impact on these resources would be smaller under the no-action alternative than under the long-term proposed action.

4.7.6.3 Paleontology

Any action that involves ground disturbance creates a potential for impacts to paleontological resources existing in the affected area. Paleontological resources may also be impacted by collecting and disturbance by the presence of people associated with these actions. However, given the variability of the scientific importance of paleontological resources, there is the potential for significant adverse cumulative impacts when all other actions are considered together. Mitigating this cumulative impact would require addressing protection of paleontological resources for these other actions on a case-by-case basis. However, impacts to paleontological resources from continuing operations of the TAPS will be avoided according to provisions in the Federal Grant that address paleontological materials, and continued operation of TAPS would not add to any significant impact on paleontological resources. Under the no-action alternative and the less-than-30-year renewal alternative, the cumulative impacts would be similar to cumulative impacts with the proposed action. Construction of a natural gas pipeline would be a major ground disturbing activity of a few years' duration. These impacts would be offset by declining oil and gas development activities on the North Slope. In summary, any ground disturbing activity involves the potential for impacts to paleontological resources requiring mitigation on a case-by-case basis.

4.7.6.4 Surface Water Resources

A number of foreseeable actions have been identified (Section 4.7.3) that could produce impacts to surface water resources in three regions associated with the TAPS ROW: the North Slope, Interior Alaska (along the TAPS ROW), and Prince William Sound. These actions could interact cumulatively with impacts from the proposed action and the no-action alternative. Impacting factors related to these foreseeable activities include permitted discharges; erosion; sedimentation; bank, channel, and shore modifications; water use; site remediation; and spills. Potential impacts of these factors on surface water resources include reduced quantities of water and degraded water quality.

Oil and gas exploration, development, and production require the use of large quantities of water. Maximum bounding estimates for one project are that construction of 1 mi of ice road requires about 1 million gal of water; an ice pad that is square and 600 ft on a side requires about 21 million gal of water; and construction of an ice airstrip requires about 8 million gal of water (BP Exploration 2000). For the same project, drill rig use would require about 9 million gal of water annually, rig-camp use for 120 people would be about 2 million gal of water annually; mobile camp water use for 60 people would be about 0.5 million gal of water per year; and ice pad, road, and airstrip maintenance would use another 9 million gal of water per year. For the North Slope as a whole, the typical annual water use for oil exploration is about 27 billion gal (ADNR 2001). This value represents about 0.27% of the total water available on the North Slope in any given year.

Water requirements on the North Slope in summer would be met by using water from lakes and river pools. Water from taliks (unfrozen water in deep pools below the surface of rivers and lakes) would be used in winter when the surface water was frozen (BLM 1983). Water

withdrawals from taliks could be limited by permit to no more than 15% of the available water (ADNR 2001). For the town of Barrow, the Barrow Utilidor System, which is owned and operated by the North Slope Borough, provides about 200,000 gal/d of water from the Isatkoak Reservoir (AWWA 2002).

Impacts to the quantity of surface water from foreseeable activities would be cumulative if the water withdrawals occurred in the same watershed. Because the total water use for the North Slope is about 0.27% of the available water, impacts from the foreseeable actions could be small in magnitude and local. Impacts from continued operation of the TAPS would be cumulative with other activities on the North Slope only if the same source area was used. Some major water users, such as oil and gas development, are not located along the TAPS ROW. However, water for construction of a natural gas pipeline may affect surface waters in the TAPS ROW, however, these effects would be small in magnitude and local. By following the guidelines on the permissible levels of water withdrawal specified in Alaska water-use permits, impacts of surface water use on the quantity of surface water could be minimized.

The quality of surface water resources (dissolved constituents and sediment) could also be affected by oil and gas exploration, development, and production; oil and gas transportation; and human habitation and development in the North Slope and Beaufort Sea area. Since water would be withdrawn from taliks during winter, oxygen demand by sediments and water could reduce the concentration of oxygen in the water needed by overwintering fish. However, only 15% of water under the ice sheet may be withdrawn (ADNR 2001), which would reduce the potential for oxygen reduction or loss and the release of harmful substances from the sediments. The quality of surface water in other areas could be affected by discharges during drilling, sedimentation and runoff from road construction, discharges from homes and developments, and spills. Impacts of these activities would be cumulative if the surface discharges or spills occurred in the same watershed. Impacts from the foreseeable actions could be small in magnitude and local. Impacts from continued operation of the TAPS would be similarly small in magnitude and local on the North Slope. However, the effects on water quality if a large spill was released directly to surface water could be large and extensive, and the magnitude of the effects would depend on the speed of cleanup response teams and the local conditions affecting oil dispersion. The probability of this type of spill occurring is very small. Impacts from anticipated or likely small spills would produce small and local impacts on surface water quality. By following guidelines established for appropriate Alaska discharge permits, limits on the volume of water that can be withdrawn under ice cover, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on water quality could be minimized.

In Interior Alaska (i.e., along the TAPS ROW), quantity and quality of surface water could be cumulatively affected by oil and gas exploration, development, and production; oil and gas transportation; oil refining; and human habitation and development. Surface water would be used for activities such as drilling, oil refining, construction (including a natural gas pipeline), dust control, and human consumption. Water requirements would be met by using water from lakes, river pools, taliks (during the winter; BLM 1983), and groundwater wells (see Section 4.7.6.5). Large construction projects, such as the natural gas pipeline, would probably obtain water from nearby rivers and streams. Impacts of these activities on surface water would be cumulative with those from the proposed action, if the water withdrawals occurred in the same watershed. As discussed in Section 4.3.6, impacts of the proposed action on surface water would be negligible in magnitude, local, and temporary because most water needs are met by using groundwater wells along the TAPS ROW. It is anticipated that the cumulative impacts of the foreseeable actions would be minimized as much as possible by using good engineering practices. Implementation of the foreseeable actions would require compliance with all applicable permit restrictions, laws, and regulations.

The quality of surface water resources in Interior Alaska could also be affected by oil and gas exploration, development, and production; oil refining; and human habitation and development. Surface water quality is affected by both dissolved constituents and sediment. Similar to withdrawal from taliks on the North Slope, water withdrawal from taliks in Interior Alaska could affect overwintering fish if a large proportion of liquid water were withdrawn. This effect is limited by water withdrawal permit conditions. Similarly, the quality of surface water could be affected by discharges during drilling, sedimentation and runoff from road construction (particularly during construction of a natural gas pipeline), refinery construction and operation, human habitation and development, and spills. Impacts of these activities would be cumulative with those from the proposed action if the surface discharges or spills occurred in the same watershed. Depending on the quantities of pollutants released, impacts from the foreseeable actions could be large in magnitude and local. Impacts from continued operation of the TAPS would, in general, be small and local because of existing permit conditions. However, impacts from a large spill could be major in magnitude and extensive, depending on the speed of cleanup response and the conditions affecting dispersal. (For example, a guillotine break caused by a helicopter or fixed-wing aircraft crash could spill oil directly into a river or stream at an elevated crossing.) In the case of smaller spills, cleanup response would limit the extent of contamination and effect on water quality. By following guidelines established for appropriate Alaska discharge permits, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on water quality would be minimized.

In the area of Prince William Sound, oil refining; oil and gas transportation; and human habitation and development could affect both the quantity and quality of available surface water. The quantity of surface water available could be reduced by activities such as road construction and dust control, building construction, and human habitation and development, however, water in the Valdez area is supplied by four primary groundwater wells (Vacation Alaska 1999). If the foreseeable project water needs were met by using groundwater from these wells or other new wells, there would be no impact to surface water quantities. Impacts from anticipated or likely small spills would produce small and local impacts because of the small volumes of oil released. (Cumulative impacts to groundwater are discussed in Section 4.7.6.5). Impacts from continued operation of the TAPS for the proposed action would, then, be the only component of the cumulative impact to surface water quantities in the Prince William Sound area. These impacts, as previously discussed, would be small in magnitude, local, and regulated by applicable permits for water use at the Valdez Marine Terminal.

The quality of surface water resources in the area of Prince William Sound could also be affected by oil refining; oil and gas transportation; and human habitation and development. Surface water quality is affected by both dissolved constituents and sediment. The quality of surface water could be affected by runoff from road construction, refinery construction and operation, human habitation and development, and spills. Impacts of these activities would be cumulative with those from the proposed action if the surface discharges or spills occurred in the same watershed. Impacts from the foreseeable actions could be large in magnitude and local. Impacts from continued operation of the TAPS would, in general, be small in magnitude and local, except for impacts from spills, which could be major and extensive (e.g., a catastrophic failure of an oil storage tank at the Valdez Marine Terminal). For anticipated or likely small spills, impacts to surface water quality would be small and local because of the small volumes of oil released. The recipients of most of these impacts would be marine waters (see Section 4.7.6.7) rather than freshwater rivers or streams, which are limited in number and size in the vicinity of the Valdez Marine Terminal. By following guidelines established for appropriate Alaska discharge permits, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on water quality would be minimized.

For the less-than-30-year renewal alternative, cumulative impacts would be as stated for the proposed action. Under the no-action alternative, the Federal Grant of ROW would not be renewed, and oil would no longer flow through the pipeline to the Valdez Marine Terminal. Oil production on the North Slope would cease, and there would be no exploratory drilling for oil. However, it is assumed gas production on the North Slope would continue, as would exploratory drilling for gas. Because oil production and exploratory drilling for oil would cease, water use on the North Slope would be greatly reduced, and impacts to surface water quality from activities (e.g., ice road construction, other construction, and camp use), discharges from homes and developments, and spills would also be greatly reduced.

In Interior Alaska, cumulative impacts along the TAPS ROW would be temporarily increased during removal of the oil pipeline and associated structures. These impacts would include water use and modification of the existing water quality. Impacts from TAPS removal would be cumulative with those from construction of a new gas pipeline. Although construction and removal impacts would only occur for a short time, the cumulative impacts along the TAPS ROW would be large in magnitude and extensive (occurring along a substantial portion of the 800-mi length of the pipeline). Once the pipeline was removed, impacts from any TAPS-related spills would no longer be possible, and impacts to surface water quality would be limited to other non-TAPS-related projects.

In the Prince Williams Sound area, impacts to surface water quantity and quality would be initially high as TAPS facilities were removed; however, these impacts would be temporary. Once removal activities were completed, impacts would be produced by other non-TAPS related projects. Because surface water would not be used for these other activities, impacts to the quantity of surface water available would be negligible. Impacts to water quality would be minimized, to the extent possible, by following good engineering practices and provisions in appropriate Alaska discharge permits.

In summary, the cumulative impacts of all activities would have small and local impacts on surface water quantity and quality. Permit requirements related to water withdrawals and discharges to surface waters, as well as cleanup of small petroleum spills, would protect surface water resources. The impacts of TAPS operations on surface water resources would be small in comparison to other actions such as oil exploration and development, water requirements for construction of a natural gas transportation system, and the requirements of other industrial and municipal systems.

4.7.6.5 Groundwater Resources

A number of foreseeable actions have been identified that could produce impacts to groundwater resources in three regions associated with the TAPS ROW: the North Slope, Interior Alaska (along the TAPS ROW), and Prince William Sound. These actions could interact cumulatively with impacts from the proposed action. Specific impacting factors for these foreseeable activities include water use, permitted discharges, site remediation, and spills. Impacts to groundwater resources include reduced quantities of water available and degraded water quality.

In the North Slope area, oil and gas exploration, development, and production; oil and gas transportation; and human habitation and development could affect the quantity and quality of groundwater directly or indirectly. While groundwater resources could be used for such activities as drilling, road construction (particularly ice roads), construction and dust control, and human consumption, water needs on the North Slope are typically met by using surface water resources (BLM 1983) (see Section 4.7.6.4). Therefore, cumulative impacts to the available groundwater from the foreseeable actions, together with the proposed action would be none to negligible.

The quality of groundwater resources could also be affected by oil and gas exploration, development, and production; oil and gas transportation; and human habitation and development in the North Slope. Both direct and indirect impacts could occur. Direct impacts on water quality would result from direct discharges to the groundwater from drilling operations (e.g., disposal of production water in deep

formations) and septic systems. However, disposal of production water in deep formations would not impact water available for human consumption. Indirect impacts on water quality would result from the infiltration of contaminated surface water derived from petroleum spills. Impacts from these sources would be cumulative with the proposed action only if contaminants reached the same aquifers. However, these impacts would be controlled and minimized by prompt cleanup actions. Impacts on water quality from the foreseeable actions would be small in magnitude and local because of the presence of the permafrost in this region. Impacts from spills from all actions could be large and extensive if contamination from unlikely or very unlikely large spill events were allowed to reach the groundwater. Impacts to water quality from continued operation of the TAPS would be small in magnitude and local on the North Slope (no cumulative impacts along the TAPS ROW would be derived from North Slope actions), except for spills, which could produce large and extensive impacts if allowed to reach the groundwater. The cumulative impact of foreseeable actions and the proposed action would be small in magnitude and local. Impacts from anticipated spills would be small and local because of the small volumes released. By following guidelines established for appropriate Alaska discharge permits, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on water quality would be minimized.

In Interior Alaska (i.e., along the TAPS ROW), groundwater quantity and quality could be cumulatively impacted by oil and gas exploration, development, and production; oil and gas transportation; oil refining; and human habitation and development. The quantity of groundwater available may be locally reduced because water would be used for industrial activities such as drilling, oil refining, construction; dust control, and human consumption. Within Interior Alaska, water needs are usually met by using groundwater wells. For example, the City of Fairbanks acquires all of its water from wells. In 1996, the monthly mean water withdrawal was about 6 million gal/d (USGS 2002b).

For the foreseeable actions in Interior Alaska, water requirements would be met by using groundwater wells, although surface water resources could be used to meet natural gas pipeline construction needs. Impacts of these activities on groundwater resources would be cumulative with those from the proposed action, if the water withdrawals were from the same aquifer. Impacts produced by the foreseeable actions could be large in magnitude and local if withdrawals were a substantial proportion of the available resource. As discussed in Section 4.3.6, impacts of the proposed action on groundwater quantities would be negligible and would be a small component of the cumulative impact. The cumulative impacts of the foreseeable actions would be minimized as much as possible by using good engineering practices. Implementation of the foreseeable actions would require compliance with all applicable permit restrictions, laws, and regulations.

The quality of groundwater resources in Interior Alaska could also be affected by oil and gas exploration, development, and production; oil refining; and human habitation and development. Both direct and indirect impacts could occur. Direct impacts could result from direct discharges to the groundwater from industrial activities and septic fields. Indirect impacts could result from the infiltration of contaminated surface water from industrial and municipal sources and from spills which were not cleaned up. Impacts of these activities would be cumulative with those from the proposed action, if the direct discharges were to the same aquifer or if contaminated surface water infiltrated the same aquifer. Impacts from the foreseeable actions could be large in magnitude and local if any wastewaters were disposed of by deep well injection. Impacts from continued operation of the TAPS would, in general, be small and local, except for impacts from unlikely or very unlikely large spills, which could be large and extensive (e.g., a very unlikely underground guillotine break caused by seismic activity or a landslide). The cumulative impact of foreseeable actions and the proposed action would be large in magnitude and local, with the contribution from continued TAPS operation being negligible to small in magnitude, except for the impacts from spills. In the case of spills, the cumulative

impacts could be very large in magnitude and extensive, particularly if a large unlikely spill was released directly to groundwater. For anticipated spills, impacts would be small and local because of the small volumes of contaminants released and because they would be promptly cleaned up. By following guidelines established for appropriate Alaska discharge permits, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on water quality could be minimized.

In the area of Prince William Sound, oil and gas transportation, and human habitation and development could affect both the quantity and quality of groundwater. The quantity of groundwater could be reduced because water would be used for activities such as industrial requirements, road construction and dust control, building construction, and human consumption and development. Water in the Valdez area is supplied by four primary groundwater wells (Vacation Alaska 1999). Water is stored in two 750,000-gal reservoirs before it is piped throughout Valdez. If foreseeable project water needs were met by using groundwater from these wells or other new wells, the impacts on the groundwater system could be large, and the water table would be lowered. Water for operation of the Valdez Marine Terminal is obtained from surface water resources. Impacts from continued operation of the TAPS under the proposed action would thus be a negligible component of the cumulative impact to groundwater quantities in the Prince William Sound area.

The quality of groundwater resources in the area of Prince William Sound could also be affected by oil refining; oil and gas transportation; and human habitation and development. Both direct and indirect impacts could occur. Direct impacts would result from direct discharges to the groundwater from septic fields. Indirect impacts would result from the infiltration of contaminated surface water. Impacts from continued operation of the TAPS would, in general, be small in magnitude and local, except for impacts from spills, which could be larger and more extensive (e.g., a very unlikely catastrophic failure of an oil storage tank at the Valdez Marine Terminal). The cumulative impact of foreseeable actions and the proposed action would be large in magnitude and local, with the contribution from continued TAPS operation being small in magnitude, except for the impacts from spills. In the case of spills, the cumulative impacts could be very large and extensive for unlikely to very unlikely spill scenarios. For anticipated spills, impacts could be small and local because of the small volumes of contaminants released. By following guidelines established for appropriate Alaska discharge permits, meeting restrictions on the storage of toxic construction and operations materials, and meeting requirements for cleanup of all toxic materials as part of construction and normal operations, cumulative impacts on groundwater quality would be minimized.

Under the less-than-30-year renewal alternative, cumulative impacts would be the same as those under the proposed action. Under the no-action alternative, the Federal Grant of ROW would not be renewed, and oil would no longer flow through the pipeline to the Valdez Marine Terminal. Oil production on the North Slope would cease, and there would be no exploratory drilling for oil. However, it is assumed gas production on the North Slope would continue, as would exploratory drilling for gas. Because oil production and exploratory drilling for oil would cease, water use on the North Slope would be greatly reduced. Because this water is normally supplied from surface water resources, there would be no effect on the groundwater resources. However, groundwater quality could still be impacted by such activities as exploratory drilling for gas (e.g., brine disposal), discharges from septic fields, and spills. With the curtailment of oil field drilling, impacts from normal operations to groundwater quality would be greatly reduced. Although the impacts of spills could still be high, the occurrence of spills would be reduced with the curtailment of oil production and exploratory drilling for oil.

In Interior Alaska, cumulative impacts along the TAPS ROW would be increased during removal of the oil pipeline and associated structures and construction of a natural gas pipeline. These impacts include water use and

modification of the existing water quality. Impacts from TAPS removal would be less than those from construction of a new natural gas pipeline. Because construction and removal impacts would only occur for a short time, the cumulative impacts along the TAPS ROW would be extensive in area (occurring along a substantial portion of the 800-mi length of the pipeline) and temporary. Once the TAPS pipeline was removed, impacts from any TAPS-related spills would no longer be possible, and impacts to groundwater quality would be limited to those produced by other non-TAPS-related projects.

In the Prince William Sound area, impacts to groundwater quantity and quality would be initially high as TAPS facilities were removed; these impacts would be temporary, however. Once removal activities were completed, impacts would be produced by other non-TAPS-related projects. Because groundwater is the primary source of water in the area, impacts to the resource could be large. Impacts to groundwater resources could be minimized, to the extent possible, by following good engineering practices and provisions in appropriate Alaska discharge permits.

In summary, cumulative impacts on groundwater would be small and local. These impacts would be related to oil and gas exploration, development, and production, and by other industry and community withdrawals. In the event of an unlikely or very unlikely large spill, groundwater could also be affected if contamination was allowed to reach the groundwater. Continued operation of the TAPS would be a small contributor to the cumulative impacts on groundwater resources.

4.7.6.6 Physical Marine Environment

Potential cumulative impacts to the physical marine environment associated with the TAPS would come from tankers traveling from the Valdez Marine Terminal through Prince William Sound to the Hinchinbrook Entrance. These transits would create noise and involve the risks of petroleum spills or other accidents. Other actions that would be cumulative with the impacts from tanker traffic are commercial fishing, recreational fishing/sightseeing, commercial sightseeing/tours, and other commercial cargo operations in Port Valdez and Prince William Sound. With the exception of the risks from larger oil spills, these cumulative impacts on the physical marine environment would be small and short-lived. Small spills from all vessels are rapidly responded to and cleaned up by the spill response infrastructure supporting the oil transportation industry.

Section 4.7.4.10.5 discusses potential spills and accidents that could impact Port Valdez and Prince William Sound. The GNOME computer program (NOAA 2000b) was used to estimate the spread of oil from the various release points identified in Table 4.7-4 GNOME uses location files to specify local conditions; this analysis used the Prince William Sound location file compiled by NOAA (2002b). The Prince William Sound location file includes the effects of five current patterns to simulate the circulation and tides in Prince William Sound and Port Valdez. NOAA (2002b) states:

> "The tides at Hinchinbrook Strait, Port Wells, Montague Strait, and Valdez Arm are each simulated with separate current patterns. The tidal circulation of Latouche Passage, Elrington Passage and Prince of Wales Passage are all simulated with two current patterns: (1) a modified portion of the Montague Strait current pattern and (2) a background current pattern. The background current pattern models the net surface currents through each of these passages: Latouche Passage (–0.3 knots); Elrington Passage (0.3 knots); and Prince of Wales Passage (–0.9 knots). The tidal current pattern for Montague Strait was extended to each of these passages with relative amplitudes that approximate the residual tides. Since the phase differences between these areas were on the order of an hour, this approximation was considered acceptable."

The spill scenarios assume that a volume of North Slope crude oil ranging from 50,000 to 290,000 bbl would be released instantaneously at various locations in Port Valdez, the Valdez Narrows, and Prince William Sound, and that it

would spread for 6 hours before response and containment. This is the range of oil spill volumes that would be expected to be released from a tanker accident (see Table 4.7-4). The actual response time might be significantly different (either higher or lower) from the assumed 6-hour value, depending on weather conditions, the location of the spill, and other factors. If the spills occurred under extreme weather conditions in which the winds and currents were different from those used in the model, response times could be longer, and the released oil could travel more rapidly, so a much larger area would be impacted by the potential oil spills than the area estimated here.

Prevailing winds in Port Valdez and Prince William Sound are generally from the northeast, with speeds up to 15 knots. The other prevalent wind direction in Port Valdez is from the southwest at about 12 knots (TAPS Owners 2001). Both of these prevailing winds were used in the model runs to estimate the impacts of the various spill scenarios. Because specific locations for these spills were not known, a number of locations from Port Valdez to the Hinchinbrook Entrance were evaluated. In addition to the effects of wind variability, the differences in currents at different times of the day were also incorporated into the calculations.

For all the release scenarios modeled, the oil slick moved out from the release point and expanded radically, except the expansion was larger in the direction of the prevailing winds and currents. The general direction of the oil movement depended on the wind direction.

The best estimate of the shape of the area in which 99% of the oil would be in the water within 6 hours after the release is that it would be an almost-circular ellipse, if the spill could not reach the shoreline. This area would extend about 4-1/2 mi in diameter from the release point. The general shape of this estimated area would be different for different release points, since it would be influenced by winds and currents in the spill location.

The GNOME program also has the capability to evaluate the relative uncertainties of various parameters used in the model projections. These calculations are implemented by using a “minimum regret” approach (see Section 4.4.4.5.2). The estimated areas that would contain the oil spill plume after 6 hours would be ellipses about 10 mi in diameter, approximately centered on the release point, in an almost circular shape.

Spills starting at locations near the center of Prince William Sound would not reach the shoreline within the assumed 6-hour response time; spills starting at locations within 5 mi of the shore could potentially reach the shoreline within the 6-hour assumed time limit. Potential oil spill locations within Port Valdez and the Valdez Narrows would release oil over large portions of the shoreline, up to 10 mi (5 mi on each side of Port Valdez or the narrows) in the assumed 6-hour response window. Potential oil spill locations near the Hinchinbrook Entrance would also release oil over large amounts of shoreline, up to 6 mi or more, depending on prevailing wind directions at the time of the spill.

All spills within the range of spill volumes evaluated would behave in a similar manner, and the oil would be transported over comparable distances. The only difference would be in the concentration of oil within the plume.

It is assumed that at the 6-hour point, the spill would be contained, and further spreading of the oil would stop. However, it is possible that some oil would escape the initial containment and could impact other areas in Port Valdez and Prince William Sound. The impacts outside the containment area would be small and localized. Within the containment area, the impacts would be significant.

It is assumed that once the oil was contained, removal actions would begin. As noted in Section 4.4.4.5.4, North Slope crude oil does not significantly dissolve into the water column during the first 24 hours after a spill; however, some dissolution does take place. Dissolved constituents resulting from the spill could have minor local impacts, but dilution effects would limit the impacts away from the spill areas. As noted in Section 3.9.3 on affected marine environment, the waters of Port Valdez and Prince William Sound are well-mixed and would dilute dissolved constituents from the spill.

Releases near the shore would heavily oil the shoreline, and the waters immediately around the area would also be affected. The oiled shoreline could also continue to affect the waters of Port Valdez and Prince William Sound in the immediate area of the spill for a long time after the initial release. However, because of dilution and the existing hydrocarbon background concentrations, changes in seawater hydrocarbon concentrations would be minimal and localized. Impacts could also occur in other areas of Port Valdez and Prince William Sound away from the release point or oiled shoreline; these impacts on seawater hydrocarbon concentrations would also be small and localized. As noted in Section 3.11.3, significant hydrocarbon background concentrations already exist in Port Valdez waters. Low concentrations resulting from long-term releases from an oiled shoreline would not be distinguishable from background concentrations at any locations except the areas very near the source location.

Mitigation for spills occurring during tanker transit from Port Valdez and in Prince William Sound would include (1) minimizing the time for response and the time required to contain a release, (2) deploying containment systems quickly, and (3) starting removal actions before weather or other adverse conditions could make containment difficult.

Under the less-than-30-year renewal alternative, the impacts from any oil spill would be the same as those discussed for the proposed action. Under the no-action alternative, oil shipments from the TAPS would cease, and there would be no risk of an oil spill from a TAPS-related tanker. However, risks from an oil spill from other marine traffic would remain. If the spill emergency response infrastructure was not maintained, the environmental effects of fuel or oil spilled by non-TAPS-related vessels could be larger than those under the proposed action.

4.7.6.7 Air Quality

Reasonably foreseeable actions that might impact air quality and AQRVs (visibility and acid deposition) include exploration, development, production, storage, refining, and transportation of oil and gas; human habitation and development; land management activities; and natural resource uses. Specific factors inherent to these actions impacting air quality and AQRVs include emissions from (1) the operation of facilities and equipment (exhaust emissions from fuel-burning equipment and fugitive emissions of dust and VOCs); (2) construction activities (exhaust emissions from heavy equipment and vehicles and fugitive emissions of dust from land disturbance); (3) accidental spills of crude oil, petroleum products, and hazardous chemicals (evaporative emissions); and (4) transportation activities (exhaust and road dust emissions from vehicles).

Emissions associated with the operation of industrial facilities and equipment are usually continuous and long-term, while those associated with construction activities or spills are usually intermittent and short-term. Emissions from transportation activities can be either short-term or long-term, depending on whether they are associated with facility construction or operational activities. Potential impacts on air quality (and AQRVs) from operational, construction, and transportation activities and those from accidental spills under the proposed action are described in Sections 4.3.9 and 4.4.4.6, respectively. Results of air quality impact modeling of emissions from TAPS facilities, including pump stations and the Valdez Marine Terminal, show that ambient air quality in the vicinity of the TAPS ROW would remain in compliance with applicable ambient air quality standards under the proposed action. In addition, available ambient air quality monitoring data in the vicinity of the TAPS ROW indicate that cumulative air quality impacts from the TAPS and other existing industrial facilities as well as from other human activities would not result in ambient air quality exceeding applicable ambient air quality standards (Table 3.13-10). Potential impacts on air quality (and AQRVs) from termination activities under the no-action alternative are estimated to be less than those under the proposed action (Section 4.6.2.9).

Twelve TAPS facilities are located along the 800 mi of the TAPS ROW. They include 11 pump stations (4 are currently in ramp-down mode) and the Valdez Marine Terminal. Therefore, it is likely that many locations of reasonably foreseeable actions would be spatially separated from the TAPS facilities by

considerable distances. In these cases, there would be little long-term cumulative impacts due to the potential long-term emissions from reasonably foreseeable actions in combination with the proposed action. In cases where reasonably foreseeable actions would be located close to TAPS facilities, there could be observable cumulative impacts. However, all new or modified industrial facilities that would have a significant amount of new emissions or emission increases (major new source or modification) would have to comply with the Prevention of Significant Deterioration of Air Quality regulations (18 AAC 50.020), which limit the maximum allowable incremental increases in ambient concentrations above established baseline levels (Table 3.13-8). Therefore, any potential long-term cumulative air quality impacts due to reasonably foreseeable actions in combination with various activities under the proposed action would be limited and would not result in deterioration that would exceed applicable ambient air quality standards.

It is also likely that many locations of construction activities or spills associated with the reasonably foreseeable actions would be separated spatially from the TAPS facilities or temporally from the TAPS-related construction activities or spills under the proposed action, or from termination activities under the no-action alternative. In these cases, there would be little or no short-term cumulative impacts due to the potential emissions from construction activities or spills associated with the reasonably foreseeable actions in combination with the proposed action or the no-action alternative. In cases where construction activities or spills associated with the reasonably foreseeable actions would be located close to TAPS facilities or occur simultaneously and in close proximity to TAPS-related construction or termination activities, there could be observable cumulative impacts. However, the potential air quality impacts of emissions from these construction activities or spills would be short-term and localized to the immediate vicinity of construction or spill sites. Mitigation measures, such as watering to control fugitive dust at construction sites and containment and recovery of spilled materials by spill response teams, would minimize the potential impacts on ambient air quality. Thus, any potential short-term cumulative air quality impacts due to construction activities or spills associated with the reasonably foreseeable actions in combination with the proposed action or the no-action alternative would be limited and would not result in deterioration that would cause ambient air quality to exceed applicable standards.

Transportation of personnel, equipment, materials, and supplies for construction activities associated with reasonably foreseeable actions, such as the natural gas pipeline, would result in increased traffic volumes on the roadways near the TAPS. Potential increases in traffic volume along Dalton Highway due to the natural gas pipeline construction and operation would be expected to be small (see Section 4.7.6.9). Existing traffic volumes on these highways are also low.[3] Thus, it is estimated that potential cumulative air quality impacts due to the emissions from small increases in traffic volumes in combination with the proposed action or the no-action alternative would be limited and would not result in deterioration of ambient air quality along these highways that would cause ambient air quality to exceed applicable standards.

In summary, little or no potential long-term and short-term impacts on air quality (and AQRVs) are estimated to result from reasonably foreseeable actions in combination with the proposed action or the no-action alternative. Such impacts would not result in deterioration of air quality that would cause ambient air quality to exceed applicable standards.

4.7.6.8 Noise

The construction and operation of industrial facilities and equipment, transportation, and mining can produce annoying or harmful levels of noise. Potential noise impacts due to

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3 Annual average daily traffic volumes along Dalton Highway range from about 200 to 300 vehicles per day, and those along the Alaska Highway range from about 400 to 3,000 vehicles per day. These values can be compared with tends of thousands to more than 100,000 vehicles per day for a busy urban highway.

operational and construction activities under the proposed action are described in Section 4.3.10. It is estimated that there would be no adverse noise impacts beyond TAPS facility site boundaries from the noise emitted during TAPS facility operations. Potential noise impacts due to any construction activities under the proposed action or termination activities under the no-action alternative would also be limited to within the TAPS facility site boundaries or the immediate vicinity of construction sites. Therefore, any cumulative noise impacts due to noise emitted from the reasonably foreseeable actions, in combination with noise emitted from TAPS operational or construction activities under the proposed action or termination activities under the no-action alternative, would be limited to within the facility site boundaries or the immediate vicinity of construction sites.

4.7.6.9 Transportation

The transportation network currently plays a key role in North Slope oil and gas exploration, development, and production. One major route by which equipment, materials, and supplies enter Alaska is via the rail marine service between Seattle and Whittier. From Whittier, the cargo is shipped by rail to Fairbanks. The cargo is then shipped by truck from Fairbanks via Dalton Highway to the North Slope for use. The Deadhorse Airport also plays an important role in North Slope operations as a terminus for personnel and some cargo.

Aside from the existing road network, some roads and workpads need to be constructed on the North Slope for oil and gas exploration. Ice roads and pads are employed when possible to reduce impacts to water, soil, and vegetation. Oil and gas exploration and development on the North Slope is an ongoing process in which a relatively constant number of contractors move from area to area to locate more producing well fields. Over time, the number of production wells does not change significantly because older well fields eventually become uneconomical. The older wells are taken off-line, while new producing wells are brought on-line as a result of the exploration and development. Thus, North Slope activities would not be expected to change significantly in the foreseeable future, and the associated demands on the area's transportation infrastructure from oil and gas exploration, development, and production could be readily accommodated.

The construction of a natural gas pipeline might impact the transportation corridor that is also used by the TAPS. The existing transportation network is expected to be capable of transporting personnel, equipment, materials, and supplies for natural gas pipeline construction. This infrastructure has been incrementally upgraded over the years since the construction of the TAPS. (Transportation of material, goods, and services for the natural gas pipeline construction might temporarily increase use on the roadways.) It is expected that any natural gas pipeline would follow existing roadways to facilitate construction and maintenance. The most noticeable impacts would occur in the immediate vicinity of the current focus of construction along the affected highways as a result of the entry and exit of workers and construction equipment. However, proper staging of equipment and gas pipeline components along the affected highways would minimize delays along the routes associated with deliveries to the current construction site. In general, any impacts to travel along the affected highways would be expected to be small because daily traffic volumes are relatively low. Annual average daily traffic volumes along Dalton Highway range from about 200 to 300 vehicles per day. Traffic volumes along the major highways south of Fairbanks vary significantly and fall into the range of approximately 300 to 2,000 vehicles per day away from the larger communities such as Anchorage, Delta Junction, Fairbanks, Glennallen, and Valdez (ADOTPF 2001; Richards 2002). Commercial truck traffic constitutes approximately 10% to 40% of these volumes. Traffic in mid-summer is close to double the annual averages in some locations. Because of these relatively low traffic volumes, additional traffic from natural gas pipeline construction would not be expected to cause significant impacts, such as traffic delays.

Under the less-than-30-year renewal alternative, the impacts discussed above for the proposed action also would apply. However, should the TAPS ROW renewal not be granted, a number of changes might occur. Without the

pipeline, an alternative means of transporting oil from the North Slope to the refineries and Prince William Sound would need to be identified. Should further transportation of oil from the North Slope prove to be infeasible, railroad transport of petroleum products from the North Pole refinery to Anchorage would cease, resulting in approximately a one-third cut in the railroad's annual revenue. A decrease or cessation of oil exploration and production on the North Slope would also decrease the need for rail shipments of materials and supplies to Fairbanks and subsequent shipment by truck up the Dalton Highway. In addition, personnel and supply transport into the Deadhorse Airport would also decrease.

4.7.6.10 Wastes

Waste impacts would result from many of the past, present, and reasonably foreseeable activities that contribute to the cumulative impact. In most instances, the majority of waste impacts from those activities would result from human habitation or presence (i.e., the generation of domestic solid wastes and domestic and sanitary wastewaters). With the exception of North Slope activities, human habitation related to these cumulative actions (i.e., the workforce engaged in those actions) would likely occur at or near population centers or established communities. It is therefore assumed that solid wastes and domestic and sanitary wastewaters attributable to that workforce would be managed in existing municipal treatment or disposal facilities. It is further assumed that the (1) relative sizes of the workforces engaged in most cumulative actions would be small relative to the sizes of the communities in which they would reside or work and (2) cumulative actions would thus have only small incremental impacts on existing waste management systems. Consequently, those waste impacts were not analyzed further, and no discussion is included here. Such assumptions are only partially correct for the North Slope, however, thus waste impacts from the presence of a workforce in the North Slope are discussed in this analysis. Among the potential cumulative actions identified in Table 4.7-2, three ongoing actions have substantial waste impacts: North Slope oil exploration, development, and production (including maintaining the North Slope workforce); oil refining at three of the four operating refineries in Alaska; and tanker loading activities at the Valdez Marine Terminal. One proposed action, the construction of a natural gas pipeline, could also have substantial waste impacts.

The potential cumulative actions for each of the ongoing actions identified above are discussed briefly below. For a more detailed discussion of these actions and their impacts, see Appendix C.

4.7.6.10.1 Waste Impacts Associated with Oil Exploration, Development, and Production.

Impacts associated with oil exploration, development, and production on the North Slope result from the management and disposal of production waters, domestic and sanitary wastewaters, other wastes from North Slope operations (e.g., NORM wastes) and solid wastes.

Production water recovered from each wellhead is either reinjected into the production well from which it was removed or injected into any of the underground injection wells located throughout the North Slope. More than 20 such Class I underground injection wells are in operation on the North Slope. Thus, water is returned to the geologic formation from which it originated or into a formation of similar depth and characteristics. Other industrial wastewaters, such as drilling muds, well development solutions, snow meltwater removed from impoundment structures, and nonhazardous industrial wastewaters associated with activities at the central processing facility, are also routinely disposed of through deep well injection. TAPS operations do not have any impacts on any of the formations that receive production water or well development wastes that are disposed of through deep well injection.

Some wastes associated with oil exploration and production on the North Slope exhibit hazardous waste characteristics. These wastes are transported to out-of-state permitted TSDFs. Hazardous wastes associated with TAPS operations are also delivered to out-of-state TSDFs. Thus, there might be some cumulative impacts at those out-of-state TSDFs that receive

hazardous waste from both TAPS and North Slope operators. However, these impacts are governed by the permit limitations under which such facilities operate.

Domestic and sanitary wastewaters associated with North Slope operations are managed by (1) biological treatment followed by discharge of treated effluents to area lakes or the Beaufort Sea or (2) injection into Class II underground injection wells located on the North Slope. Domestic and sanitary wastewaters from PS 1 are managed by stack injection. However, currently the TAPS PS 1 workforce lives in North Slope dormitories maintained by the North Slope companies; therefore, the domestic and sanitary wastewater resulting from TAPS workforce residents is combined with similar wastewater from the North Slope workforce. Thus, TAPS and North Slope operations have a cumulative impact on the area lakes and the Beaufort Sea and on underground formations as a result of the discharge of treated sanitary wastewater. These impacts are, however, limited by the conditions of the NPDES and Class II injection well permits, respectively, under which discharges to surface water or underground injection occur.

Other waste associated with North Slope operations includes retired well production and oil handling equipment that is contaminated with scale that may contain NORM precipitates that were present in production waters. This NORM waste is generated by all North Slope drillers to varying degrees that depend on the characteristics of the formations from which oil and water are being recovered. However, all such waste is centrally managed at the Mukluk Storage Yard and then transported to commercial firms in Louisiana for treatment. Surveys conducted by those responsible for the Mukluk Yard have demonstrated that NORM contamination of surrounding soils has not occurred during storage. Thus, impacts associated with NORM generation and management do not occur at the North Slope. Because acceptance criteria for oil delivered to PS 1 limit the amount of water allowed and thus the accumulation of contaminated scales, TAPS operations do not contribute to the generation of NORM wastes.

Finally, solid wastes are generated in association with North Slope activities. While some nonhazardous solid *industrial* waste is generated, the majority of solid waste is nonhazardous solid *domestic* waste from activities that support the workforce. All nonhazardous solid domestic and industrial wastes from North Slope operations are delivered to the Oxbow Landfill for disposal. Combustible solid wastes delivered to the Oxbow landfill are incinerated there before land disposal. Similarly, solid wastes from TAPS operations at PS 1 are also delivered to the Oxbow Landfill. TAPS solid waste that is combustible is incinerated at PS 1, and the ash is delivered to the Oxbow Landfill. Thus, impacts to the environment from the operation of the Oxbow Landfill are cumulative, resulting from the management of wastes from both North Slope operations and TAPS operations. However, TAPS solid waste volumes are estimated to be only a minor portion of all the wastes delivered to Oxbow.

Under the no-action alternative, oil exploration, development, and production would cease, pending development of another transportation means. Consequently, there would be a dramatic decrease in the North Slope oil company workforce and a proportional decrease in wastes associated with the support of that workforce (e.g., domestic solid waste, domestic and sanitary wastewaters). Maintaining oil production facilities until an alternative oil transportation option is established would result in small amounts of maintenance-related wastes; a small fraction of which might be hazardous waste. However, no production water, industrial wastewaters, or other wastes associated with oil exploration and production (e.g., retired well production and oil handling equipment) would be generated.

4.7.6.10.2 Waste Impacts Associated with Oil Refining Operations.

Petroleum refining is the physical, thermal, and chemical separation of crude oil into its major distillation fractions, which are then processed through a series of separation and conversion steps into finished petroleum products. Currently, four petroleum refineries operate in Alaska: Petro Star Refinery on the Kenai peninsula, Petro Star Valdez Refinery, Petro Star North Pole Refinery, and Williams Alaska Petroleum Co. North Pole

Refinery (formerly the MAPCO Refinery). Only the last three receive crude oil from the TAPS. Consequently, for the purposes of this DEIS, only activities at the three refineries in North Pole and Valdez are considered to be within the area of interest and to result in cumulative impacts.

The nature and volumes of wastes generated at refineries are functions of the quality and throughput of the raw materials (crude oil) as well as the products being generated. The petroleum refining industry uses relatively large volumes of water. Four types of wastewater are produced: surface water runoff (precipitation draining from industrialized land areas), cooling water, process water, and domestic/sanitary wastewaters. Federal regulations governing the discharge of storm water from industrial areas require the capture and treatment of storm water at all petroleum refineries, including the removal of a large fraction of both conventional pollutants (e.g., suspended solids and constituents that contribute to the water's biological oxygen demand) and toxic pollutants (e.g., certain metals and organic compounds).

Most cooling water is recycled. Any discharge of cooling water, even though it does not come into direct contact with the oil, is treated to remove any oil residues that might have resulted from leaks and to remove any chemicals that were added to the cooling water (e.g., descalers). Process waters require primary and secondary wastewater treatment. Primary wastewater treatment is the separation of oil, water, and solids. After primary treatment, wastewater can be discharged to a publicly owned treatment works (POTW) or undergo secondary treatment before being discharged directly to surface waters under an appropriate NPDES permit. For example, Williams North Pole Refinery holds an NPDES permit, issued by EPA Region 10, for the discharge of treated wastewater into a former gravel pit located on the Williams property. In addition, treated process wastewater is discharged to the City of North Pole's municipal sewage treatment plant (EPA 2002). Domestic/sanitary wastewaters and industrial wastewaters (including process waters and cooling waters) from the oil refining operations are not discharged to the same watercourses or publicly owned treatment facilities as TAPS wastewaters. Surface water runoff discharged from the North Pole Refinery may impact the same watercourses as storm waters discharged from the TAPS North Pole metering station and from segments of the ROW in the immediate vicinity.

Hazardous wastes, including oily wastes that may contain hazardous constituents (e.g., benzene), are generated during refinery operations. In addition, certain EPA-listed wastes are associated with oil refinery processes, including slop oil emulsion solids (EPA Hazardous Waste No. K049), dissolved air flotation floats (EPA Hazardous Waste No. K048), and heat exchanger bundle sludge (EPA Hazardous Waste No. K050). As discussed above, all hazardous wastes generated in Alaska are transported to out-of-state TSDFs for ultimate treatment and disposal. For example, Williams North Pole Refinery is a large-quantity generator of RCRA hazardous wastes. In 1997, Williams North Pole Refinery generated 43 tons of hazardous waste, all of which was shipped off site to out-of-state TSDFs (EPA 2002). There could be some cumulative impacts at out-of-state TSDFs that receive hazardous wastes from both TAPS operations and from oil refining operations. However, permit conditions would limit the extent of those impacts to acceptable levels.

Solid, nonhazardous wastes are also generated during refinery operations. (They include packing materials and nonhazardous sludge). These can be disposed of in on-site landfills; disposed of in off-site, local solid waste landfills; or shipped out of state to appropriately permitted landfills. If local disposal is selected, there may be a cumulative impact to the area sanitary landfills also being used by the TAPS. However, these landfills also serve their respective communities and the percentages of input to the landfills from either the TAPS or any of the refineries are expected to be small. Some outputs, such as sulfur, acetic acid, phosphoric acid, and recovered metals, are sold as by-products and transported off site.

Under the no-action alternative, although there are other sources of Alaska crude oil that could be processed at these oil refineries, transportation via other transportation modes

(e.g., truck) would be costly, and it is assumed oil refinery production would dramatically decline at the three refineries that rely on TAPS oil as their primary feedstocks. There would be a comparative decline in oil refining wastes (including waste related to workforce support).

4.7.6.10.3 Waste Impacts Associated with Tanker Operations at the Valdez Marine Terminal.

Wastes associated with oil tanker visits to the Valdez Marine Terminal include tanker ballast and bilge water and domestic solid wastes generated on board (which could include some medical wastes) during the ship's voyage to the Valdez Marine Terminal. Oil tankers berthing at the Valdez Marine Terminal discharge their ballast and bilge waters to the BWTF at the Valdez Marine Terminal for treatment before discharge to Prince William Sound (e.g., removal of oil). Appendix C provides a detailed description of wastes associated with TAPS operations. Section C.5 provides details regarding the operation of the BWTF.

Conversion of the Valdez Marine Terminal tanker fleet to comply with double-hull requirements will dramatically reduce but not completely eliminate the volume of ballast water treated in the BWTF. It can be reliably assumed that the maximum reduction in ballast water volumes will be realized by January 2015. However, a schedule for reductions in the interim period is difficult to predict, since many vessel owners are reconfiguring their fleet or purchasing new vessels on more aggressive schedules than those required by the statute. Regardless of their hull design, tankers visiting the Valdez Marine Terminal will still have bilge water that will require treatment before discharge. Under the no-action alternative, oil tanker visits to the Valdez Marine Terminal would decline to zero, and no bilge water or ballast water would be treated at the BWTF.

Domestic solid wastes generated on board are managed as "international wastes" or "regulated wastes" and are treated as potentially biohazardous. As a service to the berthing tankers, upon request, the Valdez Marine Terminal accepts domestic solid wastes, separately bags those wastes, and delivers them to a commercial firm for sterilization and ultimate disposal in a municipal landfill. Under the no-action alternative, oil tanker visits would decline to zero and the solid waste generated from the tankers also would cease.

Valdez Marine Terminal personnel report that the Valdez Marine Terminal does not treat domestic and sanitary wastewaters generated by the tankers. These wastewaters are treated under existing US Coast Guard and ADEC regulations and discharged to the ocean. None of the tankers commingle domestic or sanitary wastewaters with ballast waters or other TAPS wastewater (Edwards 2002). Finally, wastes generated during the vessel's trip to Prince William Sound as a result of maintenance or repair of on-board mechanical systems are not off-loaded at Valdez (Edwards 2002).

4.7.6.10.4 Waste Impacts Associated with Natural Gas Pipelines.

The construction and operation of the proposed natural gas pipeline would generate wastes. In addition to the pipeline, the system would include construction of a natural gas separation and treatment facility on the North Slope and compressor stations along the pipeline route. If natural gas was transported to Valdez, a gas liquefication facility and marine terminal might be located at Anderson Bay in Prince William Sound. Waste impacts would be both short term (associated with initial construction) and long term (associated with subsequent operation). During construction, substantial amounts of domestic solid waste and domestic and sanitary wastewaters would be generated in support of the construction workforce.

Wastes associated with operation of the natural gas pipeline would include wastes resulting from the support of a workforce and wastes associated with pipeline maintenance. Although less complex in its design than the TAPS, the natural gas pipeline would still require maintenance, and related activities would also generate wastes, many of which would be similar to those resulting from maintenance of the TAPS. Because the natural gas pipeline project is only at a preliminary conceptual development stage, no additional details can be provided regarding the amounts or types of operation wastes that would result or their ultimate disposal.

The LNG plant would generate industrial wastewater related to plant operations as well as domestic and sanitary wastewater from support of the workforce. In addition, LNG tankers visiting the LNG plant could generate bilge/ballast wastewaters that would have to be treated and discharged under the auspices of appropriate NPDES permits. Prince William Sound would then receive treated wastewaters from both the Valdez Marine Terminal and any new LNG plant.

In addition, the LNG plant would generate solid waste that could be disposed of in the City of Valdez municipal landfill. This would be cumulative to any solid waste generated at the Valdez Marine Terminal and disposed of at the municipal landfill. Under the no-action alternative, solid wastes from the LNG plant could continue to be disposed of at the municipal landfill, even though Valdez Marine Terminal operations would have ceased. However, under the no-action alternative, solid wastes generated during pipeline and Valdez Marine Terminal closure and dismantlement could also be disposed of at the municipal landfill.

Finally, the construction and operation of the LNG plant might cause increases in the populations of Valdez and other nearby communities, together with increases in domestic solid wastes and domestic and sanitary wastewaters, the management of which would represent cumulative impacts to those already resulting from other activities, including those associated with the Valdez Marine Terminal operational workforces. Under the no-action alternative, these cumulative impacts would be less, since employment related to the Valdez Marine Terminal would decline.

4.7.6.11 Human Health and Safety

Actions considered, which, together with the proposed action, could have cumulative impacts on human health and safety include oil and gas exploration, development, and production on the North Slope; construction and operation of natural gas pipelines; land management activities; human habitation and development; and natural resource use. Possible cumulative impacts of these actions (in conjunction with the proposed action, the less-than-30-year renewal alternative, or the no-action alternative) to workers and the general public are considered in this section.

4.7.6.11.1 Occupational Hazards.

Physical Hazards. Unintentional (including accidental) injuries are the fifth leading cause of death in the United States, primarily from motor vehicle crashes, falls, poisonings, and drownings (National Safety Council 2001). While unintentional injuries, as a whole, are the third leading cause of death in Alaska (43.4 per 100,000 population), in 1998, Alaska had the second greatest decrease (−19%) in unintentional injury death rates to the general public (National Safety Council 2001). A National Institute for Occupational Safety and Health study of death certificate surveillance data collected for the period 1980−1995 showed that Alaska was the state with the highest overall occupational injury fatality rate of 24.3 per 100,000 workers (Marsh and Layne 2001). While Alaska still has the highest worker death rate in the nation, occupation-related fatalities have been decreasing in recent years (20.5 to 13.4 during 1996−2000) (ADHSS 2002). Nationwide, the highest average annual fatality rates during the same period 1980−1995 were for workers in the mining industry (30.4) and for farmers/foresters/fishers (21.9) (Marsh and Layne 2001). However, the rates of traumatic occupational fatalities from 1980−1995 were much higher in Alaska, with the highest rates in agriculture/forestry/fishing (295.4 per 100,000 workers) and in associated farming/forestry/fishing occupations (383.2 per 100,000 workers). Other hazardous industries in Alaska include manufacturing and mining, which had 64.0 and 18.7 fatalities per 100,000 workers, respectively, in 1983−1995 (Marsh and Layne 2001).

The two industry divisions of transportation/communications/public utilities and construction, which were found to have occupational fatality rates of 39.0 and 31.5 per 100,000 workers, respectively, over the same period, are probably the most inclusive of pipeline-related activities and many of the associated cumulative actions. (The total number of fatalities from incidents directly related to TAPS pipeline construction

and operations-related incidents are 31 and 9, respectively [APSC 2001; Elleven 2002b].) It is apparent that the risk faced by workers, as defined by traumatic occupational fatality rates, is already considerably elevated in Alaska, particularly as a result of the water and air transport required for various hazardous occupations there (e.g., fishing, farming, logging, mining, and manufacturing). With the exception of workers involved in the proposed natural gas pipeline, relatively small numbers of workers will be involved in other cumulative actions (e.g., oil refining, oil and gas exploration, oil storage), and their risks of injuries and fatalities from physical hazards are expected to be in line with the historical rates, especially for the transportation/ communications/public utilities-related and construction-related cumulative activities. The use of best management practices for occupational health and safety compliance is recommended to reduce statewide fatality and injury incidence rates in all of these sectors in the future.

Of the actions considered (e.g., oil and gas exploration, development and production and oil refining, storage, and transportation [see Section 4.7.4]), the natural gas pipeline could employ the most workers during the construction phase. Key components of the project would be construction of a large CO_2 treatment plant, a large-diameter pipeline, high-efficiency compressor stations, and a natural gas liquid (NGL) recovery plant. Multiple construction projects would be spread out over 2 to 3 years. At the peak of construction, the pipeline project could employ as many as 10,000 workers. After construction, the project could directly employ 600 permanent employees. Similar to the TAPS, potential fatalities and injuries from a natural gas pipeline would be expected on the basis of incidence rates in the construction and pipeline industries, the number of FTEs, and the number of years of construction and operation. While such occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment, fatalities and injuries from on-the-job accidents can still occur. The use of best management practices for occupational health and safety compliance is recommended to reduce statewide fatality and injury incidence rates from all of the actions in combination (i.e., the proposed action, less-than-30-year renewal alternative, and the no-action alternative). The rates of occupational fatalities and injuries are expected to be similar for all alternatives.

Radiation Hazards. Another concern with respect to occupational exposures is NORM. NORM may be deposited in oil production pipes and vessels as the temperature and pressure of oil and water brought to the surface decreases. When equipment is taken out of production, actions are taken to avoid hazards from NORM exposure (N S Health Team Leader 2001). The equipment is surveyed for the presence of NORM, and any pieces with contamination greater than a minimal level (50 μR/h) are segregated, labeled, sealed in plastic, and secured in a special storage area. Such equipment is shipped off site for cleaning by a specifically licensed NORM contractor. With such procedures in place, there is little potential for any NORM exposure from oil production operations on the North Slope or during pipeline dismantlement. NORM is not an issue for the no-action alternative because it is assumed that oil production would cease.

Petroleum Spills. The cumulative assessment of human health and safety impacts from environmental releases is limited to the general public and does not include occupational exposures for cleanup workers or employees at the plants or compression facilities. Protection of these workers is regulated under the Occupational Health and Safety Act and is beyond the scope of this assessment.

4.7.6.11.2 Hazards to the Public.

As stated above, cumulative impacts of concern with respect to public impacts include cumulative air emissions and uptake of persistent, bioaccumulative, and toxic (PBT) substances from multiple sources into the food chain. Potential cumulative impacts in these categories are discussed below both for normal operations and accidents and spills.

Cumulative Impacts of Emissions to Air.

Volatile Organic Compounds. Table 4.7-8 summarizes 1999 Alaska statewide emissions of chemicals to air as reported under EPA's Toxics Release Inventory (TRI) (EPA 2002). The TRI contains information on releases of nearly 650 chemicals and chemical categories from many industries, mainly manufacturing (including petroleum refining), metal and coal mining, electric utilities, and commercial hazardous waste treatment. Although the TRI data are informative about emissions from many sources, the emissions inventory is not exhaustive because not all industrial emitters are required to report. For example, APSC has a standard industrial classification (SIC) of 4612 (transportation — crude petroleum pipelines) and is not required to report emissions. The North Slope oil producer facilities (SIC of 1311) are also not required to report emissions. For perspective, note that industrial sources are estimated to contribute only about 14% of all benzene emissions in the United States (Ott and Roberts 1998).

Of the TRI-reported emitted chemicals listed in Table 4.7-8, benzene, ethylbenzene, formaldehyde, n-hexane, toluene, and xylene are emitted from TAPS facility sources (i.e., pump stations or the Valdez Marine Terminal, see Table 3.13-6). For each of these chemicals, emissions from TAPS facilities (assuming maximum throughput) exceed those from the TRI-reported sources, with the majority of emissions from the Valdez Marine Terminal at Valdez. The TRI-reported emissions are generally quite distant from the Valdez Marine Terminal and the pump stations and, with the exception of some emissions in Fairbanks and North Pole, mostly from petroleum refineries. Note that for an unknown reason, emissions from the Petro Star refinery at Valdez were not included in the reported TRI data. It is estimated that this refinery would emit about 0.65 ton/yr of benzene and 2 ton/yr of the other VOCs (in comparison with 43 tons/yr of benzene and 69 tons/yr of the other VOCs from the Valdez Marine Terminal only).

An assessment of potential health impacts from Valdez Marine Terminal air toxics emissions was provided in Section 4.3.13.2.2. It concluded that no adverse health impacts would be expected in association with inhalation of those emissions throughout the authorization period. Some possible future projects in the regions of interest (e.g., new natural gas pipelines and perhaps a gas liquefication facility at Valdez, should a natural gas pipeline be routed there) could result in additional VOC emissions, presumably with maximum emissions similar to or less than those associated with TAPS facilities. Even with these facilities, there should be no adverse health impacts from inhalation of VOCs from all the industrial sources combined (under the proposed action, less-than-30-year renewal alternative, and no-action alternative).

Another important source of some of the same VOCs that are emitted from TAPS facilities is motor vehicle emissions. For example, in the United States, automobile emissions are estimated to account for approximately 82% of all the benzene emitted to the atmosphere (although auto emissions contribute only 18% of total benzene *exposures*; cigarette smoking contributes about 45% to exposures [Ott and Roberts 1998]). The annual average benzene concentration in U.S. metropolitan areas in 1999 was approximately 2 $\mu g/m^3$ (EPA 2001c). Auto emissions would be expected to increase over the renewal period as the state population and automobile transportation increase (the annual increase in population is estimated to be 1.5%, resulting in a 60% population increase by 2034; see Section 4.3.19.3.1). A cancer risk of about 3×10^{-5} has been estimated for residents of Valdez from benzene inhalation from all sources (Section 4.3.13.2.2). As sources such as motor vehicle emissions increase over the next 30 years, additional emission controls on mobile as well as point sources might be needed to minimize increasing cancer risks under any of the alternatives.

Criteria Pollutants. During construction of a natural gas pipeline, the main type of emission of concern during the 2- to 3-year construction period would most likely be criteria pollutants generated from excavation, heavy equipment operation, and vehicles used for transporting workers and raw materials. Unless residential areas were located in close proximity to the

TABLE 4.7-8 Toxics Release Inventory Reportable Emissions for the State of Alaska in 1999

Chemical Name	Number of Sources	Total 1999 Statewide Emissions (tons)	Cities Where Emissions Occurred (% of total)	Industry Sectors (in order of emissions amount contributed)
1,2,4-Trimethyl-benzene	6	3.1	Anchorage (14), Fairbanks (<1), Kenai (67), North Pole (18)	Manufacturing (petroleum refining); wholesale trade-petroleum products (bulk stations and terminals)
Ammonia	3	684	Fairbanks (<1), Kenai (99)	Mining-gold and silver ores; manufacturing-petroleum refining and chemicals
Antimony compounds	1	0.008	Juneau	Mining-lead and zinc ores
Arsenic compounds	1	0.25	Juneau	Mining-lead and zinc ores
Barium compounds	2	172	Healy (>99), Juneau (<1)	Electric services (power plant); mining-lead and zinc ores
Benzene	7	13	Anchorage (4), Kenai (68), North Pole (28)	Wholesale trade-petroleum products (bulk stations and terminals); manufacturing (petroleum refining)
Cadmium compounds	2	1.5	Kivilina (95), Kotzebue (5)	Mining-lead and zinc ores
Chromium compounds	3	0.046	Fairbanks(30), Juneau (1), Kotzebue (69)	Mining-lead and zinc ores; manufacturing (chemicals)
Cobalt compounds	1	0.013	Kotzebue	Mining-lead and zinc ores
Copper compounds	3	0.21	Fairbanks (<1), Juneau (<1), Kotzebue (99)	Mining-lead and zinc ores
Cyclohexane	5	11	Anchorage (3), Kenai (80), North Pole (17)	Wholesale trade-petroleum products (bulk stations and terminals); manufacturing (petroleum refining)
Ethylbenzene	6	3.7	Anchorage (4), Fairbanks (1), Kenai (77), North Pole (21)	Wholesale trade-chemical and allied products; wholesale trade-petroleum products (bulk stations and terminals); manufacturing (petroleum refining)
Ethylene glycol	2	0.35	Anchorage (11), Kenai (89)	Wholesale trade-petroleum products (bulk stations and terminals); manufacturing (chemicals)
Formaldehyde	1	0.078	Kenai	Manufacturing (chemicals)
Hydrochloric acid	1	20	Healy	Electric services (power plant)
Hydrogen cyanide	1	1.8	Fairbanks	Mining-gold and silver ores
Hydrogen fluoride	1	23	Healy	Electric services (power plant)

TABLE 4.7-8 (Cont.)

Chemical Name	Number of Sources	Total 1999 Statewide Emissions (tons)	Cities Where Emissions Occurred (% of total)	Industry Sectors (in order of emissions amount contributed)
Lead compounds	3	5	Juneau (<1), Kivalina (2), Kotzebue (84)	Mining-lead and zinc ores
Manganese compounds	3	37	Juneau (<1), Kotzebue (<1), Healy (>99)	Mining-lead and zinc ores; electric services (power plant)
Mercury compounds	1	0.047	Healy	Electric services (power plant)
Methanol	2	248	Kenai (15), Kotzebue (85)	Manufacturing (chemicals); mining-lead and zinc ores
n-Hexane	6	18	Anchorage (6), North Pole (19), Kenai (75)	Wholesale trade-petroleum products (bulk stations and terminals)
Nickel compounds	3	0.026	Juneau (2), Fairbanks (6), Kotzebue (92)	Mining-lead and zinc ores, gold and silver ores
Toluene	6	24	Anchorage (2), Kenai (80), North Pole (18)	Wholesale trade-petroleum products (bulk stations and terminals), manufacturing-petroleum refining
Xylene (mixed isomers)	8	18	Anchorage (3), Fairbanks (1), Kenai (79), North Pole (17)	Wholesale trade-petroleum products (bulk stations and terminals), manufacturing-petroleum refining
Zinc compounds	4	28	Fairbanks (<1), Kivalina (11), Juneau (32), Kotzebue (57)	Mining-gold and silver ores, lead and zinc ores

Source: EPA (2002).

pipeline or related facilities, adverse health impacts due to limited-duration increases in criteria air pollutant levels from future construction actions in conjunction with the proposed action, the less-than-30-year renewal alternative, or the no-action alternative would not be expected.

Because the population of Alaska is expected to substantially increase during the next 30 years (at an annual rate of about 1.5%), traffic and vehicular emissions of criteria pollutants would also be expected to increase. This increase might be problematic in the Fairbanks/North Pole area, which is an air quality nonattainment area with respect to CO. Inhalation of increased levels of CO could aggravate cardiovascular conditions existing in the general population. Although change in human habitation and development is an issue considered in this cumulative impacts assessment, none of the TAPS emissions of CO under the proposed action, the less-than-30-year renewal alternative, or the no-action alternative would cause a measurable increase in CO levels in the Fairbanks nonattainment area (see Sections 4.3.9.1 and 4.6.2.9.1). Therefore, although the CO levels might become more problematic as the population increased, such an increase in CO levels does not constitute a cumulative impact with respect to the action being considered.

Air Emissions, Accidents, and Spills. Under the proposed action and the no action alternative, it was determined that the potential for serious adverse health impacts exists from inhalation of contaminants emitted from spills or fires for people who remain within maximum impact distance areas (0.02, 0.4, and 4 km; and 0.2 km, respectively). Numerous hazardous materials would be used and stored in association with some of the actions considered in this cumulative impacts assessment, especially oil and gas exploration, development, and production; oil refining; and oil and gas transportation. Human health and safety impacts from accidental releases of hazardous materials could result in exposures to contaminated air, soils, groundwater, or food. However, the potential for additional cumulative adverse impacts from accidental releases is small for the following reasons. First, it is unlikely that accidental releases would occur at the same time and in close proximity to each other. Second, existing regulations require timely cleanup of environmental media contaminated by spills, so that the possibility of prolonged human exposure would be limited.

The potential for ingestion or dermal exposure of the general public to soils and groundwater contaminated due to spills of hazardous materials is very low, because there is extensive regulation with regard to the containment and cleanup of spill sites. Because spills onto gravel or soil surfaces must be cleaned up according to the ADEC requirements, there should be no complete exposure pathways or elevated concentrations remaining after remediation of these types of spill sites and, therefore, no long-term health impacts from exposure to contaminants in soil.

The cumulative assessment of human health and safety impacts from environmental releases is limited to the general public and does not include occupational exposures for cleanup workers or employees at the various plants and facilities. Protection of these workers is regulated under the Occupational Health and Safety Act and is beyond the scope of this assessment.

Potential for Exposure to Persistent, Bioaccumulative, and Toxic Chemicals. An extensive discussion of the sources and toxicity of PBT chemicals of concern is provided in Section 3.17. The PBT contaminants include persistent organic pollutants (POPs) such as certain pesticides, PCBs, some PAHs, and the heavy metal mercury. (Radionuclides are not listed as PBTs by the EPA but are also of some concern.) These persistent contaminants generally originate outside of Alaska but are deposited there as a result of long-range transport. They may persist longer in the Arctic environment than in other locations because of the lower temperatures. In the Arctic ecosystem, the PBTs accumulate and are concentrated in the fat and organ meats of animals at upper levels of the food chain. Traditional use of these animals as part of the diet is a pathway of exposure to these contaminants, especially for Alaska Natives.

As discussed in Section 3.17, levels of PCBs and mercury in tissues of Alaska Natives and others regularly consuming contaminated game may be elevated, and these exposures could cause a variety of adverse health impacts. The major source of these contaminants is long-range atmospheric transport from industrialized areas in many countries. PCB production has been stopped in most countries, but poor disposal practices may result in continued releases to the atmosphere. The major sources of mercury in the atmosphere are burning of coal, municipal waste, medical waste, and hazardous waste; operation of motor vehicles; and production of chlorine (EPA 2001a). The operation of the TAPS is not known to result in any emissions of PCBs or mercury; these chemicals are also not expected to be associated with the no-action alternative nor would the no action or less-than-30-year renewal alternatives reduce the cumulative emissions, PCBs, or mercury. Similarly, the other foreseeable actions considered in this cumulative impact assessment (i.e., oil and gas exploration, development, and production on the North Slope; construction and operation of fuel gas pipelines; land management activities;

human habitation and development; and natural resource use) would not be expected to result in emissions of PCBs or mercury. Therefore, additional cumulative adverse health impacts from exposure to these contaminants would not be likely.

The PAH benzo[a]pyrene has also been designated as a PBT (EPA 2001b). PAHs are a constituent of crude oil and refined oil products and were a major contaminant of concern with respect to food pathways after the Exxon Valdez oil spill (Field et al. 1999). There is also an ongoing debate about the sources of PAHs in PWS, including past anathropogenic sources and natural background from oil seeps, oily shales, and coal (see Section 3.11.3). Oil spills in the marine environment have the most potential for foodchain impacts, because of bioaccumulation in shellfish (see Section 4.4.4.7.3). Of the actions assessed in this cumulative impacts evaluation, oil and gas exploration, development, production, and transportation involve risk of a spill in either the North Slope or Prince William Sound marine environment. On the basis of an analysis of the data from the Exxon Valdez oil spill, the long-term human health impacts of these spills from uptake in the foodchain are not insignificant but are on the same order as those from ingestion of smoked meats and fish. It is possible that increased digestive cancer incidence rates among Alaska Natives (see Section 3.17) are associated with dietary PAH exposures, but this speculation has not been confirmed with data.

4.7.6.11.3 Summary. Possible cumulative impacts of reasonably foreseeable actions, in conjunction with the proposed action, the less-than-30-year renewal alternative, or the no-action alternative, to workers and the general public were considered in this section. The types of actions that could have cumulative impacts on human health and safety include oil and gas exploration, development, and production on the North Slope; construction and operation of fuel gas pipelines (e.g., the natural gas pipeline); land management activities; human habitation and development; and natural resource use.

Occupational. The risk faced by workers, as defined by traumatic occupational fatality rates, is already considerably elevated in Alaska, particularly as a result of the water and air transport required for various hazardous occupations there (e.g., fishing, farming, logging, mining, and manufacturing). With the exception of workers involved in the construction of proposed natural gas project, relatively small numbers of workers would be involved in other cumulative actions (e.g., oil refining, oil and gas exploration, oil storage), and their risks of injuries and fatalities from physical hazards are expected to be in line with the historical rates, especially for the transportation/ communications/public utilities-related and construction-related cumulative activities. Similar to the TAPS, potential fatalities and injuries from a natural gas pipeline would be expected on the basis of construction and pipeline industry incidence rates, the number of FTEs, and the number of years of construction and operation. While such occupational hazards can be minimized when workers adhere to safety standards and use appropriate protective equipment, fatalities and injuries from on-the-job accidents can still occur. The use of best management practices for occupational health and safety compliance is recommended to reduce statewide fatality and injury incidence rates from all of the actions in combination.

Another concern with respect to occupational exposures is NORM. However, with standard operating procedures in place, there is little potential for any NORM exposure from oil production operations on the North Slope or during pipeline dismantlement.

The cumulative assessment of human health and safety impacts from environmental releases is limited to the general public and does not include occupational exposures for cleanup workers or employees at the plants or compression facilities. Protection of these workers is regulated under the Occupational Health and Safety Act and is beyond the scope of this assessment.

Public. An assessment of potential health impacts from Valdez Marine Terminal air toxics emissions was provided in Section 4.3.13.2.2. It was concluded that no adverse health impacts would be expected in association with the inhalation of those emissions throughout the

renewal period. Some planned future projects in the regions of interest (e.g., new natural gas pipelines) could result in additional VOC emissions, presumably with maximum emissions similar to or less than those associated with TAPS facilities. Unless a large new source of VOC emissions is placed in the Valdez area (none currently planned), there should be no adverse health impacts from inhalation of VOCs from all the industrial sources combined.

Another important source of some of the same VOCs that are emitted from TAPS facilities is motor vehicle emissions. Auto emissions would be expected to increase over the renewal period as the state population and automobile transportation increased. An increased cancer risk of about 3×10^{-5} has been estimated for residents of Valdez from benzene inhalation from all sources. As sources such as motor vehicle emissions increase over the next 30 years, additional emission controls on mobile and point sources might be needed to minimize increasing cancer risks, under any of the alternatives.

During construction of a natural gas pipeline, the main type of emission of concern during the 2- to 3-year construction period would most likely be criteria pollutants generated from excavation, heavy equipment operation, and vehicles used for transporting workers and raw materials. Unless residential areas were located in close proximity to the pipeline or related facilities, adverse health impacts due to limited-duration increases in criteria air pollutant levels from future construction actions in conjunction with the proposed action or the no-action alternative would not be expected.

The projected increase in the population of Alaska over the next 30 years might be problematic in the Fairbanks/North Pole area, which is an air quality nonattainment area with respect to CO. However, none of the TAPS emissions of CO under the proposed action or alternatives would cause a measurable increase in CO levels in the Fairbanks nonattainment area (see Sections 4.3.9.1 and 4.6.2.9.1). Therefore, although the CO levels might become more problematic as the population increased, such an increase in CO levels does not constitute a cumulative impact with respect to the action being considered.

Numerous hazardous materials would be used and stored in association with some of the actions considered in this cumulative impacts assessment, especially oil and gas exploration, development, and production; oil refining; and oil and gas transportation. Human health and safety impacts from accidental releases of hazardous materials could result in exposures to contaminated air, soils, groundwater, or food. However, the potential for additional cumulative adverse impacts from accidental releases is relatively small.

The potential for ingestion or dermal exposure of the general public to soils and groundwater contaminated due to spills of hazardous materials is very low, because there is extensive regulation with regard to the containment and cleanup of spill sites. Because spills onto gravel or soil surfaces must be cleaned up according to these ADEC requirements, there should be no complete exposure pathways or elevated concentrations remaining after remediation of these types of spill sites and, therefore, no long-term health impacts from exposure to contaminants in soil.

Levels of two PBT contaminants (PCBs and mercury) in tissues of Alaska Natives and others regularly consuming contaminated game may be elevated, and these exposures could cause a variety of adverse health impacts. The operation of the TAPS is not known to result in any emissions of PCBs or mercury. Similarly, the other foreseeable actions considered in this cumulative impact assessment would not be expected to result in emissions of PCBs or mercury. Therefore, additional cumulative adverse health impacts from exposure to these contaminants would not be likely.

Oil spills in the marine environment have the most potential for foodchain impacts, because of bioaccumulation of PAHs in shellfish (see Section 4.4.4.7.3). The long-term human health impacts of these spills from uptake in the foodchain are not insignificant but are on the same order as those from ingestion of smoked meats and fish.

4.7.7 Biological Resources

4.7.7.1 Terrestrial Vegetation and Wetlands

This section evaluates the cumulative effects of the proposed action, in combination with other past, present, and foreseeable future actions, on terrestrial vegetation and wetlands communities. This cumulative effects assessment evaluates impacts in and along the Beaufort Sea, North Slope, Interior Alaska, and Prince William Sound.

The cumulative effects of past actions have resulted in the existing conditions described in Section 3.18. In general, the greatest overall effects within the region of TAPS influence have been caused by oil and gas production and transportation. However, the cumulative effects on the major vegetative zones through which the TAPS passes have generally been minor. Future actions that have the potential to affect terrestrial and wetland vegetative communities are presented in Table 4.7-2 and include oil and gas exploration, development, and production; oil refining; oil and gas transport; oil storage; human habitation and development; transportation; land management activities and plans; natural resource use; and petroleum spills.

These actions could impact vegetation by means of a number of impacting factors. Table 4.7-7 identifies the activities and impacting factors associated with these actions. Construction activities would disturb soil and probably involve physical injury to vegetation or removal of vegetation within the disturbed area. In areas with a high proportion of wetlands, such as the Arctic Coastal Plain, or during construction of large projects, such as a natural gas pipeline, wetlands could be filled in. The placement of gravel to construct drilling pads, workpads, or service roads would eliminate local vegetation and alter local hydrologic regimes, which could adversely affect terrestrial and wetland communities. These activities would also produce fugitive dust, which could injure or kill vegetation and alter vegetative communities by reducing vegetative cover, altering local soil and permafrost conditions, and changing species composition. Erosion from construction sites could result in the sedimentation of vegetative communities, particularly wetland communities. Sediments could injure or kill vegetation and alter vegetative communities.

Disturbances to vegetative communities would generally require restoration of the affected site and revegetation efforts. Vegetative communities that would then become established might not represent local natural community types and might include non-native species, which could become dominant or invade undisturbed natural areas. Activities that disturbed the soil or remove vegetation could result in changes to the underlying permafrost, causing thermokarst. Terrestrial vegetative communities and some wetland communities might be eliminated by thermokarst-induced inundation.

Spills of crude oil, diesel oil, or other fluids might result from activities associated with any of the major actions contributing to cumulative effects. Spills could injure or kill vegetation, potentially leaving affected areas unvegetated or sparsely vegetated. Impacted soils might require extended periods of time to revegetate. Small spills, however, which would be considered likely or anticipated events (see Section 4.4.1 for spill frequency definitions) would be cleaned up and would generally have negligible to minor cumulative effects on the terrestrial vegetation and wetland communities of the four major vegetation zones. Large spills, which would be considered unlikely or very unlikely events, would have greater effects but would not be considered reasonably foreseeable future events. (See Section 4.4.4.9 for a discussion of the effects of spills on terrestrial vegetation and wetlands.)

Activities associated with transportation might result in impacts to terrestrial vegetation and wetlands from the generation of fugitive dust, particularly along unpaved highways, such as the Dalton Highway. Oil and gas transportation might also involve the construction of pipelines. The elimination of terrestrial and wetland communities might occur on a large scale during the construction of an extensive pipeline system, such as a natural gas pipeline, resulting in major impacts to vegetation. Large-scale restoration and revegetation activities might be required. Past

construction projects, such as TAPS and the construction of drilling pads on the North Slope, have involved extensive vegetation restoration. Pipeline construction and operation might also result in permafrost changes and accidental petroleum spills. The loading and transport of oil tankers might also result in accidental spills of crude oil.

Other than oil and gas production, mining and logging are the primary activities that use resources. Mining includes the extraction of minerals (such as gold, silver, lead, and zinc) and sand and gravel mining for construction materials, primarily for oil field development. Mining operations for sand and gravel and placer gold mining might remove large quantities of stream bed deposits and also riparian vegetative communities. The alteration of hydrologic regimes or surface water drainage patterns could adversely affect vegetation by increasing or decreasing soil moisture or inundation. Mining activities might result in soil disturbance, dust, erosion, and sedimentation. Logging operations would remove or alter existing vegetation on logged sites and could also result in soil disturbance, dust, erosion, and sedimentation. Logged sites generally progress through successional stages to mature forest over time. Harvesting of plant material from natural vegetative communities is often associated with human settlements. The acquisition of firewood, building materials, and edible plants or fruit might result in local impacts to vegetative communities.

Certain phenomena can also impact terrestrial and wetland vegetation. For example, global warming might result in changes to permafrost and alter many vegetative communities throughout the state of Alaska. Natural pests, such as the spruce bark beetle, might also cause changes in the structure or composition of forest communities.

4.7.7.1.1 Beaufort Sea. The construction and operation of facilities for oil exploration and production would include offshore gravel islands, Beaufort Sea shore modifications, new access roads, and pipelines. Losses of vegetative communities might result from direct removal, sedimentation, or spills and might include marine vegetative communities or coastal marshes. The cumulative impacts of these actions on the Beaufort Sea would be expected to be minor. For cumulative impacts under both the proposed action and the less-than-30-year renewal alternative, there would be a negligible effect on vegetation near the Beaufort Sea, unless there was a large oil spill (see Section 4.4.4.9). The contribution to cumulative effects from TAPS to impact vegetation near the Beaufort Sea would be negligible because TAPS does not occur in that area. Under the no-action alternative, structures for oil exploration and drilling in the Beaufort Sea would not be constructed, and associated impacts to vegetation would not occur. Impacts to the Beaufort Sea from TAPS termination activities would not be expected, since the system does not extend into this region.

4.7.7.1.2 North Slope. Impacts to vegetation would result from the construction and use of drilling pads, modifications of stream banks and channels, new access roads, pipelines, and use of sand and gravel mining sites. Although oil and gas exploration, development, and production are expected to continue on the North Slope, the area of impact from individual drilling or production sites has become considerably smaller over the past 30 years as advances in technology have reduced the area required for well pads. Losses of vegetative communities might result from direct removal, sedimentation, or spills; these communities might include lowland and upland tundra. However, less than 1% of the vegetation of the Arctic Coastal Plain would likely be impacted by oil development (BLM 1998). Construction of a natural gas transportation system would also impact vegetation on the North Slope in the vicinity of existing oil production facilities and near the TAPS ROW. The cumulative effects of these activities on North Slope terrestrial vegetation and wetlands would be expected to be minor. Very little new construction or other major disturbance of vegetation on the North Slope is anticipated for continued operation of the TAPS. The contribution to cumulative impacts from the continued operation of the TAPS would be minor, unless there was a large oil spill (see Section 4.4.4.9). Under the no-action alternative, impacts to vegetation from the construction of oil

exploration and drilling structures would not occur. Impacts to the North Slope vegetation communities from TAPS termination activities would result in a small temporary contribution to cumulative impacts and an increase in North Slope communities over the long-term, although the increase would be very small relative to the total area of upland and lowland tundra vegetation zones.

4.7.7.1.3 Interior Alaska. Impacts to vegetation would result from the construction and use of new access roads, a natural gas pipeline, modifications of stream banks and channels, use of sand and gravel mining sites land development, logging, and other natural resource use. Losses of vegetative communities might result from direct removal, sedimentation, or spills; these communities might include upland tundra, boreal forest, and coastal forest. The cumulative effects of these activities on the interior terrestrial vegetation and wetlands would be expected to be minor. Very little new construction or other major disturbance of vegetation in Interior Alaska is anticipated for continued operation of the TAPS. The contribution to cumulative impacts from the continued operation of the TAPS, under both the proposed action and the less-than-30-year renewal alternative, would be minor, unless there was a large oil spill (see Section 4.4.4.9). Impacts to boreal forest, coastal forest, and upland tundra communities from termination activities under the no-action alternative would result in a small temporary contribution to cumulative impacts and a long-term increase in vegetation communities, although the increase would be very small relative to the boreal forest, coastal forest, and upland tundra vegetation zones.

4.7.7.1.4 Prince William Sound. Loss of vegetative communities might result from direct removal, sedimentation, or spills; these communities might include marine vegetative communities or coastal marshes. The cumulative effects of activities affecting these resources, such as oil storage and transportation, land development, logging, and natural resource use on the terrestrial vegetation and wetlands would be expected to be minor. The continued operation of the TAPS would have a negligible effect on Prince William Sound, under the proposed action and less-than-30-year renewal alternative, unless there was a large oil spill (see Section 4.4.4.9). Thus, the contribution to cumulative effects from the TAPS would be negligible. Under the no-action alternative, oil storage and transportation would cease and associated impacts to terrestrial vegetation and wetlands would not occur. Impacts to Prince William Sound communities from TAPS termination activities would make a very small contribution to cumulative impacts. Cumulative impacts to vegetation would continue from all other activities not related to oil transportation.

4.7.7.1.5 Summary. The cumulative effects on terrestrial vegetation and wetlands would be minor, relative to the extent of the four major vegetation zones (lowland tundra, upland tundra, boreal forest, coastal forest) within the TAPS region of influence, and the Beaufort Sea and Prince William Sound.

The contribution to cumulative effects on terrestrial vegetation and wetlands from the continued operation of the TAPS under the proposed action, less-than-30-year renewal alternative, and no-action alternative would be small.

4.7.7.2 Fish

This section evaluates the cumulative impacts of the proposed action (Section 4.3.16) in combination with other past, present, and foreseeable future activities on fish. Thus, impacts associated with actions in the Beaufort Sea, the North Slope, Interior Alaska, and in Prince William Sound are considered for anadromous, diadromous (freshwater fish that overwinter in freshwater but disperse into low-salinity coastal waters during the summer to feed) and strictly freshwater fishes. The “other actions” that are considered in this cumulative impacts evaluation include (1) oil and gas exploration, development, and production; (2) oil and gas transportation; (3) human habitation and development; (4) legislative actions; (5) land management activities; (6) natural resource use; and (7) spills (Table 4.7-2). Additional information on the scopes of these activities is

presented in Section 4.7.4. As for the proposed action (Section 4.3.16), these other actions can affect fish in a variety of ways that can be broadly categorized into impacts that result from:

- Alteration and loss of fish habitat;
- Obstructions to fish passage;
- Increased human access; and
- Effects of oil, fuel, and chemical spills.

4.7.7.2.1 Alteration and Loss of Habitat. Actions on the North Slope, in the Beaufort Sea, and in Prince William Sound might all cumulatively contribute to the alteration and loss of resources and habitat for fish that occur there and use habitats along the TAPS ROW. Oil exploration activities, offshore construction discharges, and offshore dredging or trenching might alter marine habitats and influence planktonic and benthic marine invertebrates and fish (USACE 1984, 1999) that serve as food for anadromous and diadromous fish. Similar impacts to anadromous fish could occur in Prince William Sound as a result of construction activities, dredging, or runoff from industrial sites. Affected areas would probably be more turbid than normal, and this turbidity could affect visual distances for feeding fish. Because most North Slope construction occurs in the winter when there is prolonged darkness and thick ice cover, phytoplankton photosynthesis would not likely be substantially affected. Heavy downstream sedimentation from construction or oil production activities could smother the benthos in localized areas, but effects would probably not to be widespread. In general, species occupying these areas have adapted to dynamic conditions, and they react to short-term fluctuations in water quality and habitat by either enduring and functioning under those conditions or moving out of the impact zone. Recolonization of affected areas by benthic organisms in surrounding areas would probably occur relatively rapidly in most cases. An exception would be the Boulder Patch community that lies about 6 mi seaward of the Sagavanirktok River delta. This community of epilithic flora and fauna inhabits an isolated area of rock substrate in Stefansson Sound (Dunton and Schonberg 2000). Organisms occupying the Boulder Patch are at risk from localized impacts because they are immobile, occupy a relatively small geographic area, and are an isolated community that cannot easily be repopulated from surrounding stocks. Offshore construction and trenching in this area may require special consideration.

Another habitat alteration that may affect fish resources in Prince William Sound is the introduction of nonnative organisms from the ballast water of oil tankers. Some inbound tankers, especially the newer double-hulled tankers that are expected to become prevalent within the next 10 years, carry segregated ballast water (i.e., ballast water is separated from the oil cargo compartments) that is discharged directly into Port Valdez. The segregated ballast water can contain organisms that are not native to Prince William Sound. Organisms introduced from other areas of the world may become a nuisance in the absence of predator species to control population growth. Once established, nonindigenous species may also ecologically displace native species or some species in the food chain upon which fish or other native aquatic organisms depend for survival. Hines and Ruiz (2000) investigated the numbers and types of nonindigenous organisms transported into Prince William Sound in ballast water. They concluded that large numbers of planktonic organisms are released into Prince William Sound with segregated ballast water and that there is a high potential for the types of organisms observed to survive in the water conditions in Prince William Sound. On average, they found about 360 organisms per cubic foot of water in segregated ballast water samples. Although not all of these organisms were nonnative species, 14 nonnative species were recorded (13 crustacean species and 1 fish species) from the 169 tankers sampled. A previous study (Ruiz and Hines 1997) found that when nonsegregated ballast water (i.e., the ballast water that is carried in oil-holding compartments) was introduced, it contained very few viable nonindigenous organisms. In addition, such water is processed in the BWTF before being discharged into Port Valdez, making it unlikely that nonindigenous organisms would be introduced. The tanker traffic used in support of the gas pipeline may be about 275/yr (TAPS Owners 2001a). This could add incrementally to

the potential to introduce nonnative species into Prince William Sound. However, ballast water treatment would minimize this impact.

Oil and gas exploration and development can affect fish, if ground- or vegetation-disturbing activities occur in or near waterways or if chemicals or wastes are discharged into waterways. Loss of habitat in freshwater systems can result from bank hardening, draining of water bodies, changes or temporary diversions in river or stream channels, excavations of streambed materials, removal of riparian vegetation, and changes in water quality parameters. Permits are required under Alaska Title 16 for activities in or near streams that could affect anadromous fish and their freshwater habitat or the free and efficient migrations of resident fish. Discharges of wastes and treated water from oil facilities must also comply with the Clean Water Act and NPDES permits. Compliance minimizes the cumulative effects from the described actions on aquatic habitats.

Removal of freshwater from lakes to construct ice roads and pads and for other operations could also affect fish in these water bodies. Withdrawal of water can reduce water depth in overwintering areas, thereby reducing their ability to support fish, and it can entrain fish through the pumps. Design considerations and mitigation are incorporated into these operations to minimize impacts on fish. Water withdrawals would continue to be required for future North Slope oil field developments, but efficient and appropriate regulation, compliance, and enforcement would reduce the potential impacts. Use of other options for obtaining water for ice roads and pads (e.g., desalination, use of snowmelt water, and water from flooding abandoned mine sites) may also limit potential impacts.

Construction of and maintenance operations for a gas pipeline would have impacts on freshwater habitats similar to those of the TAPS. Inspection, monitoring, and prompt corrective action would be required to limit impacts. Increased public access as a result of new pipeline construction or development would probably have only small impacts on fish habitat, primarily due to the increased erosion of stream banks by off-road vehicles and the increased amount of dust deposited by vehicles traveling on unpaved roads. The development of other industries in the vicinity of the TAPS could also have impacts on freshwater habitats, depending on the location and operational needs.

Alterations to freshwater habitats could reduce fish survival and potentially affect fish populations. The Interior column of Table 4.7-2 lists the activities that may impact freshwater habitats. These impacts would more likely occur if the alterations were allowed to persist for multiple years and if overwintering habitat was affected. However, such alterations would typically be minor in scope and would not substantially affect fish populations. In addition, many potential impacts would probably be identified and corrected before impacts to populations ever occurred. Overall, cumulative impacts from alterations of freshwater habitats in the vicinity of the TAPS would be low to moderate under the proposed action.

Overall, the magnitude and geographic scope of impacts to fish habitats are likely to be low. However, it is difficult to predict the potential impacts associated with biological organisms that could be introduced via ballast water.

4.7.7.2.2 Obstructions to Fish Passage.

Drainage structures, such as culverts and low water crossings can impede fish migration and obstruct fish passage (Section 4.3.16). Generally, such impacts may occur intermittently at some, but not all, stream crossings that require drainage structures or that require vehicles to cross streams. Impacts at stream crossings are typically addressed through proper design and maintenance of roads, pipeline river crossings, and culverts, coupled with regulation, monitoring, and corrective actions.

Little or no discernable impact to fish passage in freshwater habitats has occurred in North Slope oil fields as a result of past activities, and it is anticipated that this will also be the case for future North Slope oil fields. Construction and operation of a natural gas pipeline would likely have impacts similar to those from the TAPS. For example, new roads, workpads, and buried pipeline crossings for a natural gas pipeline could impact new areas

outside the TAPS ROW. Construction of additional roads and increased numbers of workers could result in more stream crossings and more vehicles crossing streams in the vicinity of the TAPS. This may increase the frequency of impacts to fish from obstructed passage at disturbed stream crossing areas. Other activities that may be developed on the North Slope or in Interior Alaska (Table 4.7-2) could further increase such impacts, depending on the applicable location, extent of development, level of mitigation, and regulatory control.

Inhibiting fish movement in streams can reduce access to spawning areas and potentially affect fish populations. These results are more likely if the obstructions are allowed to persist for multiple years. Fish passage in freshwater habitats has been a continuous maintenance issue along the TAPS ROW, and it is also likely to be an issue relatively frequently as a result of the cumulative actions described above. However, obstructions to fish passage would probably be identified and corrected before impacts to populations would occur. Given the geographic extent and the large number of streams that could be affected by existing and proposed activities, fish populations in some freshwater habitats may be affected over the renewal period. Overall, cumulative impacts from blocking fish passage in freshwater habitats in the vicinity of the TAPS would be low to moderate under the proposed action.

Cumulative impacts to anadromous or diadromous species may occur as a result of activities that obstruct fish movement in marine environments. Under certain meteorological conditions, structures along the Beaufort Sea mainland coast can also block the movements of diadromous fishes, particularly juveniles (Gallaway and Fechhelm 2000 and references cited therein). Because many of these species avoid high-salinity, marine conditions, they tend to remain nearshore, where they forage up and down the coast within a narrow band of warm, low-salinity water (Craig 1984). Causeways can impede coastal movement either by directly blocking fish or by modifying nearshore water conditions to the point where they might become too cold and saline for these species. On the North Slope, this impact was identified as a concern at West Dock and the Endicott Causeway, although actual impacts were identified only at West Dock. However, current construction practices and mitigation efforts have shown that breaching can alleviate blockage (Gallaway and Fechhelm 2000 and references cited therein).

The locations of causeways relative to coastal topography, local bathymetry, and freshwater drainages also is critical in determining their impact on the nearshore migration corridor (Niedoroda and Colonell 1990). For example, West Dock was constructed at the eastern end of an extensive brackish-water lagoon system (Simpson Lagoon) through which fish disperse and migrate. The causeway extends seaward into the marine environment enough beyond the 6-ft isobath to exacerbate coastal mixing processes that sometimes block the movements of those fish. In contrast, the entire Endicott Causeway was constructed inside the 6-ft isobath and does not protrude into deeper marine waters. The onshore encroachment of marine water is further impeded by the freshwater discharge of the Sagavanirktok River (Niedoroda and Colonell 1990). As a result, cells of upwelled marine water that develop at the Endicott Causeway are restricted to the seaward tip of the causeway's western leg and do not reach the mainland shore, where the water might otherwise disrupt fish migrations (Hachmeister et al. 1991; Gallaway et al. 1991).

The proper siting of any future causeway to be constructed along the Beaufort Sea is the most important consideration with regard to fish movements. In many cases, breaching might be appropriate, depending on the site location and hydrography. Other structures constructed at offshore facilities and artificial islands would not affect diadromous fish habitat and would have a limited influence on anadromous species.

Although the impact from docks or causeways may occur in the marine environment of the Beaufort Sea, it is believed that there has been little or no impact on fish movements from docks or causeways at the Valdez Marine Terminal or in Prince William Sound. Because of the extensive distributions and coastal movements of marine and anadromous species, any additional terminal structures would

probably affect only an insignificant number of individuals and a small geographic area.

4.7.7.2.3 Effects on Fish Populations from Increased Human Access. With an increase in human population associated with foreseeable future activities (Table 4.7-2), there would likely be additional recreational fishing pressure on fish populations. Currently, recreational fisheries are regulated to maintain adequate stocks and are adjusted to compensate for changes in fishing pressure. However, increased access could result in overharvest if regulations and enforcement were inadequate. The BLM and USACE (1988) reported that individuals of the species preferred for harvest were smaller and less numerous after the construction of the TAPS in areas accessible to anglers. While developments in remote areas have allowed access to previously unavailable harvest opportunities, large increases in fishing effort and catches of desirable species such as Arctic char, Arctic grayling, and lake trout were not reflected in statewide harvest surveys (Burr 2001) after the entire length of the Dalton Highway was opened in 1994. The potential for overharvest is expected to be greater in northern areas because fish productivity is low.

In the North Slope oil fields and Beaufort Sea, increased human access, with its accompanying increased fishing pressure, has not affected fish populations, although some subsistence, sport, and commercial fishing occur. Public access into Prince William Sound is increasing, and the combined effects of commercial, subsistence/personal use, and sport fishing could impact populations. Fishing activities are managed by the ADF&G and the National Marine Fisheries Service. Maintenance of fish at the desired sizes and population levels has been largely accomplished by regulations established by the Alaska Board of Fish and enforced by ADF&G. In the vicinity of Prince William Sound, a number of anadromous fish hatcheries are also utilized to produce enough fish to increase harvest above natural levels and to manage stocks. Consequently, the cumulative impact of increased human access to fish populations is expected to be minor.

4.7.7.2.4 Effects of Oil, Fuel, and Chemical Spills on Fish. Oil, fuel, and chemical spills are a primary concern with regard to oil and gas development, production, and transportation. The potential impacts of freshwater spills (see Section 4.4.4.12) are primarily localized and restricted to gravel pads at facilities or roads. Large spills into freshwater have not occurred. However, should one occur in the future, it could have substantial impacts on fish in the impacted area.

Large marine spills, such as the Exxon Valdez oil spill, could potentially have large impacts on fish. Such spills could cause mortality and injury to plankton, marine invertebrates, and fish (USACE 1999). While direct mortality of fish due to oil spills has seldom been documented, impacts on fish in natural environments have been inferred on the basis of laboratory studies. The Exxon Valdez oil spill probably had some impacts on fish, including pink salmon and herring, but there is no consensus on the extent and duration of impacts on these species (see Section 4.4.10.2). However, it appears that by 1995, fish populations and habitats had largely recovered.

Past oil spills along the TAPS and in the North Slope oil fields have been mainly confined to land, but future leaks could reach watersheds and impact fish. The future operation of the TAPS, a gas pipeline, and other industrial activity carry the risk of small-scale spills of oil, fuel, and chemicals from vehicles and machinery. Present and future North Slope oil field developments might have an impact on fish, particularly in the marine environment. The potential for spills from subsea pipelines and other sources for offshore developments in the Beaufort Sea was assessed previously (USACE 1999). Impacts of spills in solid ice or broken ice in this region may be particularly difficult to clean up.

Gas production activities could increase the risk of impacts as a result of the increased volume of liquids transported through the gas pipeline and in tankers. The magnitude of the risk of such impacts would partly depend on facility locations. Increased public access could result in some small spills from highway vehicles, off-road vehicles, and boats.

Although there is a potential for large impacts to fish from large oil spills, the risk of such spills is relatively small (Section 4.4.1). The probability of smaller spills is higher, but the impacts from such spills if they entered freshwater or marine habitats would probably be small, temporary, and unlikely to severely affect fish populations; especially in light of spill response activities that are undertaken when spill events occur.

4.7.7.2.5 Summary. On the North Slope and Beaufort Sea, the most important future activities that could contribute to cumulative impacts on fish would be planned oil and gas development activities, oil and gas transportation, and natural resource use (e.g., subsistence). In Interior Alaska, future actions that could contribute to cumulative impacts on fishes include oil and gas transport, other transportation activities, human habitation and development, and land management actions. In Prince William Sound, future actions contributing to cumulative impacts on fish include oil transport, other transportation activities, (e.g., barging and cruise ships), human habitation, natural resource use (e.g., commercial, subsistence, and recreational fishing), and land management activities. However, none of these activities are expected to significantly increase cumulative impacts on fish or affect the viability of species' populations. Oil spills would not significantly add to cumulative impacts, except for an unlikely large spill to aquatic habitats, in which case impacts similar to the Exxon Valdez oil spill could occur (see Section 4.4.4.10).

TAPS operations are only a small component of the cumulative impacts associated with the activities listed in Table 4.7-2. However, the indirect effects of the TAPS are a significant contribution to cumulative impacts to fish, because of the interdependence of current and foreseeable future oil development, production, and transportation activities with the TAPS.

Cumulative impacts of the less-than-30-year renewal alternative on fish would be similar to those of the proposed action. TAPS operations, monitoring, and maintenance activities; and other present and foreseeable actions would essentially be the same for both alternatives (except for years of the TAPS renewal period). The shorter renewal period would not preclude any other current or foreseeable actions listed in Table 4.7-2 from occurring. Also, a subsequent renewal option may be a possibility following the less-than-30-year renewal period. Thus, the differences in cumulative impacts between the two alternatives would be negligible (e.g., differences would likely be within the same order of magnitude).

Differences in cumulative impacts between the no-action and the proposed-action alternatives on fish would be more evident than those between the less-than-30-year renewal alternative and the proposed action, particularly within the North Slope. While activities associated with gas production and transportation would occur under both alternatives; oil production and transportation would be reduced to very low levels for the no-action alternative. Thus, most oil production facilities would be idled. Also, the incremental changes that would have occurred from future oil field developments would not occur. Therefore, the level of impacts to fish within the North Slope would be less for the no-action alternative, except for subsistence harvest levels that may increase. The potential for accidental oil spills would also decline within the North Slope, along the TAPS ROW, and within Prince William Sound. However, the infrastructure required to promptly clean up any spills that might occur within these areas might not be available (e.g., response equipment and teams associated with the TAPS would not be present). The potential for introduction of nonnative organisms within Prince William Sound would decrease from the decrease or elimination of oil tanker traffic within Prince William Sound.

4.7.7.3 Birds and Mammals

This section evaluates the cumulative impacts of the proposed action in combination with other reasonably foreseeable actions on birds and terrestrial mammals. Past and present activities that contribute to cumulative impacts are part of the existing baseline and are discussed in Sections 3.20 (birds) and 3.21 (terrestrial mammals). Actions directly associated with the oil and gas industry that could contribute to cumulative impacts include

ancillary facilities and infrastructure (e.g., pipelines, roads, landing strips, gravel mines, and pump stations), refineries, terminals, and tanker transport. Other actions within the region of influence that could contribute to cumulative impacts include human habitation and development, transportation systems, natural resource use (including subsisence and sport hunting), spills, and natural events (e.g., forest fires and insect infestations) (Section 4.7.4). Legislative actions and land management activities could also have a controlling influence on the environment.

It is expected that in general, the cumulative impacts on birds and terrestrial mammals would be similar to the impacts associated with the proposed action (Sections 4.3.17 and 4.4.4.11). Thus, cumulative actions could impact these wildlife resources by (1) habitat loss, alteration, or enhancement; (2) disturbance or displacement; (3) mortality; (4) obstruction to movement; and (5) spills. The effects that these actions may cause include (1) immediate physical injury or death; (2) increased energy expenditures or changes in physiological condition that may reduce survival or reproduction rates; or (3) long-term changes in behavior, including the traditional use of ranges (Calef et al. 1976). Possible differences between cumulative impacts and the impacts from the proposed action would depend on the intensity (magnitude), scale (geographic area), duration, timing and frequency, synergy (impact interaction), and likelihood of the impacts associated with the cumulative actions (USACE 1999).

4.7.7.3.1 Habitat Loss, Alteration, or Enhancement. Within the North Slope, oil and gas exploration, development, and production, along with the construction and operation of ancillary facilities (e.g., gravel mines, roads, pipelines, and drill pads), could result in a cumulative reduction in habitat for wildlife. Future developments within the North Slope could result in continued habitat alteration, although new developments would have smaller footprints and result in a relatively smaller impact than in the past (TAPS Owners 2001a). The cumulative loss from all listed projects in the North Slope may have localized effects on the distribution or density of some wildlife species over the life of the oil fields (MMS 1998). Overall, fragmentation of the tundra by oil facilities has not been a major factor affecting bird use of the Prudhoe Bay oil field. There may have been a rearrangement of birds, but there was probably no net change in bird abundance (Troy and Carpenter 1990; TERA 1993). The potential effect on species such as caribou might not be measurable because of the natural variability, including productivity, of a large population (ADNR 1999).

Within the North Slope, more than 21,550 acres have been filled and covered by gravel for airstrips, drill pads, roads, and other structures. This total includes 10,653 acres distributed by mine sites and gravel placement within the oil fields and 10,900 acreas occupied by the portion of TAPS within the North Slope (Ambrosius 2000; Gilders and Cronin 2000). However, this represents a very small portion (~0.02%) of the more than 56.8 million acres that occur within the Arctic Coastal Plain (Gilders and Cronin 2000).

The loss of wildlife habitat from the development projects represent a small decrease in the amount of available tundra habitat in the North Slope (MMS 1998). The avoidance by wildlife of areas near industrial developments that might otherwise be usable habitat (i.e., functional habitat loss) also contributes to the cumulative loss of habitat associated with facility development (Cameron et al. 1995; Nellemann and Cameron 1998; James and Stuart-Smith 2000). However, cumulative impacts would be negligible because the amount of habitat physically affected would be small compared to the amount available (ADNR 1999).

Gravel fill generally eliminates tundra habitat. However, it can provide habitat for some species. For example, it provides insect relief areas for caribou; denning habitat for arctic foxes and ground squirrels; and nesting sites for semipalmated plover, ruddy turnstone, and Baird's sandpiper; and feeding habitat for Lapland longspurs (Pollard et al. 1990; Truett et al. 1994 and references cited therein). Arctic fox den density was found to be greater within developed areas than on adjacent undeveloped tundra; using culverts and road embankments as den sites (Ballard et al. 2000).

Although structures may occasionally be a barrier to wildlife movements, they can provide a haven from predators, pests, or weather, or a platform for feeding, hunting, or nesting (Truett et al. 1994). In general, birds use gravel pads more for feeding and resting than for nesting; while mammals rest and, less often, feed on the gravel pads (Pollard et al. 1990). Caribou use gravel pads and roads as insect relief habitat during the mosquito season (June to mid-July) and use the shade of oil field structures when oestrid flies are abundant (mid-July to early August). The availability of man-made insect-relief habitats may allow caribou to remain near preferred foraging habitats, thereby lessening the energy demands normally imposed upon caribou during the insect season (Pollard et al. 1996a).

Shorebirds and waterfowl commonly feed and rest on impoundments associated with gravel pads (Pollard et al. 1990). Pacific loons nest and rear their young in impoundments created by oil field developments (Kertell 1996).

Dust shadows might be increased by the addition of roads, facility pads, and greater traffic loads associated with gas commercialization on the North Slope. Construction of the natural gas pipeline would increase traffic loads on the Dalton Highway, contributing to the effect in the TAPS study area. The dust shadows affect a limited amount of habitat but will continue as long as heavy traffic occurs on gravel roads. Cumulative impacts of dust shadows on wildlife would be similar to those addressed in Section 4.3.17.1.

A new North Slope oil field could require permanent gravel roads and pads for production facilities, which would incrementally increase the area affected by changes in drainage patterns. However, the footprint for new developments would require less area than in the past. For example, the “P” Pad built in the Prudhoe Bay Oil Field is 70% smaller than the “A” Pad built in the 1970s (Gilders and Cronin 2000). The construction of a natural gas pipeline would also contribute to these types of effects on wetlands, because trenching for the pipeline, burial of the pipeline, and placement of gravel for compressor stations and access roads would cover wetland sites and affect natural drainage patterns. If the gas pipeline was routed approximately parallel to the TAPS alignment, impacts could be minimized if the existing TAPS workpad, access roads, stream crossings, and material sites were used when feasible (TAPS Owners 2001a).

Construction of natural gas pipeline would disturb up to 23,216 acres of habitat (TAPS Owners 2001a). Because the gas pipeline would be buried, impacts would be short term, lasting during the construction period and time required for revegetation. However, to allow access to the pipeline, the overlying ROW would be maintained in an early stage of succession (i.e., in boreal forest areas), similar to that of the TAPS ROW. This could total up to about 8,425 acres during the period of gas pipeline operation (TAPS Owners 2001a). The gas condition facility would require an area of about 300 acres (TAPS Owners 2001a) within the 56.8 million acre North Slope. A further 390 acres of habitat may be disturbed for construction of a gas liquefication plant at Valdez, if this option were selected (TAPS Owners 2001a).

Several studies have documented that birds such as raptors perch and nest on oil field and pipeline structures and that swallows and other birds nest on structures at several TAPS pump stations (see Section 4.3.17.1). Similarly, Pollard et al. (1990) and Rodrigues (1992) documented extensive use of gravel pads and adjacent disturbed sites in the North Slope oil fields by birds. Offshore artificial drilling islands would provide new artificial habitats that would attract birds (USACE 1999). This situation was documented on the Endicott Causeway, which was colonized by common eiders. In addition, molting long-tailed ducks aggregate on the leeward side of the causeway (TAPS Owners 2001a). Present and future oil and gas development on the North Slope, particularly offshore in the Beaufort Sea, might involve the construction of more offshore islands, which would likely provide more nesting and molting habitat for birds.

4.7.7.3.2 Disturbance or Displacement.

High levels of air and vehicle traffic are associated with the petroleum industry in the North Slope. For example, up to 1,200 helicopter trips per year have taken place just to support offshore development. Such activities

could cause short-term displacement of nesting, feeding, and/or molting birds (MMS 1998). Traffic and human activity associated with the TAPS and the Dalton Highway can disturb female caribou with young calves (Cameron and Whitten 1980); while roads, pipelines, and human activitiy may block, delay, or deflect individual caribou as they move through the Prudhoe Bay oil field (Pollard et al. 1996a). Nevertheless, movements of large groups of caribou do occur through the oil fields (Pollard et al. 1996b). Pregnant and maternal cows are sensitive to human activities within the North Slope (Cameron et al. 1985). They will avoid roads with relatively low traffic levels (e.g., < 100 vehicles/day) for about two weeks following partuition and tend to remain > 0.6 mi from roads (Cronin et al. 1994). Caribou bulls in general and all caribou during the insect harassment are least likely to avoid developments (Wolfe et al. 2000). Cameron et al. (1992) observed that the calving caribou of the Central Arctic caribou herd were displaced outward after construction of the Milne Point road system; relative densities within 1.2 mi of the road system decreased by over two-thirds. Similarly, Nellemann and Cameron (1998) observed that increasing density of roads in the Kuparuk Development Area near Prudhoe Bay decreased caribou density. Caribou densities declined by 63% when there were 0.0 to 0.5 mi of roads/mi^2 and declined by 86% when there were more than 1.9 to 2.8 mi of roads/mi^2. The higher road densities virtually excluded cow-calf pairs (Nellemann and Cameron 1998). In contrast, Carruthers and Jakimchuk (1987) did not observe traditional migration of the Nelchina caribou herd (in the Gulkana River area) to be affected by the TAPS and the Richardson Highway.

During the post-calving season, caribou distribution is largely unrelated to distance from infrastructure; they regularly occur within the oil fields, and they often occur close to infrastructure (Cronin et al. 1998a). Although some level of cumulative effect to caribou is likely from petroleum development, clear separation of the cumulative effects from natural variation in caribou habitat use and demography is difficult (Wolfe et al. 2000). No population-level impacts to any wildlife species have been documented (reviewed in Truett and Johnson 2000).

Helicopter and fixed-wing aircraft flights associated with the multitude of North Slope projects could result in combined or repeated disturbances to wildlife. Such impacts could be effectively reduced by restricting flight paths to avoid sensitive nesting areas during active breeding and brood-rearing periods and by establishing minimum flight altitudes to reduce ground-level noise (USACE 1999). While a few species, such as wolves and foxes, habituate to human presence, they are nevertheless disturbed by aircraft and other vehicles (ADNR 1999). Brant react to aircraft by alert posturing, running, or entering water. Interruptions of feeding may have deleterious effects on body reserves; and molting birds that move to undisturbed areas would be exposed to predators within the open tundra. A single aircraft could disturb birds from dozens of lakes in its flight path (Simpson et al. 1982). Repeated exposure of caribou to low-level military jet overflights, especially during sensitive periods, may reduce calf survival and increase daily activities (Calef et al. 1976; Maier et al. 1998; Wolfe et al. 2000). Females of the Delta caribou herd with newborn calves apparently move away from areas where they are disturbed by jet aircraft overflights (Murphy et al. 1993). However, Valkenburg and Davis (1984) believe that the effects of disturbance from hunters on snowmobiles may be more important than aircraft overflights.

Traffic along hundreds of miles of existing and future pipeline roads could disturb and displace wildlife. Disturbance to caribou would be generally short-term (e.g., a few hours or less). Less time spent lying and more time moving about are the two consistent reactions by caribou to disturbance. Disruption of the feeding and resting cycle, accompanied by increased energy expenditures by running may contribute to energetic stress (Murphy and Curatolo 1987). If calving caribou are displaced from a high-quality forage area, there is a potential for lowered calf survival (ADNR 1999). To date, the cumulative impacts of North Slope oil and gas developments have caused minor displacement of the Central Arctic caribou herd from a small portion of its calving range without an apparent

adverse effect on herd abundance or overall productivity.

Future North Slope oil field developments may contribute to the disturbance and displacement of wildlife. However, mitigation measures, such as restricting the timing of the activity and locating facilities away from nesting or calving areas, could minimize impacts. Operation of the gas pipeline project would have a negligible impact. Localized disturbances to wildlife would occur during its construction.

In Prince William Sound, the cumulative effect of aircraft and vessel traffic associated with the oil industry, commercial and recreational fishing, tourism, and other commercial and recreational activities could result in long-term displacement of birds from nesting and feeding habitats (MMS 1995). However, most effects of disturbance and displacement would be local and minor at the population level because most species have relatively low density (BLM 1998).

4.7.7.3.3 Mortality. The Dalton Highway has provided access to previously remote areas north of the Yukon River. Concern exists that this increased access has adversely affected moose, caribou, wolf, and bear populations as a result of increased harvests (McLellan 1989; Yokel 1999). The increase in Alaska's human population since TAPS construction has also increased the hunting pressure on the state's wildlife. ADF&G has responded to this pressure where necessary by restricting seasons and bag limits and by implementing predator control programs to increase the number of ungulates available to hunt (see TAPS Owners 2001a).

Increased densities of predators and scavengers attracted to areas of human activity may result in increased predation pressure on prey populations. This situation has recently become a management issue, mainly for ground-nesting birds on the North Slope (Day 1998), but it is difficult to document. Increases in the abundance of foxes are well-documented in the North Slope oil fields (Burgess 2000). However, because pipeline facilities are more dispersed than are oil field facilities, this problem would be small south of PS 1. Within the North Slope, losses of birds due to elevated levels of predators would be in addition to losses associated with habitat loss, displacement, and so forth (BLM 1998).

Similarly, increased densities of predators and scavengers might increase the occurrence and rate of transmission of wildlife diseases, including rabies (Follmann et al. 1988). The primary reservoir of rabies in the North Slope area is the arctic fox, whereas south of the Brooks Range, the red fox and other carnivores are sources of greater concern (Winkler 1975).

Other causes of wildlife mortality in Alaska include intentional mortality (i.e., sport and subsistence harvest, management and research mortality) and unintentional mortality (i.e., railroad and road kills; unreported harvests; defense of life and property mortality) (TAPS Owners 2001a). Vehicle collisions with terrestrial mammals, particularly moose, are an issue of public safety as well as a source of wildlife mortality (TAPS Owners 2001a). Black bears continue to be a problem in Valdez as a result of city garbage management and lack of fencing at the Valdez Marine Terminal (Schmidt 1999; Lawlor 1999; Shoulders 1999; Brown 1999).

Birds, especially those using early green-up areas in dust shadows along the TAPS ROW, could be killed by vehicles (Shoulders 1999; Schmidt 1999). Road kills have not been a problem in the North Slope oil fields, although there have been occasional mortalities of caribou and bears. The same trend would be likely during present and future North Slope oil field developments and a gas transmission line project. A gas pipeline might increase traffic on highways, particularly during construction. This situation would be unlikely to impact large numbers of animals. Increased public access might increase the numbers of road kills from Valdez to the North Slope, while the National Missile Defense System is unlikely to have an impact. Traffic associated with other industrial activities might result in road kills, depending on the location and extent of developments.

Birds might also fly into structures, particularly offshore structures during periods of fog. Also, some birds (e.g., cliff swallows) that nest at the TAPS pump stations might fly into the pump station structures. Structures and bright

lights at the Valdez Marine Terminal might attract birds during inclement weather (Senner 1999). Collisions normally occur during spring and fall when birds are migrating through the area. Although they could result in the loss of individual birds, the cumulative effect would not be considered significant (USACE 1999).

In the North Slope oil fields, there is some anecdotal evidence for bird mortality at nearshore structures such as Endicott and at the seawater treatment plant at the end of the West Dock causeway. Bird mortality at such structures, however, has been intermittent and local and has involved only a few individuals. Present and future North Slope oil and gas developments could also cause some bird mortalities. It has been postulated that lights at offshore facilities such as Northstar might attract migrating birds that could then collide with structures (USACE 1999).

High predator populations in the North Slope oil fields are associated with natural factors such as high prey availability and natural den sites. However, because of the availability of supplemental food at the North Slope Borough Landfill and in dumpsters throughout the North Slope oil fields, populations of predators, such as bears, foxes, gulls, and ravens, have increased over the past three decades. Although there is no definite cause-and-effect relationship between human food and predator numbers, predators have adversely affected nesting success of birds that nest on the ground, especially colonial nesting snow geese, and possibly some ducks and shorebirds (TAPS Owners 2001a).

The introduction of exotic animals (mostly foxes, but also rats, voles, ground squirrels, and rabbits) has been among the most damaging source of direct mortality to seabirds of all the factors associated with human activity (Bailey 1993). Unlike an oil spill or some other one-time catastrophe, predators have a continuing negative impact on seabird populations. Combined with this source of seabird loss is the detrimental impact of large fish harvests on seabirds (e.g., seabirds are accidentally killed in drift gill nets, major shifts in fish stocks have altered seabird food supplies, and possible effects of fish biomass) (Hatch and Piatt 2001). Disease, predation, fluctuations in prey, and severe weather are among the natural phenomena that also contribute to cumulative impacts on wildlife (MMS 1998).

The natural gas pipeline and other industrial developments could result in more workers within remote areas and could increase hunting pressure depending on location and extent of development. However, it is likely that firearms will be prohibited from gas-pipeline construction sites and facilities (as with APSC facilities today) and that hunting will be prohibited from the ROW of a gas pipeline, as with the TAPS ROW. Increased public access could result in the greatest impact to wildlife through sport hunting, while an NMDS may bring more military personnel who hunt, although hunting may be prohibited on the military site (TAPS Owners 2001a).

The Central Arctic caribou herd has increased in size since oil field development and operation began. Similar increases have occurred to all major caribou herds in northern Alaska and Canada, and are presumed to be independent from the effects of oil field development (Klein 1991). In fact, the populations of many wildlife populations that spend at least part of the year in the vicinity of oil fields are either stable or larger than when oil field development began. In addition to caribou, these include muskox, brown bear, polar bear, arctic fox, snow goose, brant, and other waterfowl and shorebirds (see Cronin et al. 1986b).

4.7.7.3.4 Obstruction to Movement.

Present and future North Slope oil field developments could further obstruct wildlife movements. For example, during the brood-rearing period when species such as brant are flightless, roads, causeways, and other structures could present a barrier to movement (ADNR 1999). Roby (1978) reported that during summer, caribou with calves were the group most sensitive to the Dalton Highway. Caribou cows with calves may be underrepresented along the Dalton Highway during the calving season due to avoidance of the road, habitat selection, or predator avoidance. Roads (without adjacent pipelines) that have heavy traffic (e.g., >60 vehicles/h) appear to impede caribou movement. Pipeline-road combinations tend to

have a synergistic effect on impeding caribou movements (Curatolo and Murphy 1986; Cronin et al. 1994). Regardless, the Central Arctic Herd of caribou has grown in numbers since the mid-1970s (i.e., from about 5,000 in 1978 to 20,000 in 1998), and any redistribution of caribou in the spring has apparently not adversely affected population growth (TAPS Owners 2001a). The ADF&G management objectives for this herd (10,000 individuals) are being met, and herd-levels impacts due to the oil field are not apparent (Cronin et al. 1998b).

It is reasonable to expect that measures designed to provide caribou and other large mammals with unimpeded movement (e.g., pipelines at least 5 ft aboveground and minimizing permanent roads alongside pipelines) would also be used in the future. Therefore, cumulative impacts that would obstruct wildlife movements would be minor (USACE 1999).

The natural gas pipeline would have little or no impact on animal movements because only a few aboveground structures would be required on the North Slope and along the pipeline route. The gas pipeline would be buried and have no impact, except during construction. The NMDS would have very localized impacts in the area of development. Increased public access could result in more highway traffic and increased obstruction of wildlife movements. The impact from other industrial activity would depend on its extent and location (TAPS Owners 2001a).

4.7.7.3.5 Spills. About 400 spills of diesel, crude, and hydraulic oils and other substances (e.g., drilling wastes and seawater) occur yearly in the North Slope. Many of the oil spills occur as a result of corroded infrastructure (Schmidt 2002). Multiple spills could adversely affect wildlife if more disturbances occurred while populations were still recovering from the initial disturbance (USACE 1999). Potentially, tens of thousands of birds (e.g., long-tailed ducks, common eider, and other sea ducks) could be killed as a result of oil spills within the Beaufort Sea over the life of the oil fields. Other species, such as brant and snow geese, could be similarly affected by oil spills into coastal salt marshes or the Sagavanirktok River delta, respectively (MMS 1998). Based on experience, land-based spills of crude oil in the oil fields are uncommon and have only impacted tens of acres. Diesel spills have been more common and have affected hundreds of acres but mostly within gravel pads. Current management and cleanup techniques are effective in reducing the occurrence of spills and in removing spills when they occur (Jorgenson 1997).

Present and future North Slope oil field developments could include more offshore facilities, which would increase the potential for marine oil spills (USACE 1999). For example, oil pipelines will be used for the Northstar development in the Alaskan Beaufort Sea, and fuel barges will be used for supply. Depending on the time of year and the volume of the oil spill, several thousand birds could be affected by a spill in the Beaufort Sea (USACE 1999). Significant impacts could occur to post-nesting birds that concentrate along the coast for brood rearing, molting, premigratory staging, or migration (BLM 1998). Caribou could be impacted by a large oil spill in the North Slope if it occurred during the spring or insect-harassment period, when caribou are found in coastal waters or on beaches. However, only several hundred caribou, at most, might die from oiling, and recovery would probably occur within one generation (MMS 1998).

As discussed in Section 4.4.4.11, a land-based oil spill can contaminate individual animals, their habitats, and their food resources. Species such as foxes may be attracted by dead oiled wildlife at a spill site or by human activity associated with spill cleanup. A large spill would probably disturb and displace most animals (other than foxes and other scavengers) from the area due to extensive activities associated with spill cleanup activities (ADNR 1999). Leaving some residual oil in place may be less damaging than the potential long-term effects of intensive cleanup activities (Jorgenson and Cater 1996).

A large oil spill (e.g., from a tanker spill) in Prince William Sound could have deleterious impacts similar to those that resulted from the Exxon Valdez oil spill. They could include the loss of hundreds of thousands of marine and coastal birds, hundreds of eagles, and scores of river otters, bears, and deer. Smaller oil spills and contamination routinely occur (e.g., from natural crude oil seeps, and from bunker and

diesel fuel spills) (Burger and Fry 1993). Small oil spills would have an additive effect, perhaps causing death to several thousand marine and coastal birds, only a few river otters, and very few bears or deer. Bird losses would be an incremental addition to the hundreds of thousands of birds that annually die in driftnets within the North Pacific, Bering Sea, and Gulf of Alaska (MMS 1998). However, present and future oil transport through Prince William Sound is now safer than before the Exxon Valdez oil spill because of the implementation of the SERVS vessel escort system. In addition, the use of double-hulled tankers in the future will add further protection against potential tanker spills (TAPS Owners 2001a).

4.7.7.3.6 Summary. On the North Slope and in the Beaufort Sea, the most important future activities that could contribute to cumulative impacts on birds and terrestrial mammals would be planned oil and gas development activities, oil and gas transportation, and natural resource use (e.g., subsistence). In Interior Alaska, future actions that could contribute to the cumulative impacts on these species would include oil and gas transport, other transportation activities, human habitation and development, and land management actions. For example, timber harvests and post-harvest management may directly and indirectly affect winter habitat of caribou through loss of lichen (Wolfe et al. 2000). In Prince William Sound, future actions that could contribute to cumulative impacts on birds and terrestrial mammals would include oil transport, other transportation activities (e.g., barging and cruise ships), human habitation, natural resource use (e.g., commercial and recreational fishing, hunting, and trapping), and land management activities. However, it is expected that none of these activities would significantly increase cumulative impacts or affect the viability of species' populations. Oil spills would not significantly add to cumulative impacts, except for an unlikely to very unlikely large spill to aquatic habitats; in this case, impacts similar to those from the Exxon Valdez oil spill could occur (see Section 4.4.4.11).

Impacts associated directly with the TAPS are only a small component of the cumulative impacts associated with the activities listed in Table 4.7-2. However, the indirect effects of the TAPS are a significant contributor to cumulative impacts to birds, and terrestrial mammals because of the interdependence of current and foreseeable oil development, production, and transportation activities with the TAPS.

Cumulative impacts of the less-than-30-year renewal alternative on birds and terrestrial mammals would be similar to those of the proposed action. TAPS operations, monitoring, and maintenance activities; and other present and foreseeable actions would essentially be the same for both alternatives (except for the duration of the TAPS renewal period). The shorter renewal period would not coincide with any other current or foreseeable actions listed in Table 4.7-2. Also, a subsequent renewal option might be a possibility following the less-than-30-year renewal period. Thus, the differences in cumulative impacts between the two alternatives would be negligible (e.g., differences would likely be within the same order of magnitude).

Differences in cumulative impacts between the no-action alternative and the proposed action on birds and terrestrial mammals would be more evident, particularly within the North Slope. While activities associated with gas production and transportation would occur under both alternatives, oil production and transportation would be reduced to very low levels for the no-action alternative. Thus, most oil production facilities would be idled. Also, the incremental changes that would have occurred from future oil field developments would not occur. Therefore, the level of disturbance to wildlife within the North Slope would be less for the no-action alternative as the level of vehicle use and human activity would reduced. For example, caribou using gravel pads during periods of insect harassment would not be disturbed on pads housing idled facilities. The potential for accidental oil spills would also decline within the North Slope, along the TAPS ROW, and within Prince William Sound. However, the infrastructure required to promptly clean up any spills that may occur within these areas may not be available (e.g., response equipment and teams associated with the TAPS would not be present).

4.7.7.4 Threatened, Endangered, and Protected Species

Cumulative impacts to threatened, endangered, and protected species result from past, present, and reasonably foreseeable future actions in the three regions crossed by the TAPS: (1) North Slope and Beaufort Sea; (2) Interior Alaska; and (3) Prince William Sound. Cumulative impacts are considered separately for species in these three regions because there are few species that occur in more than one. Past and present activities that contribute to cumulative impacts are part of the existing baseline and are described in Section 3.22. Only past activities or events whose impacts still influence the status of listed or protected species are considered here. No critical habitat, as designated by the ESA, occurs in the area affected by TAPS; therefore, cumulative impacts on critical habitats are not discussed here.

Tables 4.7-9, 4.7-10, and 4.7-11 provide an overview of the relative contributions of the proposed action and past, present, and reasonably foreseeable future actions to cumulative impacts on listed and protected species. Five categories of impact are considered:

- *No effect:* Activity has not produced or is not expected to produce an effect on the species.
- *Negligible effect:* Activity has produced or is expected to produce an adverse effect, but the effect is or would not be distinguishable from natural variability in population size.
- *Minor effect:* Activity has produced or is expected to produce a small but measurable decrease (about 5% or less) in population size that does or would not affect the viability of the population.
- *Moderate effect:* Activity has produced or is expected to produce a moderate measurable decrease (more than about 5%) in population size that does or would not affect the viability of the population.
- *Large effect:* Activity has produced or is expected to produce a measurable decrease in population size that does or would affect the viability of the population.

The same five categories are used to describe the overall cumulative effect (i.e., the effect of all past, present, and future actions together on the species of concern). These designated levels of impact are consistent with the definitions of “threatened” and “endangered” as provided in the ESA and presented in Section 3.22.

For listed species (i.e., those listed as threatened or endangered by the federal government or the state), the effects of past and present activities as represented in the existing baseline are considered moderate if the species is threatened and large if the species is listed as endangered. The effects of past and present activities on state species of special concern are considered minor. The effects of past and present actions on other species were based on the current status of populations relative to predisturbance population estimates, as described in Section 3.22.

The relative impacts of future actions on listed and protected species were estimated on the basis of information presented in Section 4.7.4. The impacting factors associated with future actions that affect listed and protected species are similar to those described for the proposed action (see Section 4.3.14). The relative magnitude of impacts was determined from the area that would be affected by the future action and the nature of the impact (i.e., habitat alteration, noise, air emissions, changes in hydrology).

Only petroleum spills that are anticipated or likely to occur are considered in this cumulative impact evaluation. These include spills that result from vandalism or sabotage, because, on the basis of past frequencies of occurrence, these types of spills are likely to occur. Only large spills (which are considered unlikely or very unlikely to occur) would contribute substantially to the cumulative impact on listed and protected species. Since these spills are not “reasonably foreseeable,” their effects are not described here. It is important to note that the proposed action would not affect the waters of

TABLE 4.7-9 Cumulative Impacts on Threatened, Endangered, and Protected Species on the North Slope and Beaufort Sea[a]

	Relative Contribution to Cumulative Effect									
Species	Existing Baseline[b]	Oil and Gas Exploration, Development, and Production	Oil and Gas Transportation	Human Habitation and Develop-ment	Transportation (other than oil and gas)	Land Manage-ment	Natural Resource Use	Petroleum Spills[c]	Proposed Action[d]	Overall Cumulative Effect
Arctic peregrine falcon	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Negligible
Spectacled eider	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Moderate
Steller's eider	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Moderate
Bearded seal	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible
Beluga whale[e]	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible
Bowhead whale	Large	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Large
Gray whale	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible
Pacific walrus	Minor	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Minor
Polar bear	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible
Ribbon seal	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible
Ringed seal	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible
Spotted seal	Negligible	Negligible	Negligible	None	None	None	Negligible	Negligible	None	Negligible

a None = activity has not produced or is not expected to produce any effect; negligible = activity has produced or is expected to produce an adverse effect, but the effect on population size would not be distinguishable from natural variability in population size; minor = activity has produced or is expected to produce a small but measurable (5% or less) decrease in population size that does not affect the viability of the population; moderate = activity has produced or is expected to produce a moderate measurable decrease (more than 5%) in population size that does not affect the viability of the population; large = activity has produced or is expected to produce a measurable decrease in population size that affects the viability of the population.

b Existing baseline incorporates the effects of current ongoing activities and residual past effects (i.e., the effects of past activities that continue to influence baseline conditions).

c Only those petroleum spills that are considered anticipated or likely to occur are presented here. Very large spills that are unlikely or very unlikely to occur could have impacts ranging from no effect to large effect depending on the location and extent of the area affected.

d The direct and indirect effects of the proposed action are presented.

e Beaufort Sea and Chukchi stocks.

TABLE 4.7-10 Cumulative Impacts on Threatened, Endangered, and Protected Species in Interior Alaska[a]

Species	Relative Contribution to Cumulative Effect									
	Existing Baseline[b]	Oil and Gas Exploration, Development, and Production	Oil and Gas Transportation	Human Habitation and Development	Transportation (other than oil and gas)	Land Management	Natural Resource Use	Petroleum Spills[c]	Proposed Action[d]	Overall Cumulative Effect
American peregrine falcon	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Negligible
Blackpoll warbler	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Minor
Gray-cheeked thrush	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Minor
Olive-sided flycatcher	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Minor
Townsend's warbler	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	None	Negligible	Negligible	Minor

a None = activity has not produced or is not expected to produce any effect; negligible = activity has produced or is expected to produce an adverse effect, but the effect on population size would not be distinguishable from natural variability in population size; minor = activity has produced or is expected to produce a small but measurable (5% or less) decrease in population size that does not affect the viability of the population; moderate = activity has produced or is expected to produce a moderate measurable decrease (more than 5%) in population size that does not affect the viability of the population; large = activity has produced or is expected to produce a measurable decrease in population size that affects the viability of the population.

b Existing baseline incorporates the effects of current ongoing activities and residual past effects (i.e., the effects of past activities that continue to influence baseline conditions).

c Only those petroleum spills that are considered anticipated or likely to occur are presented here. Very large spills that are unlikely or very unlikely to occur could have impacts ranging from no effect to large effect depending on the location and extent of the area affected.

d The direct and indirect effects of the proposed action are presented.

TABLE 4.7-11 Cumulative Impacts on Threatened, Endangered, and Protected Species in Prince William Sound[a]

Species	Relative Contribution to Cumulative Effect								
	Existing Baseline[b]	Oil and Gas Transportation	Human Habitation and Development	Transportation (other than oil and gas)	Land Management	Natural Resource Use	Petroleum Spills[c]	Proposed Action[d]	Overall Cumulative Effect
Steller's eider	Moderate	None	None	None	None	Negligible	Negligible	Negligible	Moderate
Beluga whale[e]	Moderate	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Moderate
Dall's porpoise	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	None
Fin whale	Large	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Large
Gray whale	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	None
Harbor porpoise	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	None
Harbor seal	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor
Humpback whale	Large	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Large
Killer whale	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Negligible
Minke whale	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Negligible
Pacific white-sided dolphin	Negligible	Negligible	None	Negligible	None	Negligible	Negligible	Negligible	Negligible
Sea otter	Moderate	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Moderate
Steller sea lion	Large	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Large

a None = activity has not produced or is not expected to produce any effect; negligible = activity has produced or is expected to produce an adverse effect, but the effect on population size would not be distinguishable from natural variability in population size; minor = activity has produced or is expected to produce a small but measurable (5% or less) decrease in population size that does not affect the viability of the population; moderate = activity has produced or is expected to produce a moderate measurable decrease (more than 5%) in population size that does not affect the viability of the population; large = activity has produced or is expected to produce a measurable decrease in population size that affects the viability of the population.

b Existing baseline incorporates the effects of current ongoing activities and residual past effects (i.e., the effects of past activities that continue to influence baseline conditions).

c Only those petroleum spills that are considered anticipated or likely to occur are presented here. Very large spills that are unlikely or very unlikely to occur could have impacts ranging from no effect to large effect depending on the location and extent of the area affected.

d The direct and indirect effects of the proposed action are presented.

e Beaufort Sea and Chukchi stocks.

the Beaufort Sea, except in the case of an unlikely or very unlikely catastrophic oil spill into the Sagavanirktok River that could not be contained before it entered the Beaufort Sea.

The proposed action would result in a negligible contribution to cumulative impacts on listed and protected species on the North Slope (spectacled eider, Steller's eider, and Arctic peregrine falcon) and no contribution to cumulative impacts on species in the Beaufort Sea because the proposed action would not affect the water of the Beaufort Sea (Table 4.7-9).

The largest contribution to cumulative impacts on species occupying the North Slope and Beaufort Sea would result from past and current activities, including activities and effects in other portions of the ranges of these species. For example, for the spectacled eider, the ingestion of lead shot and ecosystem-level changes elsewhere in its range might have been major contributors to the declines in the population of the species (USFWS 1999). Population status and factors affecting the status of listed and protected species are discussed in Section 3.22. The most important future activities that could contribute to cumulative impacts on the North Slope and Beaufort Sea are planned oil and gas development activities, oil and gas transportation, and natural resource use (subsistence harvests). However, on the basis of information available none of these activities are expected to noticeably increase the cumulative impact or affect the viability of species' populations.

Spectacled and Steller's eiders could be affected by future activities and facilities that would disturb their habitat, including the development of new production facilities and oil and gas transportation infrastructure. Increased predator abundance associated with human occupation and the subsequent increased mortality of eider eggs and young have been identified as a concern on the North Slope but could be mitigated with proper disposal and management of food waste (USFWS 2002). New development is expected to have relatively minor effects, given the overall availability of habitat across the North Slope; consequently, the overall cumulative impact on eiders would be relatively unchanged. Cumulative impacts are not expected to threaten the population viability of either the spectacled or Steller's eider.

Concern has been raised about the effect of underwater noise and disturbances associated with oil and gas development on whales inhabiting the Beaufort Sea. All whale species that have been examined show some aversion to underwater noise (see Section 3.22). A recent evaluation of the cumulative impacts of leasing and exploration activities on bowhead whales of the Outer Continental Shelf portion of the U.S. Beaufort Sea concluded that these activities were not likely to jeopardize the continued existence of this species, but that adverse effects of noise on whale behavior were possible (Knowles 2001).

None of the species in Interior Alaska are currently listed by the federal government as threatened or endangered. The American peregrine falcon has been de-listed because the population has recovered. Several neotropical migrant bird species are considered species of special concern by the state (blackpoll worbler, gray-cheeked thrush, olive-sided flycatcher, Townsend's warbler), but past and present actions affecting existing populations mostly result from impacts in other portions of the ranges of these species. Future actions in Interior Alaska that could contribute to the cumulative impact on these species include oil and gas transport, human habitation and development, other transportation activities, land management actions, and petroleum spills (Table 4.7-10). The contributions to the cumulative impact from all of these activities and from the proposed action are expected to be negligible given the area of habitat potentially affected compared to that available.

Future actions contributing to cumulative impacts on listed and protected species in Prince William Sound include oil transport (tankering), other transportation activities (e.g., barge traffic), human habitation, natural resource use (e.g., commercial and recreational fisheries), land management, and petroleum spills.The largest contribution to the cumulative impact results from past and existing impacts. The Exxon Valdez oil spill has affected several species in the Sound, including the sea otter and Steller sea lion (Section 3.22.3; Table 4.7-11). Past and present impacts to fin whale,

humpback whale, beluga whale, and Steller's eider, for the most part, occur in other portions of the ranges of these species (see Section 3.22). Reasonably foreseeable future actions in the Sound, because of their nature and size (see Section 4.7.4), would contribute relatively minor increments to the overall cumulative impact, and these increments are not expected to reduce the viability of existing populations in Prince William Sound.

The proposed action would result in a negligible contribution to cumulative impacts on listed and protected species in Prince William Sound (Table 4.7-11). Very minor amounts of water pollutants would be released as effluent to Port Valdez during normal operations of the TAPS. On the basis of past monitoring results, these permitted discharges would not affect overall water quality in the Sound. Similarly, anticipated or likely spills associated with the proposed action are expected to be relatively small, and, if existing oil spill contingency plans for response and cleanup are followed, any impacts from the spills should be short in duration. Large spills (not included in Table 4.7-11) that are considered unlikely or very unlikely could contribute substantially to the cumulative impacts on listed and protected species in Prince William Sound. The impacts of such a spill would depend on many factors including location, weather, time of year, and area affected.

The effects on marine mammals of underwater noise associated with boat and tanker traffic is a concern in Prince William Sound, much as it is in the Beaufort Sea. Unlike in the Beaufort Sea, however, no substantial increases in noise are anticipated in Prince William Sound, since tanker and boat traffic is not expected to increase substantially over the TAPS renewal period. Decreasing throughput during the renewal period could result in decreased tanker traffic and reduced noise levels.

The cumulative impact of the less-than-30-year renewal alternative on listed and protected species would be very similar to that of the proposed action. The only difference between the proposed action and this alternative is the length of the renewal period. As for the proposed action, a decision could be made to renew the Federal Grant at the end of the renewal period. Therefore, ultimately, the period of time during which the TAPS would operate under the less-than-30-year renewal alternative could be identical to that under the proposed action. A shorter renewal period would not preclude any other existing or foreseeable actions from occurring. Consequently, the cumulative impact of this alternative could be the same as that of the proposed action.

The cumulative impact of the no-action alternative on listed and protected species would be quite different from that of the proposed action. Differences result from the relationship between the TAPS and oil and gas production on the North Slope. For the no-action alternative it is assumed that oil exploration and production activities would cease pending development of another means of transporting the oil to market, but that gas production and transportation would occur via a natural gas pipeline. Thus, the cumulative impact of the no-action alternative would be less than that of the proposed action because of the reduction in impacts associated with oil exploration and production on the North Slope and oil transportation in Prince William Sound. Although there would be some potential for a short-term increase in impacts resulting from termination activities for production facilities on the North Slope and on Prince William Sound, the overall cumulative impact on listed and protected species of the no-action alternative would be minor and less than that of the proposed action.

In summary, the impacts of the proposed action would represent a small incremental contribution to the cumulative impact on listed and protected species. For all of these species, the largest contributions to cumulative impact would occur in other portions of the species' range. On the North Slope, past and present oil and gas production activities would be the largest contributors to cumulative impact, while important future contributors would include oil and gas exploration and development activities; oil and gas transportation; and use of natural resources (subsistence harvest). Activities in Interior Alaska, including the proposed action, would result in negligible contributions to the cumulative impact on species that occur there. In Prince William Sound, the largest contributors to

cumulative impacts would be associated with past, present, and future oil and gas transportation (tankering) and use of natural resources (commercial fishing).

The cumulative impact of the less-than-30-year renewal alternative on listed and protected species would be very similar to that of the proposed action because TAPS operation and associated activities would continue and the impacts of other future activities would be similar. In contrast, the cumulative impact of the no-action alternative on listed and protected species would be quite different from that of the proposed action. Differences would result from the relationship between the TAPS and oil and gas production on the North Slope. Under the no-action alternative, the cumulative impact would be less than it would be under the proposed action because of the reduction in impacts associated with oil exploration and production on the North Slope and oil transportation in Prince William Sound. Although there would be some potential for a short-term increase in impacts resulting from termination activities for production facilities on the North Slope and Prince William Sound, the overall cumulative impact on listed and protected species under the no-action alternative would be minor and less than that under the proposed action.

4.7.8 Social Systems

4.7.8.1 Subsistence

The evaluation of impacts to subsistence under the proposed action concluded that any negative impacts that occurred would be extremely small (see Section 4.3.20). This conclusion was tentative because of the absence of data necessary to make a more certain assessment, including assigning impacts to the TAPS (as opposed to other activities) and determining the magnitude of possible impacts. Similar data inadequacies limited the strength of conclusions drawn for subsistence under the less-than-30-year renewal alternative (see Section 4.5.2.20) and the no-action alternative (see Section 4.6.2.20); these inadequacies also affect the evaluations conducted in this section.

For cumulative impacts, several effects of all actions on subsistence would be possible. These effects, in turn, would vary in importance depending on the geographic area being considered.

- Larger amounts of cash would probably be available to individuals pursuing subsistence activities, enabling them to purchase improved subsistence-related technologies (though the precise impact of cash or subsistence activity has not been measured).

- Larger amounts of cash would probably be available to individuals pursuing recreational hunting and fishing, enabling them to buy improved technologies for sport harvests and to take advantage of general conditions conducive to such activities (though the precise impact of cash on recreational hunting and fishing has not been measured).

- More access to rural Alaska may be provided by the construction and maintenance of additional access roads associated with other current or potential activities, such as oil and gas exploration on the North Slope and construction, operation, and maintenance of a natural gas pipeline.

- Increased numbers of outsiders would be introduced to rural Alaska through their involvement in reasonably foreseeable other actions, increasing the number of potential competitors for fish and game resources with those currently relying on these resources for subsistence, The number of people involved directly and indirectly in other actions, however, would not be large and in many cases would be temporary (TAPS Owners 2001a).

- The overall state population may grow in response to the direct and indirect economic effects of current and reasonably foreseeable actions, and the increased number of residents would possibly generate increased competition for subsistence resources.

- More activity would potentially increase disruption to the movement of terrestrial mammals and fish, although such disruption

is expected to be small-scale (i.e., not at a population level) and often temporary (see Sections 4.7.7.2 and 4.7.7.3).

- Additional projects, which would introduce more infrastructure, people, and activities, could further limit the areas where subsistence could be pursued.

On the North Slope, many of the current and reasonably foreseeable actions tend to involve the oil and gas oil industry — through exploration, development, production, support, and transportation. A second important future action there would be the construction and operation of a natural gas pipeline with facilities on the North Slope. Finally, the northern part of Gates of the Arctic NPP is located on the North Slope, where it overlaps with portions of tranditional subsistence harvest areas for Anaktuvuk Pass and Nuiqsut (see Figures 3.24-1 and 3.27-2, and Appendix D). Likely cumulative impacts to subsistence in the North Slope would include the following:

- Improved subsistence by enhanced travel to and from subsistence areas, increased harvest levels or efficiency, or both, through the availability of additional cash;

- Improved sport harvests by enhanced travel to and from hunting and fishing areas, increased harvest levels, increased opportunities to pursue recreational hunting and fishing, or combinations of these consequences through the availability of additional cash;

- Restrictions against using certain areas traditionally used for subsistence;

- Disruption to the movement of subsistence resources; and

- Introduction of additional competitors to areas traditionally relied upon by local rural communities for subsistence.

The Alaska Native communities of Anaktuvuk Pass and Nuiqsut, both heavily reliant on subsistence in general and caribou hunting in particular, likely would experience the above cumulative impacts to subsistence on the North Slope. In part these impacts would be directly associated with various activities and land management strategies and have been identified elsewhere. The presence of infrastructure and crews associated with oil and gas exploration and development restricts subsistence in areas traditionally used for that purpose (Haynes and Pedersen 1989). Although the establishment of Gates of the Arctic NPP did not disallow subsistence activities in the park area, it did introduce certain restrictions (e.g., allowable modes of transportation) that increased the difficulty of subsistence (Ned 1992; Reakoff 1992). The impact of the TAPS and other human activities on caribou remains a hotly debated issue. Although scientific evidence indicates that human activities could change movement patterns (Horejsi 1981; Lenart 2000; Murphy and Lawhead 2000; Tyler 1991; Wolfe et al. 2000), and traditional ecological knowledge from several of the rural communities in the vicinity of the TAPS associate the pipeline and related activity with changes in herd movement (ADF&G 2001; Moses 1993), disruption to movement patterns does not appear to have occurred at a large scale involving more than relatively few individual animals (see Sections 3.20 and 3.21). Increased competition for subsistence resources could also occur from nonlocal hunters and fishermen as a result of introducing more individuals to this part of Alaska through employment-related activities. Although likely levels of hunting and fishing are unkown, residents from both Anaktuvuk Pass and Nuiqsut have identified competition for resources as key problems for subsistence (ADF&G 2001). Indirect impacts resulting from cumulative actions also are likely, mainly by further reducing the flexibility of subsistence practitioners to pursue resources where and when they are available, and by reducing harvests in an area felt to be experiencing reduced subsistence resources (Ned 1992; Nelson 1992). Nevertheless, the large size of traditional subsistence harvest areas for Anaktuvuk Pass and Nuiqsut (see Figure 3.24-1), coupled with evidence for increased populations of key subsistence resources in recent years (TAPS Owners 2001a) and the successful regulation of harvests by ADF&G (see Sections 4.7.7.2 and 4.7.7.3), suggests that the magnitude of impacts from competition and restricted use likely would be minor. The TAPS contribution to cumulative

impacts to subsistence on the North Slope would be relatively small.

Cumulative impacts to subsistence would also occur in Interior Alaska. Impacts here would relate in particular to oil and gas development and transportation, coupled with continued management of Gates of the Arctic NPP and Wrangell-St. Elias NPP. The most important cumulative impacts to subsistence associated with the proposed action would include:

- Improved subsistence by enhanced travel to and from subsistence areas, increased harvest levels or efficiency, or both, through the availability of additional cash;
- Improved sport harvests by enhanced travel to and from hunting and fishing areas, increased harvest levels, increased opportunities to pursue recreational hunting and fishing, or combinations of these consequences through the availability of additional cash;
- Restrictions against using certain areas traditionally used for subsistence; and
- Disruption to the movement of subsistence resources.

A number of interior communities would be expected to experience cumulative impacts to subsistence: Alatna, Allakaket, Big Delta, Chitina, Coldfoot, Copperville, Copper Center, Delta Junction, Evansville, Gakona, Glennallen, Gulkana, Hughes, Kenny Lake, Livengood, Manley Hot Springs, Minto, Paxson, Rampart, Stevens Village, Tanana, Tazlina, Tonsina, and Wiseman (see Figure 3.24-1). However, the magnitude of the impacts would vary, depending on the community's proximity to one or more activities included in the cumulative analysis. For instance, Alatna, Allakaket, Evansville, and Wiseman all have part of their respective subsistence harvest areas within Gates of the Arctic NPP (Figure 3.24-1). Parts of the subsistence harvest areas of Chitina, Copper River, Gakona, Glennallen, Gulkana, Kenny Lake, Paxson, and Tonsina, in turn, lie within Wrangell-St. Elias NPP. Although subsistence for traditional and personal use is allowed within the parks, many subsistence practitioners feel that restrictions on subsistence in the parks makes that activity unduly difficult (e.g., Mekiana 1992; Moses 1992). As noted in Section 3.24, the subsistence harvest areas of several interior communities intersect the TAPS, and its presence restricts hunting from certain areas. Construction of a natural gas pipeline through a large portion of Alaska could add additional restrictions. However, once again the large size of traditional subsistence harvest areas for Interior Alaska communities (see Figure 3.24-1), increased populations of key subsistence resources in recent years (TAPS Owners 2001a), and harvest regulation by ADF&G (see Sections 4.7.7.2 and 4.7.7.3), suggests that the overall cumulative impacts associated with the proposed action would be minor. The TAPS contribution to cumulative impacts to subsistence in the Interior Alaska would be relatively small.

Cumulative impacts on subsistence in Prince William Sound would be possible as a result of past, current, and reasonably foreseeable future actions. These impacts could include those from anticipated and likely hazardous materials spills — that is, smaller volume spills that are reasonably foreseeable (see Section 4.7.4.10). The most important possible cumulative impacts to subsistence in Prince William Sound would include these:

- Improved subsistence by enhanced travel to and from subsistence areas, increased harvest levels or efficiency, or both through the availability of additional cash;
- Improved sport harvests by enhanced travel to and from hunting and fishing areas, increased harvest levels, increased opportunities to pursue recreational hunting and fishing, or combinations of these consequences through the availability of additional cash; and
- Disruption to the movement of subsistence resources.

Although all three of the impacts listed immediately above might affect subsistence in Prince William Sound, the greatest potential impact would be caused by the disruption due to a tanker accident. Table 4.7-4 identifies seven spill scenarios under *anticipated* and *likely* frequency ranges that would release varying

amounts of crude oil or diesel fuel into the sound; the releasing as much as 82,000 bbl of oil. The release of such a large volume of oil would have negative impacts on certain species of fish, birds, and mammals. The magnitude of the impacts would be determined in part by the location of the release point and the duration of the spill. Moreover, current oil spill contingency plans for spills in Prince William Sound, coupled with the SERVS tanker escort system (with accident prevention and spill containment capabilities), likely would help to limit the size of the area affected and thus the impacts. The location and size of traditional subsistence harvest areas in Prince William Sound (for Chenega Bay and Tatitlek) would enable avoidance of spill areas. That capability, coupled with evidence of successful regulation of harvests by ADF&G (see Sections 4.7.7.2 and 4.7.7.3), suggests that the magnitude of impacts to subsistence in and around Prince William Sound due to cumulative impacts likely would be minor. The TAPS contribution to cumulative impacts to subsistence in Prince William Sound would be very small. The direct effects primarily would be associated with occasional disruptions to the movement of small numbers of subsistence resources due to human.

Cumulative impacts for the cases of the other alternatives considered in this DEIS would vary slightly from those just discussed for the proposed action. Under the less-than-30-year renewal alternative, impacts likely would be about as small as those outlined earlier in this section; if anything, they would be smaller because there would be less time for impacts to accumulate (see also Section 4.5.2.20). Cumulative impacts of the no-action alternative likely would change, in part as a result of reduced employment opportunities, which would result in less cash to finance subsistence activities at the same time the need for subsistence to meet basic living requirements increased. In addition, although competition with recreational hunting and fish might be reduced, certain geographical restrictions would be eliminted. On the whole, cumulative impacts on subsistence under the no-action alternative and proposed action would be different but the net effect might be the same.

In summary, cumulative impacts to subsistence likely would vary for the three broad geographic regions — the North Slope, Interior Alaska, and Prince William Sound area. In all cases, negative cumulative impacts to subsistence should not be large. Those occurring in the North Slope likely would be the greatest, due primarily to the relatively large amount of oil and gas exploration, development, and production occurring there and the associated human activity and restrictions on subsistence in certain areas (see BLM 1998). However, the size of subsistence harvest areas in all three regions would leave much of these areas unaffected by cumulative impacts—that is, still available for subsistence, and outside the geographic influence of various cumulative activities that might cause minor disruptions to subsistence resource movements. Moreover, the increase in size of certain subsistence resource populations over the past several years suggests that improved availability of certain species may help compensate for reduced access to certain subsistence areas. Negative cumulative impacts associated with the less-than-30-year renewal alternative likely would be less than those associated with the proposed action, while those associated with the no-action alternative would probably be less still.

4.7.8.2 Sociocultural Systems

Impacts on sociocultural systems take the form of changes to Alaska Native and rural non-Native sociocultural systems because of one of the alternative actions considered, or in conjunction with other past, present, and reasonably foreseeable actions in the cumulative case. Although it is the nature of sociocultural systems to evolve in response to shifting challenges or surrounding conditions, rapid, large-scale change that often accompanies close interaction with other, more modern societies can be cause for concern. Large shifts and rapid changes prevent sociocultural systems from incrementally adjusting to conditions and discarding those changes that do not help them survive. Moreover, such large-scale changes place members of a sociocultural system under pressure, since they may face situations for which there are no established cultural guidelines to help them respond. With the

consideration of additional actions under cumulative impacts, one adds further opportunities for interaction between modern industrialized American society and Alaska Native and rural non-Native sociocultural systems, providing the potential for extremely rapid change in the latter two.

Similar to the analysis of impacts under the proposed action alone (see Section 4.3.21), cumulative impacts associated with the proposed action likely would include positive and negative effects. For example, although their association with sociocultural systems is indirect, in addition to the TAPS, many cumulative actions contribute (or will contribute) revenues that help support a variety of state programs, public services, and infrastructure construction and maintenance. Such programs include the state revenue sharing program, the safe communities (municipal assistance) program, legislative grants, and capital project matching grants, which provide funds to eligible communities for a range of infrastructure development and maintenance activities and public services (Alaska Department of Community and Business Development 2002a,b). Access to such public programs can have tangible positive effects. For instance, infant mortality among Alaska Natives decreased from approximately 36% between 1988–1990 and 1996–1998, while overall mortality fell by more than 12% over the same time period (Alaska Department of Health and Social Services 2001b). In 1998, nearly 70% of residents in the North Slope Borough had a minimum of a high school education in 1998, despite being one of the most geographically remote parts of the United States (North Slope Borough 1999). Despite improvements in certain conditions, it is worth noting that Alaska Natives unfortunately continue to lag behind in several indicators. For example, of the 15 indicators of health status for which Alaska Natives can be split out separately from all Alaskans (including the two mentioned immediately above), Alaska Natives rated poorer than the entire state in 12 (Alaska Department of Health and Human Services 2001b).

Negative effects of the past, present, and reasonably foreseeable future actions similarly appear to be associated with the sociocultural systems considered in this DEIS, some more directly than others. For instance, Strohmeyer (1997) speaks of the fragmentation during the 1970s of Alaska Native nuclear and extended families that form the core of indigenous sociocultural systems in Alaska, as growing numbers of individuals relocated to take advantage of wage employment on construction of the TAPS (see also Reckord 1979). More troubling, certain measures of societal health and mental health indicate that Alaska Native sociocultural systems are out of balance. Suicide rates for Alaska Natives, which had grown to 69 per 100,000 by the end of the late 1980s (see Section 3.25), fluctuated considerably during the 1990s —declining to about 41 in 1997 before rising again to 53 in 1998 (which was more than five times the rate for the United States as a whole in 2000; Alaska Department of Health and Human Services 2001b). Substance abuse among Alaska Natives, which began to grow shortly after statehood (see Section 3.25), also continues to be a problem. Alaska Natives are nearly two to three times more likely to have lifetime alcohol dependence, more likely than any ethnic group in Alaska to engage in binge drinking, more likely to have fetal alcohol syndrome than non-Natives, and four times more likely to be amphetamine dependent than Whites in Alaska (Alaska Department of Health and Social Services 1999, 2001b). Violence in Alaska Native society remains much greater than for Alaska as a whole, with the rate of homicide among Alaska Natives nearly twice that of all Alaskans in 1998 (Alaska Department of Health and Human Services 2001b).

The reason for citing improvements as well as problems among Alaska Natives is to provide a sense of the complicated situation facing these sociocultural systems (as well as the evaluation of impacts of possible actions). Although one can argue for a link between improvements and modern services and programs, such as improved health care and a widespread school system, the causes of social maladies are not as clear. However, in the case of suicide, many researchers have postulated that high rates among Alaska Natives are associated with the sudden introduction of money and modern American culture (Hlady and Middaugh 1988; Kettl and Bixler 1991, 1993; Kraus and Buffler 1979). Acculturation also has been linked to

alcohol use as well (Kelso and DuBay 1989). This evaluation of cumulative impacts uses the possible association between rapid acculturation of Alaska Native (and, to a lesser extent, rural non-Native) sociocultural systems and persisting social problems as a means of assessing cumulative impacts to those systems.

The cumulative impacts to sociocultural systems would be expected to affect the North Slope and Interior Alaska more than other regions. Of particular concern with regard to the North Slope would be the additional activities that would accompany oil and gas exploration, development, and production slated for that portion of Alaska over the coming years. As discussed in Section 4.3.21, it is true that the (largely) Alaska Native sociocultural systems of the North Slope have experienced considerable and fairly constant interaction with outsiders over the past three decades, largely as a consequence of oil-related activities. These people have thus become somewhat accustomed to interacting with modern Western society. However, key components of both the Nunamiut and Taremiut traditional sociocultural systems contrast dramatically with the additional changes likely to occur under cumulative impacts. More than two decades ago, some negative impacts (violence and substance abuse) were documented in these societies (e.g., Kruse et al. 1981. Over the last three decades, additional impacts occurred with the enormous surge of income to the North Slope Borough, its development (much involving dramatic improvements to infrastructure), the need to guide this development, and the management of funds made available through oil development (Strohmeyer 1997). Some of these factors introduced authority structures and status differences unknown in traditional Iñupiat society. In addition to the two Northern Eskimo sociocultural systems noted above, cumulative impacts would also be likely to affect the communities of Anaktuvuk Pass and Nuiqsut (see Figure 3.24-1) as well as other Iñupiat communities. As described in Section 3.24 and Appendix D, Section D.3, both of these communities have mixed economies that combine subsistence and wage labor (ADCED 2001). The association of the cumulative actions considered in this DEIS (particularly oil- and gas-related activities and the possible construction of a natural gas pipeline) with any negative impacts is not clear or direct, given the modernization that continues to occur throughout Alaska resulting from many causes, although they certainly contribute to acculturation on the North Slope. TAPS contributions to sociocultural impacts on the North Slope, both positive and negative, would be relatively small compared with the other activities occurring there.

Cumulative impacts to sociocultural systems would also be likely in Interior Alaska, to both the (largely) Athabascan Alaska Native sociocultural systems and to non-Native sociocultural systems located there. In Interior Alaska, other activities that occurred in the recent past, are currently under way, or are reasonably foreseeable would not be as geographically concentrated as on the North Slope; thus their potential impacts would also be dispersed geographically. As a result, in some cases, it is unlikely that the cumulative impacts on rural sociocultural systems would be as great in Interior Alaska as they would be on the North Slope. One exception likely would be positive impacts of public services, state-funded programs, and infrastructure, which Interior Alaska in particular relies upon (the North Slope Borough, with incoming tax revenues from the oil industry, funds certain services and programs themselves). The construction and operation of a natural gas pipeline would probably cause sociocultural impacts of the sort outlined above; these would generally be associated with increased acculturation and modernization and with the increased influence of a cash economy (though the latter likely would serve to replace the current mission at Fort Greely). Sociocultural systems of particular concern would be those with members located near the TAPS. Native systems of particular concern would be (south to north) the Ahtna, Tanana, Koyukon, and Gwich'in Athabascans. Alaska Native and rural non-Native communities of particular concern would include Alatna, Allakaket, Big Delta, Chitina, Coldfoot, Copperville, Copper Center, Delta Junction, Evansville, Gakona, Glennallen, Gulkana, Hughes, Kenny Lake, Livengood, Manley Hot Springs, Minto, Paxson, Rampart, Stevens Village, Tanana, Tazlina, Tonsina, and Wiseman (see Figure 3.24-1). The extent of the cumulative impacts experienced in each village would likely vary with the degree to which it was affected by current and foreseeable future

actions, in terms of the involvement of community members in these actions or in terms of the effects on the community itself from an increased influx of outsiders and increased exposure to the outsiders' sociocultural systems. Negative cumulative impacts likely would be less to rural non-Native sociocultural systems, such as found in Wiseman, in part because many have their roots in American society. As described in Section 3.24 and Appendix D, Section 3, all of these communities have mixed economies that combine subsistence and wage labor; those with larger non-Native populations located close to major roads tend to rely more on the latter (ADCED 2001). The association of the cumulative actions considered in this DEIS (particularly oil- and gas-related activities and the possible construction of a natural gas pipeline) with any negative impacts in Interior Alaska is not clear or direct, given the modernization that continues to occur throughout the state due to many causes, although they certainly contribute to acculturation in Interior Alaska. TAPS contributions to sociocultural impacts in the Interior, both positive and negative, likely would be relatively small compared with the other activities occurring there.

Cumulative impacts would probably occur to the sociocultural systems in Prince William Sound, but they would probably be less extensive than those that would occur in Interior Alaska or the North Slope. There are two reasons for this conclusion. First, in the Prince William Sound area, there are generally fewer total actions taking place that would disrupt Alaska Native or rural non-Native sociocultural systems than there are in the other two regions, especially the North Slope. Second, the sociocultural systems in the Prince William Sound area that are examined in this DEIS are primarily Chugach Alutiiq and Eyak. These two Alaska Native systems have already been subject to considerable cultural change over the past two centuries (see Section 3.25). Communities anticipated to experience sociocultural impacts include three Alaska Native villages: Chenega Bay, Eyak, and Tatitlek (Figure 3.24-1).

Impacts from tanker spills might also affect sociocultural systems in Prince William Sound. One possible source of sociocultural impacts from spills associated solely with the TAPS would be the disruption of subsistence or commercial fishing activities. This could cause a reorientation of economic activities (see Section 4.4.4.15). However, as discussed in Section 4.7.8.1, reasonably foreseeable spills (*anticipated* or *likely* frequency categories) would tend to be smaller, and current spill-response capabilities would likely limit impacts. Moreover, the only documented subsistence areas in Prince William Sound are in Chenega Bay and Tatitlek (see Figure 3.24-1). Potential economic-related sociocultural impacts due to the disruption of commercial fisheries would be greater, though the relatively small size of *anticipated* and *likely* spills, coupled with spill prevention and cleanup contingency plans and the use of the SERVS system for tanker escort (TAPS Owners 2001a), likely would limit impacts to much less than those experienced from the Exxon Valdez spill (see Sections 4.7.6.6 and 4.7.7.2.4). As described in Section 3.24 and Appendix D, Section D.3, Chenega Bay, Cordova, and Tatitlek occur in the Prince William Sound area and have mixed economies that combine subsistence and wage labor (ADCED 2001). As above, the association of the cumulative actions considered in this DEIS (particularly oil-related activities) with any negative impacts to sociocultural systems in the Prince William Sound area is not clear or direct, given the modernization that continues to occur throughout Alaska due to many causes. TAPS contributions to sociocultural impacts in the Prince William Sound area, both positive and negative, would be relatively small compared with the other activities occurring there.

Cumulative impacts associated with the less-than-30-year-renewal alternative likely would be similar to those just described for proposed action-associated cumulative impacts. Cumulative impacts associated with the no-action alternative also likely would be similar to those discussed under the proposed action cumulative case, though the magnitude likely would be less both for positive and negative consequences. Reduced negative impacts could result from a reduction in potential acculturation were the TAPS discontinued — removing some sources of interaction with personnel maintaining the pipeline and related facilities as well as

sources of wage employment. Reduced positive impacts likely would be of particular concern. Not renewing the Federal Grant would remove a source of wage employment for rural Alaskans, which as noted can have positive as well as negative consequences. It would also remove a considerable amount of state and local (North Slope Borough) tax revenues used to fund public services, programs, and infrastructure (see Section 4.6.2.19). Under the less-than-30-year renewal alternative, the TAPS contribution to cumulative sociocultural impacts would be relatively small compared with the likely effects of other cumulative actions. Under the no-action alternative, in contrast, the relative contribution of discontinuing the TAPS would be quite large. In certain cases, it would likely affect the feasibility of other actions (e.g., oil exploration, development, and production on the North Slope) considered in the cumulative cases as well.

Overall, cumulative impacts to sociocultural systems likely would be a mix of positive and negative consequences. Both probably are a consequence of continued acculturation and influence by modern American society, particularly affecting Alaska Native sociocultural systems but also influencing rural non-Native systems. As was the case when evaluating sociocultural impacts under the proposed action (see Section 4.3.21), clearly linking acculturation with the TAPS or any of the cumulative actions considered in this DEIS is largely impossible, given the general modernization that continues to occur throughout Alaska for a variety of reasons.

4.7.8.3 Economics

The assessment of the cumulative economic impacts of the TAPS covers the impacts from continued operation (including several for less than 30 years) and no action, together with impacts from other existing and projected economic development activities likely to occur in the state during the proposed lease renewal period. The economic impacts of any spills that could potentially occur in Prince William Sound during tanker operations are also included. The analysis combines the impacts from the TAPS continued operation and no action with those from the most important major projects expected to occur during the period 2004 to 2034 and qualitatively assesses the resulting aggregate impact on the economy of the state and pipeline corridor region. Although numerous projects are slated for development in Alaska (see Section 4.7.4), the only projects considered to be likely to create significant cumulative impacts in association with the continued operation of the TAPS and no action are the natural gas pipeline designed to transport gas from the North Slope to Canada and the proposed National Missile Defense System (NMDS) at Fort Greely. The impacts of all oil field development considered are likely to occur under the proposed action. Other economic development activities, such as the Wrangell-St. Elias NPP and mining development near Fairbanks, although they would add to the overall level of economic activity in the state, would not be as significant as the pipeline project, NMDS, and a large potential oil spill.

The largest planned activity likely to occur during the renewal period would be the construction and operation of the proposed natural gas pipeline from the North Slope. Gas would be transported through the pipeline to serve markets in both Canada and the United States. The total capital cost associated with the pipeline would be between $5 and $6 billion, and it would take up to 7 years to build (CERA 1999). The largest impact of the pipeline to the state and local economy would be the tax revenues it would generate. On the basis of the impact of the Trans Alaska Gas System (TAGS), a pipeline that was proposed to transport liquid petroleum gas from the North Slope to Valdez and that would have had a throughput rate (2 billion ft^3/d) similar to that of the proposed pipeline, it is estimated that revenues from the pipeline would amount to $189 million annually in royalties and severance taxes and $188 million annually in property taxes (TAPS Owners 2001a). The exact size of revenues would depend on tax rates, actual daily throughput rates, and the market price of natural gas. Additional benefits of the pipeline would be the possibility of further North Slope economic development, and the potential for reduction in the cost of natural gas throughout the state.

Employment that would be created by the pipeline is difficult to estimate, given the

provisional status of the project. Since the length of time required for its construction is assumed to be less than that estimated for the TAGS, given that it would be a shorter pipeline and that there would be processing facilities (CERA 1999), it is likely that the employment impacts from the project would be less than those estimated from the TAGS. The TAGS employment impact is assumed to be 7,200 direct workers during the peak year of an 8- to 10-year construction period, and an additional 3,300 jobs would be created indirectly in the state as a whole. Annual operations jobs are estimated to be 550, with an additional 1,250 indirect jobs (TAPS Owners 2001a). It is likely that the pipeline would employ a large number of construction workers from outside the state, and while wages and salaries would produce local spending and state tax revenues, a significant portion of wages and salaries during construction would leave the state, and worker wages would be used to support families located elsewhere in the United States. Deterioration in the provision of local public services might also occur in some communities along the proposed route in the short term as a large number of in-migrating workers arrive, especially if some are accompanied by their families.

The NMDS includes a facility to be located in Alaska to support an anti-ballistic missile system, most likely at Fort Greely, near Delta Junction. The system would cost $626 million and create 300 direct construction jobs over a five-year period and create an additional 620 jobs in the state (U.S. Army Space and Missile Defense Command 1999). A total of 360 direct operations jobs and an additional 110 indirect jobs would be created. Currently, 600 civilian and military jobs are under threat as part of the plan to close the base at Fort Greely (TAPS Owners 2001a). A large number of construction workers from outside the state could be expected as a result of the project, and depending on the where these workers live during construction, they could strain the ability of local governments to provide adequate public services to the local communities in the vicinity of the site.

In addition to new economic development activity projected for the state, oil spills in Prince William Sound could also result in additional spending and tax revenues at the state level and in local communities. For example, as a result of the Exxon Valdez oil spill in 1989, Exxon Corporation spent more than $2.6 billion on cleanup activities in the following three-year period (Etkin 1998), creating an average of 2,500 direct cleanup jobs and approximately 2,500 indirect jobs over the period (ADOL 1990). These jobs more than offset losses in the fishing and tourism industries (IAI 1990). The local economy, in particular, was stimulated by income generated by the oil spill; income doubled and employment increased by 30% in the Valdez-Cordova Census Region in 1989 (TAPS Owners 2001a). Many of the cleanup jobs were filled by temporary in-migrants from outside the state, reducing the benefits to the state and local economy. In addition to the economic benefits associated with employment and income generated as a result of the spill, significant compensation was paid by Exxon to various parties in the state. Almost $300 million was paid to commercial fishermen, while $1,025 million was paid to the state and federal government in criminal and civil settlements for damage to the environment in Prince William Sound. In addition, APSC paid $98 million to commercial fishermen and has significantly increased its annual spill response expenditures to $60 million, primarily benefiting the Valdez local economy (TAPS Owners 2001a).

While the Exxon Valdez oil spill was a significant event in the operation of the TAPS, creating significant benefits to the state and local economy that more than offset the economic damage to the fishing and tourism industries in Prince William Sound, it is unlikely that a spill of such magnitude, even if it occurred again, would create the same level of economic activity. Considerable efforts have been made to provide more adequate response capabilities for spills of the same magnitude. It may be reasonable to assume, therefore, that the economic impacts resulting from the Exxon Valdez oil spill, excluding those associated with compensation, represent the upper bound for any potential accidental spill. The local and state economic impacts from smaller spills that would be well within the capability of the spill response authorities would therefore probably be far less significant. The possibility of compensatory claims in the event of a spill might still remain,

however, since the long-term effect of the Exxon Valdez oil spill on the environment of Prince William Sound has not been clearly established (TAPS Owners 2001a). Even in the absence of significant local employment and income impacts like those that occurred as a result of the Exxon Valdez spill, the ultimate distribution of compensation among parties (in the event of a lawsuit and settlement following a serious spill) would mean that local and state economic impacts might still be significant.

Although the natural gas pipeline would impact the economy of the state, the cumulative economic impacts of North Slope and continued TAPS operations, together with the pipeline project, would probably not be significantly larger than the impacts of current North Slope and TAPS operations. The gas pipeline would probably be the most important new project for the state in the next decade, and its most significant impact would be tax revenues in the form of severance taxes, royalties and property taxes for the state, and additional property taxes for local governments. However, it is likely that gas pipeline construction would not begin until after 2010 during a period of declining revenues from North Slope production and TAPS throughput that will begin in 2006 (see Section 4.3.19.1). Impacts from the gas pipeline might therefore merely partially offset the decline in state oil revenues over the renewal period. Employment impacts at the state level, while significant during construction, would be likely to impact the economy only in the short term; the longer-term overall impact on the state would probably be small, even though pipeline operations workers are likely to be relatively highly paid.

At the local level, impacts of continued TAPS operations and the gas pipeline in the short term would also probably be significant, with a major influx of workers expected during the construction period. Depending on where these workers reside during pipeline construction, there might be substantial impacts on local employment and income in the smaller communities as well as impacts on the ability of local governments to provide adequate public services, especially if many workers are accompanied by their families. There might also be major impacts at the local level if construction of the gas pipeline project and the NMDS occurred simultaneously in the Fairbanks/Delta Junction area, but such impacts are unlikely, given the proposed schedules for the two projects.

Cumulative employment and income impacts associated with NMDS and oil spills in Prince William Sound would probably be much less significant with regard to the economy of the state than they would be with regard to the local economies in which each is located. Employment and income impacts of the NMDS would only offset the decline in employment resulting from base realignment at Fort Greely, with no major impacts to local public service provision expected. Any major employment and income impacts resulting from a spill would be unlikely, given the significant upgrading of spill response capability since the Exxon Valdez accident. Any increases in activity would most likely be concentrated in Valdez. Any in-migrating workers would probably not have a major impact on the ability of local government to provide adequate local public services.

Construction and operation of the gas pipeline project and the NMDS under the no-action alternative would partially offset the losses in employment, income, and tax revenues that would occur at both the state and local levels with the end of TAPS operation and North Slope production. Construction of the pipeline project would not conflict with the latter stages of TAPS termination activities or the NMDS, and pipeline operation would likely provide an alternative basis of support for state and local revenue generation and continuing efforts toward diversifying the state's economy away from natural resource extraction activities.

The impacts of continued TAPS operation for the less-than-30-year renewal alternative, together with the gas pipeline and NMDS, would be less than those for the proposed action. Less oil-related investment would occur in the North Slope fields and other parts of the oil sector, and supporting industries, together with lower levels of private and public investment in the non-oil-related parts of the economy, would produce less employment, income, and tax revenues.

4.7.8.4 Cultural Resources

No cumulative impacts are anticipated for cultural resources. Although other projects might adversely affect cultural resources, adherence to federal and state laws pertaining to cultural resources should mitigate adverse effects associated with the additional projects. As stated in Section 4.3.22, the renewal of the TAPS ROW could adversely affect known cultural resources, but these impacts could be mitigated on a project-by-project basis through avoidance, monitoring, data recovery, etc.

4.7.8.5 Land Use and Coastal Zone Management

4.7.8.5.1 Land Use. The TAPS and other actions in the vicinity of the pipeline have had cumulative effects on land ownership and use near the ROW during the past 25 years. Valid legal access for TAPS operation and maintenance has been acquired on the lands it crosses. Access to public and some private lands has increased in the vicinity of the pipeline due to construction of the Dalton Highway, TAPS access roads, and airstrips. Some trespassing and conflict of use issues have resulted on native lands. Some increases in recreational, residential, municipal, and commercial land uses have occurred; some of which can be attributed to the pipeline. Commercial development has occurred at three development nodes along the Dalton Highway. The existence of the pipeline has contributed to the increase in oil exploration, development, and transportation activities at the North Slope during the past 25 years.

Other actions unrelated to the TAPS have greatly affected land ownership and use in Alaska. The passage of the Alaska National Interest Lands Conservation Act (ANILCA) in 1980 resulted in numerous designations of conservation system units. Lands have also been conveyed from federal to state government, and from state to local government and Native Alaskans.

The largest new development reasonably foreseeable in the vicinity of the TAPS is a natural gas pipeline project. In this project, a buried natural gas pipeline would run parallel to the TAPS ROW. A gas processing facility would be constructed on the North Slope, and compressor, pigging, and valve stations would be constructed intermittently along the pipeline.

The gas pipeline and its related infrastructure would have some effects on land use in the vicinity of the TAPS. Aesthetics would be affected along and/or within the TAPS ROW, with resulting effects on recreation likely (see Section 4.7.8.6). Noise from construction, operation, and maintenance of the gas pipeline and related structures would likely be audible from some recreation areas and could interfere with recreational activities. During construction, a temporary increase in noise might also occur on lands set aside for wildlife habitat conservation, disturbing wildlife. Effects on military, residential, municipal, commercial, or private land use could also occur, not only from increased noise, but from preclusion or interference of use from the gas pipeline and related structures. Conflicts with mining and other natural resource use would be possible, depending on the route of the pipeline and locations of structures.

Finally, although there would be an influx of personnel associated with the gas pipeline, it would be unlikely to result in an increase in residential, municipal, or commercial development. The new personnel associated with the project would probably just offset the workforce reductions that have recently resulted from the closure of Fort Greely and proposed APSC reorganization.

Additional recreational development and/or increased use of existing developed recreation areas would also be unlikely. However, increased access would likely result from construction of the gas pipeline and could contribute to an increase in recreational use of undeveloped public lands.

Spills (see Sections 4.4.4.17.1 and 4.6.2.23.1) could also occur as the result of a variety of actions, including oil exploration and development, oil refining, oil storage activities, and transportation. Small spills could disrupt other land uses, although a large spill would have the greatest impact. If there was a spill from the natural gas pipeline, resulting in volatilization of the gas, the potential for a fire

would exist. A fire would result in temporary evacuation of nearby areas, long-term aesthetic impacts to the landscape, and potential long-term interference with land uses.

If there were no spills, renewal of the TAPS ROW would continue to have only small impacts on land use in the vicinity of the pipeline. However, the anticipated construction of the natural gas pipeline and related infrastructure would have larger impacts on land use. The combined effects from both pipelines would increase the currently existing impacts on land use in the vicinity of the TAPS, depending in large part on the location of the natural gas pipeline and related structures. If the TAPS ROW were renewed for less than 30 years, the cumulative effects would be similar to those under the proposed action.

However, the cumulative effects under the no-action alternative would be much different from those under either the proposed action or the less-than-30-year renewal alternative. Less commercial, municipal, and residential development would be expected to occur due to a downturn in the state economy resulting from lost oil revenues. Use of state recreation areas, sites, and parks would decline because of closures resulting from state funding reductions. Oil exploration, development, and transportation activities at the North Slope would cease, although natural gas development at the North Slope and construction of a natural gas pipeline might still occur.

Cumulative effects on land use from the TAPS will continue to occur, whether the ROW is renewed for 30 years, less than 30 years, or not at all. Few, if any, additional effects on land ownership would be expected, regardless of renewal.

4.7.8.5.2 Coastal Zone Management.

The TAPS and other actions in the vicinity of the pipeline have had cumulative effects on the North Slope Borough and Valdez coastal zones during the past 25 years. Aesthetic and land use impacts from the TAPS and other activities are evident in both zones. However, the operation and maintenance of the TAPS and related facilities, including the Valdez Marine Terminal are permitted activities in compliance with the enforceable policies in both the North Slope Borough CMP and the Valdez CMP. The TAPS is also a development activity consistent with both CMPs. (See Section 4.3.23.2 for effects on coastal zone management from the proposed action.) Other currently existing development in the coastal zones would be expected to be consistent and in compliance with the CMPs as would future development, and therefore would be unlikely to have a large cumulative impact on coastal zone management. Spills from the TAPS, a future natural gas pipeline, or oil and gas development represent actions that could have the greatest potential cumulative effect on coastal zone management with regard to either the North Slope Borough or Valdez CMP.

North Slope Borough Coastal Management Program. Oil and gas exploration, development, and production activities would be expected to continue within the North Slope Borough coastal zone. Construction of a natural gas processing facility has been proposed. The facility would service a gas pipeline that would parallel the TAPS, either within or adjacent to the ROW. The pipeline would be buried along most of its length.

The natural gas processing facility would add to the existing visual impact within the North Slope Borough. The gas pipeline would also represent a visual impact if any segment of it was above ground. However, the North Slope Borough CMP allows for development activities as long as they do not substantially interfere with subsistence activities in the borough or jeopardize the continued availability of subsistence resources. The additional processing facility, the natural gas pipeline, and ongoing oil and gas activities would not be expected to interfere with or jeopardize subsistence within the borough, although an impact would be expected to occur (see the cumulative effects discussion on subsistence).

Impacts to subsistence resources within the North Slope Borough coastal zone could occur from a land or water-based petroleum spill. The magnitude of the impacts would depend on the volume, location, duration of the spill, as well as the time of year it occurred. Aesthetic impacts would also occur, and cleanup activities could be

substantial and long term. Potential effects to the North Slope Borough coastal zone from TAPS spills are discussed in Section 4.4.4.19.2. Similar impacts would result from petroleum spills from other resources. Spills could also occur from the natural gas pipeline if it was constructed, resulting in volatilization that could temporarily impair air quality. Volatilized gas could lead to a fire, resulting in damage to subsistence resources and temporary evacuation of areas within the borough, thereby disrupting subsistence activities. Disruption to other development activities within the borough would also be likely.

As discussed in Section 4.4.4.19.2, renewal of the Federal Grant would continue to be consistent with the North Slope Borough CMP and in compliance with enforceable policies. In the absence of spills, continued operation and maintenance of TAPS would have very little additional effect on coastal resources and activities within the borough. The cumulative effects from the renewal of the ROW for less than 30 years would be similar to those under the proposed action.

If the no-action alternative were implemented, TAPS-related activities would cease in the North Slope Borough coastal zone. Land occupied by the TAPS and related oil exploration, production, and transportation facilities would be available for other development activities, consistent with ACMP statewide standards and the North Slope Borough CMP. Some aesthetic and land use impacts would likely result.

Some cumulative effects on the North Slope Borough coastal zone from the TAPS will continue to occur, whether the ROW is renewed for 30 years, less than 30 years, or not at all. Because of required compliance with statewide ACMP standards and the North Slope Borough CMP, additional effects would likely be small.

Valdez Coastal Management Program. The Valdez CMP allows for a variety of activities within the coastal zone, including development, and those activities would be expected to continue. No major developments are currently planned within the Valdez coastal zone, but any additional development would add to the existing visual impact of the Valdez Marine Terminal.

Normal operation and maintenance of the TAPS and the Valdez Marine Terminal would not impact the Valdez coastal zone. However, impacts to other activities within the coastal zone could occur from small spills, although a major land- or water-based petroleum spill at the Valdez Marine Terminal, or from an oil tanker, other commercial vessel, or private vessel would be most disruptive. A spill at the Valdez Marine Terminal that erupted into fire or a spill to water within the coastal zone, especially to Prince William Sound, would likely damage coastal resources (including aesthetics) and interfere with other coastal zone activities. These impacts would be similar to the potential impacts on the Valdez coastal zone from TAPS spills discussed in Section 4.4.4.19.2.

As discussed in Section 4.4.4.19.2, renewal of the Federal Grant would continue to be in compliance with the enforceable policies in the Valdez CMP. In the absence of spills, continued operation and maintenance of the TAPS and the Valdez Marine Terminal would have very little additional effect on coastal resources and activities within the Valdez coastal zone. The cumulative effects under the less-than-30-year renewal alternative would be similar to those under the proposed action. Under the no-action alternative, TAPS and related activities would cease, and the Valdez Marine Terminal would be removed. Other permitted activities could then occur in those areas, which would likely have associated aesthetic and land use impacts.

4.7.8.6 Recreation, Wilderness, and Aesthetics

4.7.8.6.1 Recreation. The TAPS and other actions have had some cumulative effects on recreation on federal and state lands in the vicinity of the pipeline. Access to public lands has increased since construction of the TAPS, particularly as a result of the construction of the Dalton Highway, resulting in an increase in recreational opportunities and use in some areas. The pipeline is visible from some recreation areas, sites, and parks. At some

locations, noise from TAPS-related infrastructure (such as pump stations) is audible.

The passage of ANILCA in 1980, which created numerous conservation system units in Alaska, greatly increased recreational opportunities in the vicinity of the TAPS. The existence of these opportunities has increased recreational use of public lands near the TAPS. Oil revenues have allowed for greater funding of state recreational areas, sites, and parks, which has also increased recreational opportunities and use.

These impacts from the TAPS would continue with renewal of the ROW. The only large development — recreational or otherwise — reasonably foreseeable at or near recreation areas, sites, or parks in the vicinity of the TAPS is the potential construction of a buried natural gas pipeline within or adjacent to the TAPS ROW, beginning about the year 2010. The anticipated route of the pipeline would parallel the TAPS. A gas processing facility would be constructed on the North Slope, and compressor, pigging, and valve stations would be constructed intermittently along the pipeline.

The gas pipeline and its related infrastructure would substantially add to the currently existing visual impacts along, and within, the TAPS ROW. Only temporary visual impacts would occur from burying the gas pipeline but construction of the related infrastructure would represent long-term aesthetic impacts. Since sight-seeing is a very popular recreational activity in Alaska, these visual impacts would somewhat diminish the quality of that recreational experience for some people. Infrastructure visible from recreation areas, sites, or parks might also reduce the quality of other recreational experiences such as hiking or camping.

In addition, noise from construction of the gas pipeline and compressor, pigging, or valve stations could be audible from some recreation areas, sites, and parks, depending on the location of the pipeline and related infrastructure, which is currently uncertain. Additional vehicular and air traffic resulting from the construction, operation, and maintenance of the natural gas pipeline would also add to current noise audible from recreation areas, sites, or parks, particularly those in proximity to a highway. Lastly, increased access resulting from construction of the gas pipeline could contribute to an increase in recreational use of undeveloped public lands.

Recreation in the vicinity of the TAPS could also be affected in the future by a major land- or water-based TAPS spill, particularly a major spill. Visual and noise impacts could occur, especially from long-term cleanup activities. Both temporary evacuation and long-term closure of recreation areas would be possible. Potential effects to recreation from TAPS spills are discussed in Section 4.4.4.18.3.

Spills could also occur from the natural gas pipeline if it was constructed, resulting in volatilization that could temporarily impair air quality. Volatilized gas could lead to a fire, resulting in evacuation of recreation areas, long-term aesthetic impacts to the landscape, and potential closure of sites.

In the absence of spills, renewal of the Federal Grant of ROW, either for 30 years or a lesser term, would continue to have only small impacts to recreation in the vicinity of the pipeline. However, the anticipated construction of the natural gas pipeline and related infrastructure would also impact recreation. The combined effects from both pipelines would increase the currently existing impacts on recreation in the vicinity of the TAPS, depending in large part on the location of the natural gas pipeline and related structures. The effects from renewal of the TAPS for less than 30 years would be similar to those under the proposed action.

The cumulative effects on recreation from the no-action alternative would likely be greater than those from either the proposed action or the less-than-30-year renewal alternative. The currently existing visual and noise impacts from the TAPS would end after termination activities were completed. Oil revenues would decline and eventually cease, resulting in decreased funding of state recreation areas, sites, and parks. The reduced funding would be expected to force closure of some state areas, sites, and parks, resulting in a decrease in recreational opportunities and use levels in the vicinity of the TAPS.

Cumulative effects on recreation from the TAPS and other actions would continue to occur, regardless of the length of the renewal, or even in the event of no action. In spite of some visual and noise impacts from TAPS infrastructure and increased traffic, the overall cumulative effects on recreation from the TAPS are generally favorable, since oil revenues generated by the TAPS help to fund state recreation areas, sites, and parks. However, decreased throughput during the renewal period would result in decreased state revenues, which could impact state recreational funding, although not as much as no action.

4.7.8.6.2 Wilderness. The Wilderness Area within the Gates of the Arctic NPP is the only federally designated Wilderness Area within a few miles of the TAPS or in the vicinity of the proposed gas pipeline. No state designated, or federal or state proposed, wilderness areas exist in the vicinity of the TAPS or the proposed gas pipeline.

The only large action that has occurred in the past near the eastern portion of the Gates of the Arctic NPP Wilderness Area is the construction of the TAPS. The pipeline continues to be the only large development in the vicinity. The currently existing cumulative effects on the Wilderness Area are due to the TAPS.

The construction of a buried natural gas pipeline within or adjacent to the TAPS ROW as it passes the Gates of the Arctic NPP is a reasonably foreseeable future activity and would add to the indirect impacts of the TAPS. Temporary visual impacts would occur from burying the pipeline and would persist until revegetation occurred. Any compressor, pigging, or valve stations constructed along the pipeline and visible from the Gates of the Arctic Wilderness Area would add to the existing visual impact. Noise from construction could be audible within the wilderness, and the additional vehicular and air traffic resulting from the construction, operation, and maintenance of the natural gas pipeline would also add to current noise audible from the Wilderness Area. Lastly, an increase in personnel in the area due to the additional pipeline could potentially result in an increase in recreational use in the Gates of the Arctic Wilderness Area.

Spills in the vicinity of the Gates of the Arctic NPP could occur from the natural gas pipeline if it was constructed, and they could result in a fire that would impair air quality in the vicinity of the Wilderness Area. Long-term aesthetic impacts to the landscape could occur from a fire, and potentially be visible from the Gates of the Arctic NPP Wilderness Area. See Section 4.4.4.18.2 for a discussion of potential impacts on wilderness from TAPS spills.

In the absence of spills, renewal of the TAPS ROW would continue to have only small visual and noise impacts to the Wilderness Area. However, the anticipated construction of the natural gas pipeline and related infrastructure would also have indirect impacts to wilderness. The combined effects from both pipelines would likely have a more substantial impact on the Gates of the Arctic NPP Wilderness Area than the current impact, depending in large part on the location of the natural gas pipeline. The cumulative impacts would be similar under the proposed action and the less-than-30-year renewal alternative.

Cumulative effects on wilderness from the no-action alternative would result in elimination of the currently existing visual impact of the TAPS as well as some of the noise associated with the pipeline and related traffic on the Dalton Highway. Increased access and a small increase in use would be expected to continue.

4.7.8.6.3 Aesthetics. The TAPS and several other actions have resulted in a large cumulative visual impact in the vicinity of the pipeline. The TAPS and its related infrastructure represent one of the more substantial visual impacts on the landscape along much of its length. The highways that it parallels also represent major aesthetic impacts, as do the communities and other developments within the pipeline viewshed. Other existing visual impacts include additional pipelines and oil development infrastructure on the North Slope; commercial, industrial, residential, and recreational development along the Dalton and Richardson Highways; mining operations; pipeline viewing stations; and the Valdez Marine Terminal.

All of these visual impacts currently exist and have existed for many years or decades

along the length of the pipeline. Development in the vicinity of the pipeline is expected to occur slowly, as it has in the past. No major municipal, commercial, industrial, recreational, or mining development has been identified adjacent to the TAPS, and no major additional TAPS-related construction is anticipated. However, a 200- to 300-acre residential development and an approximately 2,000-acre agricultural development have been proposed about 5 mi south of Copper Center.

In addition, the TAPS corridor has been proposed for the construction of a natural gas pipeline within the next decade. The anticipated route of the pipeline would parallel the TAPS. A gas processing facility would be constructed on the North Slope, and compressor, pigging, and valve stations would be constructed intermittently along the pipeline. These stations would add to the currently existing visual impacts along, and within, the TAPS ROW. Even though the gas pipeline would be buried, the ROW would be visible and would likely be maintained in a state visually different from surrounding areas. This would be similar to buried segments of the TAPS, which are visually different from surrounding areas.

Aesthetics could also be affected in the future by a land- or water-based petroleum spills from oil exploration, development, or production; oil storage; or oil transportation by tanker. Visual impacts, including cleanup activities, could be long-term and similar to the aesthetic impacts from a TAPS spill, as discussed in Section 4.4.4.18.3. Spills could also occur from the natural gas pipeline if it was constructed, resulting in volatilization that could temporarily impair air quality. Volatilized gas could lead to a fire, further degrading air quality until it was extinguished. Long-term aesthetic impacts to the landscape could occur from a fire, depending on its extent.

As discussed in Section 4.3.24.3, renewal of the TAPS ROW would continue to have mostly localized impacts to aesthetics in the vicinity of the pipeline. In the absence of spills, continued operation and maintenance of the TAPS would have very little additional aesthetic effect on the landscape. However, the anticipated construction of the natural gas pipeline and related infrastructure would have additional visual impacts on the landscape in the vicinity of the TAPS. That potential project, combined with existing aesthetic impacts from the TAPS, as well as other probable future development in the vicinity of the pipeline, would combine to create a major aesthetic impact in the vicinity of the TAPS ROW, under the proposed action or less-than-30-year renewal alternative.

The cumulative effects to aesthetics would be lessened somewhat under the no-action alternative because the TAPS and related infrastructure would be removed. The rate of development in the vicinity of the pipeline would also be expected to slow because of the economic impacts of lost oil revenues. However, the gas pipeline would still likely be built, and the residential and agricultural development near Copper Center would also probably still occur. Overall, the aesthetic impacts would be less under the no-action alternative than under either of the renewal options.

4.7.8.7 Environmental Justice

The evaluation of cumulative impacts with implications for environmental justice depends first on the identification of high and adverse cumulative impacts in other impact areas (groundwater, human health, etc.) and then on whether these impacts would affect minority and low-income populations disproportionately. Disproportionate impacts can occur two ways: (1) because the environmental justice population under consideration is present at a percentage higher than that found in the state as a whole, or (2) because the environmental justice population under consideration is more susceptible to such impacts. In either case, it is a necessary precondition that the cumulative impacts have already been determined to be high and adverse. Analyses indicate that high and adverse impacts would not be anticipated for cumulative actions combined with the proposed action, less-than-30-year renewal alternative, or the no-action alternative (Table 4.7-12; see Sections 4.7.6, 4.7.7., and 4.7.8).

4.7.9 Summary

Many activities in the TAPS region of interest (TAPS ROW, North Slope, and Prince

William Sound) contribute to cumulative effects on the environment. These activities are listed in Table 4.7-13. If it were not for the construction of the TAPS, some of these activities would not take place, including oil and gas exploration, development, and production on the North Slope; refinery operations; potential natural gas transport; and oil transport from Valdez to market. However, other petroleum industry activity would still occur in the TAPS region of interest even in the absence of the TAPS, including the transport of petroleum products into and within Alaska and the storage of oil for industrial, transportation, and domestic use. The petroleum industry affects many segments of the Alaskan economy by creating jobs, providing revenue for government services, and providing income to support subsistence lifestyles. These secondary effects are most evident when economic and social issues are the subject of an assessment. However, some activities within the TAPS region of interest are independent of the oil industry. These include activities based on Alaska's other natural resources, such as mining, forestry, tourism, and fishing.

The cumulative impact assessments presented in Sections 4.7.6 through 4.7.8 integrate the effects of all actions taken together under three scenarios. The first scenario, which is analyzed in the most detail, considers the impacts from all actions, including the operation of the TAPS, for another 30 years. This is the proposed action. The second scenario considers all actions taken together with a less-than-30-year authorization of TAPS operations. The third scenario considers all actions taken together with no action, which would involve ending TAPS operation and removing TAPS facilities. The cumulative impacts associated with these three scenarios are summarized in Table 4.7-13. The impacts of the latter two scenarios are described by being compared with the impacts of the first (proposed action) scenario.

Many of these impacts are secondary. Three major cross-cutting impacts are identified in this analysis. First, the generation of road dusts affects vegetation, soils, and permafrost; this impact, in turn, affects surface hydrology and snowmelt; and this impact affects birds and mammals. Second, activities associated with petroleum exploration and development use large quantities of water that are taken from surface water under ice, which constitutes an important habitat for overwintering fish. Third, developments in all areas affect fish and mammal populations, which are important subsistance resources for Alaskans; in addition, the income and access provided by these developments affect the ability of and need for people to utilize these subsistence resources. Although the cumulative impacts on these resources, as analyzed in Sections 4.6 through 4.8, are, in general, minor and local, knowledge about their relationships is still important to reach an understanding of the environmental consequences of the proposed action. No major synergistic effects were identified in the cumulative analysis.

TABLE 4.7-12 Summary of Anticipated Cumulative Impacts under the Proposed Action

Issue Area	EIS Section	Summary of Impacts[a]
Soils and permafrost	4.7.6.1	All negative cumulative impacts to the North Slope, Interior Alaska, and Prince William Sound area are anticipated to be highly localized and limited to the areas disturbed.
Sand, gravel, and quarry resources	4.7.6.2	Negative cumulative impacts are anticipated to be highly localized; to be limited to areas where sand, gravel, and quarry resources are extracted; and to occur on a project-by-project basis.
Paleontology	4.7.6.3	Negative cumulative impacts could occur in areas disturbed by any additional projects; such impacts would be monitored and mitigated on a case-by-case basis.
Surface water impacts	4.7.6.4	Negative cumulative impacts could be small and local on the North Slope, in Interior Alaska, and Prince William Sound; following good engineering practices and adhering to regulatory guidelines should help to minimize impacts.
Groundwater resources	4.7.6.5	Negative cumulative impacts on both water quality and quantity might accompany reasonably foreseeable construction; on the North Slope, impacts to water quality likely would be less than elsewhere because of the wide presence of permafrost; impacts to the Fairbanks and Valdez areas could be greater because of their larger concentrations of population and reliance on wells for domestic water supply; following good engineering practices should help to minimize impacts.
Physical marine environment	4.7.6.6	Negative cumulative impacts primarily would accompany spills in the Beaufort Sea or Prince William Sound, but the volumes of any reasonably foreseeable spills would be low enough to be readily cleaned up and to limit the magnitude of their effects.
Air quality	4.7.6.7	Negative cumulative impacts should be constrained by regulatory limits to acceptable levels or should be relatively low in general (e.g., impacts from increased traffic).

TABLE 4.7-12 (Cont.)

Issue Area	EIS Section	Summary of Impacts[a]
Noise	4.7.6.8	Negative cumulative impacts should be localized and short term, primarily during construction of any infrastructure; contributions from the TAPS are anticipated to be relatively minor.
Transportation	4.7.6.9	Negative cumulative impacts should not be large, since anticipated increases in traffic volume would not be large and could be accommodated by the existing infrastructure; contributions by the TAPS are anticipated to be relatively minor.
Wastes	4.7.6.10	Negative cumulative impacts could accompany wastes generated by North Slope oil exploration, development, and production; oil refining at three refineries; tanker loading at the Valdez Marine Terminal; and (possibly) the construction and operation of a gas pipeline; the magnitude of impacts are anticipated to be within acceptable limits, as set by regulatory standards; the TAPS would be a relatively small contributor to the aggregation of wastes from past, current, and reasonably foreseeable activities.
Human health and safety	4.7.6.11	Negative cumulative impacts to workers could occur as physical hazards but could be minimized by employing safety practices in each project considered; negative impacts to workers from NORM are expected to be negligible; negative impacts to the public from VOCs are not anticipated to be large under cumulative impacts, unless a large new source of such compounds is located near the Valdez Marine Terminal; an increase of CO likely would accompany growths in population and the amount of vehicular traffic, but the TAPS contribution to this growth would be negligible; possible negative impacts to the public might accompany spills accumulating from different actions. Impacts, however, would be localized, and it is extremely improbable that spills associated with different activities would occur at the same time and location (near human settlement); negative impacts due to TAPS from persistent, bioaccumulative, and toxic chemicals are not anticipated.

TABLE 4.7-12 (Cont.)

Issue Area	EIS Section	Summary of Impacts[a]
Biological resources	4.7.7 (Biological Resources, Overview), 4.7.7.1 (Terrestrial Vegetation and Wetlands), 4.7.7.2 (Fish), 4.7.7.3 (Birds and Terrestrial Mammals), and 4.7.7.4 (Threatened, Endangered, and Protected Species)	Negative cumulative impacts on terrestrial vegetation and wetlands are anticipated to be minor to negligible; negative cumulative impacts on fish due to habitat loss/alteration, obstruction to fish movement, increased human access, and small (reasonably foreseeable) spills are anticipated to be minor; negative cumulative impacts to birds and terrestrial mammals due to habitat loss, alteration, or enhancement; disturbance or displacement; mortality; obstruction to movement; and small (reasonably foreseeable) spills could be large in certain local areas but overall are anticipated to be minor at the population level; negative cumulative impacts to threatened, endangered, and protected species are anticipated to be negligible to minor and should not threaten population viability.
Subsistence	4.7.8.1	Negative cumulative impacts would affect subsistence hunting and fishing, particularly on the North Slope (and, to a lesser extent, Interior Alaska), primarily as a result of restrictions on areas where subsistence could be pursued and possible disruptions to subsistence resource movements from human presence and activities; however, both of these main impacts are not anticipated to be particularly severe, with restricted access affecting relatively small portions of large subsistence harvest areas, and changes in animal movement patterns often being temporary and usually affecting only relatively few individual animals; contributions of the TAPS to these cumulative impacts are expected to be relatively small.
Sociocultural systems	4.7.8.2	Negative cumulative impacts might accompany continued interaction with modern American society and continued growth in importance of the cash economy in sociocultural systems founded on cooperation and subsistence; these changes, however, are largely a part of changes occurring throughout Alaska and not attributable solely to cumulative actions considered in this DEIS; contributions of the TAPS to these cumulative impacts are expected to be relatively small.

TABLE 4.7-12 (Cont.)

Issue Area	EIS Section	Summary of Impacts[a]
Economics	4.7.8.3	Temporary, local, negative cumulative economic impacts might occur during the construction of a gas pipeline and the NMDS, primarily testing the capabilities of local services; no long-term or statewide negative cumulative impacts are anticipated; anticipated positive economic impacts of these two projects likely would help to offset declines in economic activity expected to accompany reduced oil volumes transported through the TAPS over the coming decade.
Cultural resources	4.7.8.4	Negative cumulative impacts to cultural resources are expected to be minor, in part because existing state and federal regulations regarding such resources would be adhered to in the context of project development and operation.
Land use and coastal zone management	4.7.8.5	Negative cumulative impacts on land use are anticipated to be minor; negative cumulative impacts similarly are anticipated to be minor, both on the North Slope and in Prince William Sound; contributions of the TAPS to these cumulative impacts are expected to be relatively small.
Recreation, wilderness, and aesthetics	4.7.8.6	Negative cumulative impacts to recreation (sightseeing) could accompany the addition of a gas pipeline, depending on its location and design, although these effects should be localized; negative cumulative impacts to wilderness similarly could accompany a gas pipeline, although it would occur primarily during construction; negative cumulative impacts to aesthetics could accompany the addition of a gas pipeline and associated infrastructure to the TAPS ROW, although this infrastructure would be located in areas with modified visual surroundings already in place; contributions of the TAPS to recreation, wilderness, and aesthetics cumulative impacts would be relatively minor.

[a] Impacts are summarized here for the convenience of the reader. Details of the impact evaluations could not be included because of space limitations; additional information may be found in the referenced DEIS section.

Table 4.7-13 Summary of Cumulative Effects

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Soils and Permafrost	4.7.6.1			
Disturbance		Minor and local impacts on soils. TAPS operation would be a minor contributor to cumulative effects.	Same impacts as those under the proposed action.	Temporary increases in soil disturbance from TAPS facility removal. Longer-term impacts would be reduced as a result of decline in oil exploration and development.
Road dust		Minor and local effects on vegetation would affect soils; minor and local effect on permafrost affects local ponding, flooding, and soils. TAPS operation would be a substantial contributor, but not the major contributor, to this effect. All activities north of Fairbanks on unpaved roads would generate road dusts.	Same impacts as those under the proposed action.	Temporary reduction in traffic-generated road dust during removal of TAPS facilities. Longer-term reduction in road dust would result from decline in oil exploration and development.
Sand, Gravel, and Quarry Resources	4.7.6.2	.		
Use of resource		Local sources of sand and gravel would be used. Quarry stones would be transported to the North Slope from Brooks Range. There would be minor impacts on resources. TAPS operation would be a minor contributor to this effect.	Same impacts as those under the proposed action.	Use would decline with decline in oil exploration, development, and production.
Paleontology	4.7.6.3			
Disturbance and collecting		Potential negative impacts from actions would require mitigation or protection on a case-by-case basis. TAPS operations would include procedures to protect resources.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action. There would be less potential disturbance with decline in oil exploration, development, and production.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Surface Water	4.7.6.4			
Quantity of surface water		The large amount of water required for ice roads for oil and gas development and production on the North Slope would be met from surface sources. Impacts on taliks would be small when winter withdrawals were limited by permit restrictions. TAPS operation would have a very small effect on surface water quantity.	Same impacts as those under the proposed action.	Surface water requirements would be reduced with a decline in oil exploration and development.
Quality of surface water		Potential impacts of withdrawals from taliks for ice roads could affect quality of water needed for overwintering fish. Impact would be small when withdrawals were limited by permit restrictions. TAPS operation would have a negligible effect on surface water quality. There would be small local impacts caused by discharges to surface water from other actions and by reasonably foreseeable small spills from other actions and TAPS operations.	Same impacts as those under the proposed action.	Potential effects of water withdrawals on water quality are less likely with reduced water requirements for oil and gas development. Discharges to surface water from other actions would continue. Risk of small spills would decrease because of the reduction in oil exploration, development, and production activity and the removal of the TAPS.
Groundwater Resources	4.7.6.5			
Quantity of groundwater		Withdrawals from all activities would have small and local effects. Fairbanks and Valdez are the largest groundwater users. Municipal use would have minor impacts.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Quality of groundwater		Releases would have local effects. Impacts of produced water injection in deep aquifers would not affect supplies for human consumption.	Same impacts as those under the proposed action.	Produced water injections would be reduced with declining oil industry.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Physical Marine Environment	4.7.6.6			
Spills (oil, fuel, other liquids)		Spills in Prince William Sound could occur from all forms of marine traffic. Reasonably foreseeable spills would be rapidly cleaned up and of local consequence.	Same impacts as those under the proposed action.	Risk of spills from transportation of North Slope oil would be reduced. Reduction in the spill cleanup and response infrastructure could increase impact of spills.
Air Quality	4.7.6.7			
Releases		Negative cumulative impacts should be constrained to acceptable levels by regulatory limits, or should be relatively low in general (e.g., impacts from increased traffic). The TAPS would be a minor contributor to air pollutant releases.	Same impacts as those under the proposed action.	Releases would be reduced as a result of declining oil industry.
Noise	4.7.6.8			
Construction and operations		Local impacts from all activities.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Transportation	4.7.6.9			
System requirements		Anticipated increases in traffic volume would not be large and could be accommodated by existing infrastructure. No increases in traffic would result from continued TAPS operations.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Wastes	4.7.6.10			
Disposal requirements		Waste impacts from all actions are expected to be within acceptable limits, as set by regulatory standards.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action. Oil industry wastes would decrease.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Human Health and Safety	4.7.6.11			
Occupational hazards		Best management practices could reduce fatality and injury rates for all industries. Operating procedures could limit exposure to naturally occuring radionuclides (NORM). TAPS operation does not produce NORM.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action; however decline in oil production would reduce NORM production.
Public hazards — toxic emissions		No adverse health impacts would be expected from inhalation of industrial air emissions in the Valdez area. TAPS operation is a contributor to organic air pollutant emissions in the Valdez area.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action; however, organic air pollutant emissions from TAPS would cease.
Public health — persistent organic pollutants and mercury		Levels of PCBs and mercury in tissues of Alaska Natives and others consuming contaminated natural food supplies would be elevated from past actions and global sources. There would be no impact from other actions or from TAPS operation.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Terrestrial Vegetation and Wetlands	4.7.7.1	Impacts from all actions would be minor to negligible and local.	Same impacts as those under the proposed action.	Declining oil exploration and development would reduce impacts. A temporary increase in disturbance would result from removal of TAPS facilities.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Fish	4.7.7.2			
Habitat alteration and loss		Impacts would be minor and not substantially affect fish populations.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Obstructions to fish passage		Impacts would be low to moderate.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Increased human access		Impacts would be minor.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Spills		Impacts of small spills would be local and minor; risks of large spills would be low.	Same impacts as those under the proposed action.	Impacts from small spills and risks of large spills would decline with declining oil production.
Birds and Terrestrial Mammals	4.7.7.3	Effects from habitat loss, alteration, or enhancement; disturbance or displacement; mortality; obstruction to movement; and small (reasonably foreseeable) spills could be large in certain local areas, but, overall they are expected to be minor at the population level.	Same impacts as those under the proposed action.	Impacts on the North Slope would decline with declining oil exploration, development, and production. Minor increased disturbance would occur during TAPS facility removal.
Threatened and Endangered Species	4.7.7.5	Impacts to threatened, endangered, and protected species are anticipated to be negligible to minor and should not threaten population viability.	Same impacts as those under the proposed action.	Impacts on the North Slope and Prince William Sound would decline with declining oil exploration, development, and production. Removal of TAPS facilities might create temporary, minor impacts.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Subsistence	4.7.8.1	Subsistence hunting and fishing, particularly on the North Slope (and, to a lesser extent, in Interior Alaska) could be negatively impacted, primarily as a result of restrictions in areas where subsistence can be pursued and possible disruptions to the movement of subsistence resources from human presence and activities. However, both of these main impacts are not anticipated to be severe, with restricted access affecting relatively small portions of large subsistence harvest areas and with changes in animal movement patterns often temporary and usually affecting only a relatively few individual animals. Contributions from the TAPS to these cumulative impacts are expected to be relatively small.	Same impacts as those under the proposed action.	Impacting factors would be different from those described under the proposed action (e.g., reduced employment, reduced competition from sport hunting and recreation, increased need for resources, removal of barriers), but the overall cumulative effect might be the same.
Sociocultural Systems	4.7.8.2	In sociocultural systems founded on cooperation and subsistence, negative cumulative impacts might accompany their continued interaction with modern American society and the continued growth in the importance of a cash economy. However, these changes are largely a part of changes occurring throughout Alaska and are not attributable solely to cumulative actions considered in this DEIS. The contribution of the TAPS to these cumulative impacts would be relatively small.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Economics	4.7.8.3	Temporary, local negative cumulative economic impacts might occur during the construction of a gas pipeline and the NMDS; they would primarily test the capabilities of local services. No long-term or statewide negative cumulative impacts are anticipated. Anticipated positive economic impacts of these two projects likely would help to offset declines in economic activity expected to accompany reduced oil volumes transported through the TAPS over the coming decade.	Less-oil related investment would occur in the North Slope oil fields, as would lower levels of non-oil-related public and private investments. The result would be less employment, income, and tax revenues.	Construction of a natural gas transportation system might partially offset the losses in employment, income, and tax revenues that would accompany the end of TAPS operation and North Slope oil production.
Cultural Resources	4.7.8.4	Negative cumulative impacts to cultural resources are expected to be minor, in part as a result of adhering to existing state and federal regulations on such resources during project development and operation.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Land Use and Coastal Zone Management	4.7.8.5	Negative cumulative impacts on land use are anticipated to be minor. Negative cumulative impacts similarly are anticipated to be minor both on the North Slope and in Prince William Sound. The contribution of TAPS operation to these cumulative impacts is expected to be relatively small.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.

Table 4.7-13 (Cont.)

Topic	Section	Cumulative Effects (Effects from All Actions)		
		Proposed Alternative	Less-Than-30-Year Renewal Alternative	No Action
Recreation, Wilderness, and Aesthetics	4.7.8.6	Negative cumulative impacts to recreation (sightseeing) could accompany the addition of a gas pipeline, depending on its location and design, although these impacts should be localized. Negative cumulative impacts to wilderness similarly could accompany a gas pipeline, primarily during construction. Negative cumulative impacts to aesthetics could accompany the addition of a gas pipeline and associated infrastructure to the TAPS ROW, this infrastructure would be located in areas where visual surroundings have already been modified. The contribution of TAPS operation to recreation, wilderness, and aesthetics cumulative impacts would be relatively minor.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.
Environmental Justice	4.7.8.7	There would be no high or adverse cumulative impacts to minority or low-income populations.	Same impacts as those under the proposed action.	Same impacts as those under the proposed action.

4.8 Other NEPA Considerations

4.8.1 Unavoidable Adverse Impacts

The unavoidable adverse impacts under the proposed action (i.e., renew the ROW for 30 years) and the less-than-30-year renewal alternative (i.e., renew the ROW for less than 30 years) are discussed in detail in Sections 4.3 through 4.7 and are summarized in this section. In general, these impacts are small and may be mitigated or offset by the positive aspects of the actions. There would be continued localized impacts to the environment as a result of operation, construction, and maintenance activities, such as soil and vegetation disturbances, the use of surface and groundwater resources, and air emissions. However, such impacts are readily mitigated through measures already in place, as discussed in Section 4.1. The potential impacts from spills would remain, and those impacts could be adverse. However, preventive and mitigative measures are in place to limit and repair the damage from spills.

Under both alternatives to renew the ROW, impacts on subsistence and sociocultural systems would continue. However, numerous factors are involved that would negate or limit adverse effects. For example, while local disruption of animal movement patterns would continue, the ability of subsistence resource users to meet their needs would continue to be enhanced by the availability of the financial resources to purchase modern technology.

The no-action alternative (i.e., not renew the ROW) would have localized unavoidable adverse impacts on fish and wildlife during pipeline dismantlement, removal, and restoration activities. These impacts would cease after the completion of these activities and would not threaten entire fish or wildlife populations. However, the potentially adverse impacts on economics would last for a number of years. Initially, the pipeline termination activities would create jobs and revenue. However, as termination activities ceased, those jobs and additional revenue would end. The large reduction in revenues from terminating the TAPS operations would adversely impact the ability of the state to provide public services, and a reduction of the Permanent Fund would impact all Alaskans. The no-action alternative would indirectly affect North Slope oil production, as well as other industries.

4.8.2 Relationship Between Local Short-Term Uses of the Environment and Long-Term Productivity

The comparison of the proposed action and the less-than-30-year renewal alternative shows that the impacts over the possible 30-year renewal period vary little on an annualized basis between the two alternatives. The use of the environment under the alternatives to renew allows the continued passage of North Slope crude oil to the Port of Valdez. The use of the TAPS further facilitates the development and production of North Slope oil fields. This allows the continued generation of revenues from the operation of the North Slope oil fields, TAPS, and contributions into Alaska's Permanent Fund. These monies would be used by Alaska and its residents beyond any renewal period.

At the end of the TAPS activities under the proposed action, the less-than-30-year alternative, and the no-action alternative, there would be continued use of the environment for the duration of termination activities. At the end of termination activities, the impacts from TAPS on the physical environment would end, and restoration of the environment would continue. As the impacts of the operation of the TAPS would be small and temporary, the long-term productivity of the physical environment would not be affected by any of the alternatives.

4.8.3 Irreversible and Irretrievable Commitment of Resources

Within the physical environment, the continued disturbance of soil and withdrawal of sands, gravels, and quarry resources under the proposed action and the less-than-30-year alternative to support TAPS construction and maintenance activities would result in the partial loss of these resources. Similarly, other materials (such as fuels, structural steel, and lumber) would be consumed in continuing TAPS operations and in TAPS termination activities, to include actions under the no-action alternative. Some of the material would be available for reuse after TAPS termination activities.

In general, the impacts of the three alternatives on biological resources would not constitute irreversible and irretrievable commitment of resources. While there would be impacts on individuals, entire populations would not be adversely impacted. In localized areas, vegetation and animal life and habitats would be affected by the TAPS and TAPS termination activities (e.g., oil spills). However, the affected individuals would be replaced by other members of their population. The restoration of habitat under the various stipulations would reverse the loss of wildlife resources over time.

The trend of effects of modernization on Alaska Native cultural systems would continue under all alternatives. The subsistence resources used by Alaska Native groups, although possibly disrupted by the activities under all three alternatives, would not be irreversibly and irretrievably committed. As stated above, these subsistence resources would recover for biological resources.

Cultural and paleontological resources are nonrenewable. The continued operation of the TAPS would create the potential for damage to cultural and paleontological resources from oil spills and construction and maintenance activities. This irreversible and irretrievable commitment of resources also would potentially exist during termination activities under the no-action alternative.

Under the proposed action and the less-than-30-year renewal alternative, the continued operation of the TAPS would allow continued use of North Slope oil resources. Potential oil spills from the continued operation of the TAPS would result in the economic loss of the spilled material and the resources needed to manage the materials. Under the no-action alternative, the ability to use North Slope oil resources would cease until an alternative means of transportation was developed.

4.8.4 Mitigation of Adverse Effects

During the analysis and assessment conducted for this DEIS, no new mitigation measures were identified. Existing mitigation measures are presented in Section 4.1.

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5. Consultation and Coordination

5.1 Public Scoping

The BLM published a Notice of Intent "To Prepare an Environmental Impact Statement (EIS) for the Renewal of the Federal Agreement and Grant of Right-of-Way (ROW) for the Trans-Alaska Pipeline System (TAPS)" in the *Federal Register* (Vol. 66, No. 147) on July 31, 2001. The Notice of Intent initiated the public scoping process and invited public comments on the content and issues that should be addressed in the EIS. The BLM conducted scoping for the proposal to renew the TAPS ROW grant from July 31 to October 19, 2001. During that period, the BLM invited the public and interested groups to provide information and guidance, suggest issues that should be examined, and express their concerns and opinions on all aspects (past, present, and future) of the proposal to renew the Federal Grant.

During the scoping process, seven ways were provided for the public to submit comments to the BLM on the proposal to renew the TAPS ROW:

- Open public meetings held in Anchorage, Barrow, Delta Junction, Fairbanks, Glennallen, and Valdez, Alaska;
- Traditional mail;
- Hand delivery;
- Toll-free facsimile transmission;
- Toll-free voice message;
- Electronic mail; and
- Directly through a Web site on the Internet.

This variety of ways to communicate issues and submit comments was provided so as to encourage maximum participation. All comments, regardless of how they were submitted, received equal consideration.

More than 1,700 people participated in the scoping process by providing comments, requesting information, attending public or tribal consultation meetings, or visiting the TAPS Renewal EIS Web Site. In addition, more than 100 organizations, including Alaska Native organizations; environmental organizations; private industry; and local, state, and federal government agencies, provided comments. Several comments were documented during conversations and facilitated discussions at the public meetings. More than 230 individuals and organizations provided comments. Those comments were submitted in the following ways:

- 53% via the TAPS Renewal EIS Web Site,
- 15% orally at public meetings,
- 11% by fax,
- 9% by regular mail,
- 7% by e-mail,
- 4% delivered by hand, and
- 1% by telephone.

Comments originated from 37 states and the District of Columbia. Of those comments, 48% were from Alaska and 52% were from the other states. States with the most commentors were Alaska, 100; California, 19; Wisconsin, 8; and Texas, 6. Georgia, New York, and Pennsylvania each had 5 commentors. Other states had 4 or fewer commentors, with 11 states having just one commentor. No comments were received from other countries. During the scoping period, a total of 2,411 visits were made by 1,370 visitors to the TAPS Renewal EIS Web Site.

The BLM published a scoping report (BLM 2001) that summarized and categorized the major themes, issues, concerns, and comments expressed by private citizens, government agencies, Alaska Natives, private firms, and nongovernmental organizations. The BLM considered the comments in developing the alternatives and analytical issues that are contained in this EIS.

5.2 Government-to-Government Consultation

The BLM works on a government-to-government basis with Alaska Native Tribes. The government-to-government relationship was formally recognized by the federal government on November 6, 2000, with Executive Order 13175. The BLM coordinates and consults with tribal governments, Native communities, and individuals whose interests might be directly and substantially affected by renewing the Federal Grant of ROW. The BLM strives to provide the Tribes a sufficient opportunity for productive participation in BLM planning and resource management decision making.

In addition to implementing the public scoping process, the BLM initiated a government-to-government consultation process for issues related to renewal with affected Alaska Native villages and tribes. For example, the BLM identified 21 affected villages within the TAPS corridor and developed a formal consultation process with those affected villages. The government-to-government consultation process includes a number of communication tools, such as, certified letters to the affected Tribes providing information and meeting opportunities, meetings with tribal organizations and regional corporations to seek input and facilitate communication, opportunities for early previews of NEPA documentation, and facilitated workshops. The BLM will continue to conduct government-to-government interactions with Alaska Natives throughout the NEPA process, extending to the issuance of a Record of Decision.

5.3 State of Alaska Coordination

The BLM, through the JPO, maintains close cooperation and communication with the State of Alaska in the renewal process for the TAPS ROW. The ADNR is the State of Alaska lead agency for renewal of the State Lease component of the TAPS ROW. The ADNR and BLM are working together in an integrated renewal process that satisfies both federal and state requirements. The coordination specifically addresses the production of the federal EIS and the state compliance report. By scheduling the coincident preparation of these two documents, the BLM and ADNR can coordinate public comment and publication cycles. It is expected that this coordination will allow for more efficient public input and permit a coordinated approach to interactions with the applicant.

5.4 Other BLM Planning Activities

The BLM has three multiple use land use plans that encompass portions of the TAPS. The Southcentral Management Framework Plan was issued in 1980 (BLM 1980). It covers portions of the TAPS on BLM lands south of the Alaska Range but discusses no management decisions affecting the TAPS. The Fort Greely Resource Management Plan (RMP) was issued in 1994 (BLM and USARAK 1994). It acknowledges the prior existence of the TAPS and states that the BLM will protect “valid existing rights,” which include the TAPS ROW through this military installation south of Delta Junction. The Utility Corridor Proposed RMP (BLM 1989) is the third plan. In this plan, the BLM makes the preeminence of the pipeline very clear for its lands north of the Yukon River. The 1991 ROD (BLM 1991) states that “the primary management direction and use of BLM-administered lands in the Utility Corridor is for energy transportation.” The Utility Corridor Proposed RMP also states, “No proposed management action [in the plan] should be interpreted as limiting current or future energy transportation needs in the Utility Corridor. The need for the transportation of energy minerals supersedes all other uses of the Utility Corridor” (BLM 1989).

5.5 Agency Consultation

As part of Section 7 of the Threatened and Endangered Species Act (16 USC §1536), the BLM has submitted a Biological Evaluation (BE) of the proposed action contained in the DEIS to both the USFWS and the NMFS. The BE responds to a formal request by USFWS and NMFS to evaluate project impacts on threatened

and endangered species or critical habitat that occur within the vicinity of TAPS.

The BLM has begun negotiations with the Alaska SHPO to develop a programmatic agreement (PA) that will clarify the procedures pertaining to cultural resources in association with future TAPS operation. A PA defines the procedures for considering historic properties with respect to an entire agency program within the framework of Section 106 of the NHPA and formalizes the relationships between the various agencies responsible for compliance with Section 106 (16 USC §470f).

5.6 References for Chapter 5

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6. Review and Analysis of Comments Received on the Draft Environmental Impact Statement

Reserved for Final EIS

7. List of Preparers

The following is the list of individuals who participated in the preparation of this DEIS.

Name	Education/Experience	Contribution
Joint Pipeline Office		
James H. Ducker	Ph.D. History, M.A. History; 6 years of experience in historical research, 15 years in planning and environmental assessment	TAPS renewal NEPA coordinator; introduction; alternative descriptions
Argonne National Laboratory		
Joseph J. Adduci	B.A. Geography; 7 years of experience in geographic information system (GIS) applications	GIS data acquisition, integration, management and analysis; preparation of maps and figures
Cynthia A. Adornetto	MEPM (Masters in Environmental Policy and Management), B.S. Natural Resources Management; 17 years of experience in environmental planning and permitting, 8 years in environmental assessment	Technical lead for land use and coastal management; and for recreation, wilderness, and aesthetics
Timothy Allison	M.S. Mineral and Energy Resource Economics, M.A. Geography; 14 years of experience in regional analysis and economic impact analysis	Technical lead for economics
Georgia A. Anast	B.A. Mathematics/Biology; 12 years of experience in environmental assessment	Comment/response management; glossary
Halil I. Avci	Ph.D. Nuclear Engineering; 21 years of experience in safety analysis; 17 years in environmental assessment and waste management	Technical lead for the spill team
Bruce M. Biwer	Ph.D. Chemistry; 12 years of experience in environmental assessment, 10 years involving transportation risk	Transportation systems
James P. Butler	Ph.D. Environmental Health Sciences; 21 years of experience in health risk assessment	Technical lead for human health and safety
Brian L. Cantwell	B.S. Forestry; 20 years of experience in cartography and geographic research, 5 years in geographical information system (GIS) applications	GIS data acquisition, integration, management and analysis; preparation of maps and figures

Name	Education/Experience	Contribution
Young-Soo Chang	Ph.D. Chemical Engineering; 20 years of experience in meteorology, air quality, and noise impact assessments	Climate and meteorology; air quality; and noise
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John D. DePue	M.S. Biology; 27 years of experience in technical and environmental assessment editing	Lead technical editor
Stephen M. Folga	Ph.D. Gas Engineering; 8 years of experience in technology assessment and waste management	Spill scenarios
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Matthew Greby	B.A. Anthropology; 20 years of experience in archeological research	Paleontology
Rebecca A. Haffenden	J.D., B.A. Psychology; 12 years of experience in environmental regulation and environmental impact analysis	Hazardous materials and waste management
Heidi M. Hartmann	M.S. Environmental Toxicology and Epidemiology; 15 years of experience in exposure and risk analysis and public health assessment	Human health and safety analysis
John Hayse	Ph.D. Zoology; 16 years of experience in ecological research and environmental assessment	Biological resources analysis (fish)
Patricia E. Hollopeter	M.A. Philosophy; 20 years of experience in technical editing	Technical editor
Elizabeth K. Hocking	J.D.; 12 years of experience in regulatory and policy analysis.	Glossary of environmental laws
Philip H. Kier	ScD Nuclear Engineering, J.D.; 40 years experience in engineering, 12 years in environmental assessment	Spill scenarios

Name	Education/Experience	Contribution
Ronald L. Kolpa	M.S. Inorganic Chemistry, B.S. Chemistry; 30 years of experience in environmental regulation, auditing, and planning	Technical lead for hazardous materials and waste management; lead author for sections on existing mitigative measures and impacting factors
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James A. Kuiper	M.S. Biometrics, Certificate in Remote Sensing; 15 years of experience in geographic information systems (GIS), programming, and remote sensing	Technical lead for GIS data acquisition, integration, management and analysis; preparation of maps and figures
Kirk E. LaGory	Ph.D. Zoology, M.En. Environmental Science; 27 years of experience in ecological research, 16 years in environmental assessment	Technical lead for biological resources; threatened and endangered species
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John C. Molburg	Ph.D. Engineering and Public Policy, B.S. Mechanical Engineering; 20 years of experience in process and mechanical design of power and chemical plants and engineering analysis of environmental issues and technologies	Spill scenarios
Marita Moniger	B.A. English; 24 years of experience in editing and writing	Technical editor
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Daniel J. O'Rourke	M.S. Industrial Archaeology; 10 years of experience in cultural resources management, 6 years in historical property issues	Cultural resources

Name	Education/Experience	Contribution
Edgar C. Portante	MSEE Power Systems, M.M. (Masters in Management) Business, MSEE Energy Markets (candidate); 18 years of experience in power systems research and analysis, 6 years in gas and oil infrastructure analysis	TAPS infrastructure
David A. Poyer	Ph.D. Economics, M.A. Economics, B.S. Chemistry; 20 years of experience in applied economic theory and public policy analysis	Economics
Elizabeth A. Stull	Ph.D. Zoology; 35 years of experience in ecological research, 26 years in environmental impact assessment	Technical lead for cumulative impacts analysis
Bobby Templin	M.S. Environmental Engineering, Professional Engineer, American Academy of Environmental Engineers; 24 years of experience in environmental management, hazardous waste disposal, and weapons disposal	Argonne deputy program manager
David Tomasko	Ph.D. Civil Engineering; 24 years of experience in hydrogeology and fluid mechanics	Technical lead for geology and water resources, including hydrological analysis of spill events
Robert A. Van Lonkhuyzen	B.A. Biology; 10 years of experience in ecological research and environmental assessment	Biological resources (vegetation and wetlands)
William S. Vinikour	M.S. Biology with environmental emphasis; 26 years of experience in ecological research and environmental assessment	Biological resources (birds and mammals); assistant technical lead for cumulative impacts analysis
Konstance L. Wescott	M.A. Anthropology, B.A. Mathematics and Sociology/Anthropology; 15 years of experience in archaeology, 13 years in environmental assessment	Document manager
Gustavious P. Williams	Ph.D. Civil Engineering, B.A. Asian Studies, B.S. Civil Engineering; 16 years of experience in environmental sciences, 11 years in environmental impact assessment	Physical marine environment; marine chemistry
C. Ron Yuen	Ph.D. Geology; 21 years of experience in engineering geology, environmental geology, and hydrogeology	Physiography and geology; soils and permafrost; seismicity; sand, gravel, and quarry resources

8. Glossary

100-year flood: A flood which on the average will be equaled or exceeded once in every 100 years.

aboriginal: In general, the term aboriginal applies to persons who can trace their origins to the native people who inhabited a region when the first Europeans arrived.

abutment (bridge): The outermost end supports on a bridge. Abutments support the bridge at each shore of a stream.

acceleration (g): The rate at which velocity changes, either by increasing or decreasing. Velocity is the distance traveled per unit of time.

acute effect: An adverse effect that develops rapidly and often subsides after the exposure stops.

acid: A *corrosive* liquid with a *pH* of less than 7.

acre-foot: The amount of water required to cover one acre of land to a depth of one foot (approximately 325,900 gallons).

active fault: A *fault* that is likely to have another earthquake sometime in the future. A fault is commonly considered to be active if it has moved one or more times in the last 10,000 years.

active layer: A seasonally thawed surface layer of *soil* that lies above permanently frozen ground (*permafrost*). It can be between a few centimeters and about 3 meters thick.

active zone: The zone in which the *permafrost* thaws.

acute hazardous waste: *Hazardous waste* that is very toxic and can be fatal to humans in small amounts.

advection: The process by which substances are transported along with the bulk motion of flowing gas or liquid; moving along with the current.

aerobic: A biological process that occurs in the presence of oxygen.

aesthetics: Things that can be appreciated through the five senses (e.g., visual resources).

affected environment: For an *environmental impact statement*, a description of the existing environment covering information necessary to assess or understand the impacts. It must contain enough detail to support the impact analyses and must highlight environmentally sensitive resources.

aggradation: Propagation; filling in or leveling by deposition.

airblast overpressure: Increased air pressure (above normal atmospheric pressure) resulting from the explosion of unconfined charges.

air pollutant: Any substance in air that could, if present in a high enough concentration, harm humans, other animals, vegetation, or material. *Pollutants* may include almost any natural or artificial composition of matter capable of being airborne.

air quality: A measure of the quantity of pollutants, measured individually, in the air. These levels are often compared to regulatory standards.

Air Quality Control Region (AQCR): An interstate or intrastate area designated by the U.S. *Environmental Protection Agency* for the attainment and maintenance of *National Ambient Air Quality Standards.*

air quality standards: The level of selected *pollutants* set by law that may not be exceeded in outside air. They are used to determine the amount of pollutants that may be emitted by industry.

airshed: A term used to describe those areas where significant portions of *emissions* result in deposition of various *air pollutants* to a region.

air toxics: Substances that have adverse impacts on human health when present in the *ambient air.*

Alaska Coastal Management Program (AS 46.40): See Chapter 9.

Alaska Historic Preservation Act (AS 41.35): See Chapter 9.

Alaska Natives: The *indigenous* people of Alaska.

Alaska National Interest Lands Conservation Act: See Chapter 9.

Alaska Native Allotment Act of 1906: See Chapter 9.

Alaska Native Claims Settlement Act: See Chapter 9.

Alaska Permanent Fund Dividend: An annual per capita (per person) payment from a savings account established in 1976 using a portion of royalties paid to the State from oil production on State land.

Alaska Statehood Act of 1958: See Chapter 9.

alcids: A family of marine birds with a stout bill, short wings and tail, webbed feet, a large head and heavy body, and thick, compact plumage. They are found in the northern parts of the Northern Hemisphere and include auks, guillemots, murrelets, and puffins.

alevin: A young fish, particularly a young salmon, that is still attached to the yolk sac.

alkane chains: A series of organic compounds with general formula C_nH_{2n+2}. Examples are propane (with n=3) and octane (with n=8).

alkaline: Having the properties of a *base* with a *pH* of more than 7.

alkalinity: The total measurable *bases* in a volume of water; a measure of the material's capacity to neutralize *acids*.

alluvial: Formed by the action of running water; of or relating to river and stream deposits.

alluvial deposits: Relating to mud and/or sand deposited by flowing water.

alluvial fan: A gently sloping mass of *alluvium* deposited where a stream leaves a narrow canyon and enters a plain or valley floor. The material is deposited because the change from a steep gradient to a flatter gradient causes the stream to suddenly lose transporting power. Viewed from above, it has the shape of an open fan. An alluvial fan can be thought of as the land counterpart of a *delta*.

alluvium: A general term for *clay*, *silt*, sand, gravel, or similar unconsolidated material deposited by a stream or other body of running water.

ALOHA model: A computer model (Areal Locations of Hazardous Atmospheres) used to assess the impacts of potential chemical releases.

ambient: Undisturbed, natural conditions such as temperature; surrounding conditions.

ambient air: The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. It is not the air in immediate proximity to emissions sources.

Ambient Air Quality Standards: Regulations prescribing the levels of airborne pollutants that may not be exceeded during a specified time in a defined area.

ambient noise: The background noise in an area or environment. It is a composite of sounds from many sources near and far.

American Indian Religious Freedom Act: See Chapter 9.

ammonia (NH_3): A colorless gas with a strong, pungent odor, formed from the natural breakdown of manure, plants, and animals. It is present in water, soil, and air and acts as a source of nitrogen for plants and animals. It can be very toxic to fish and other aquatic life.

ammonites: Spiral-shaped *mollusks*, related to the modern-day octopus and squid.

amphipods: Small *crustaceans* living in or next to the water, including sand fleas and whale lice. They are often abundant on the bottom of coastal bays and *estuaries*.

amplitude: The amplitude of a seismic wave is the amount the ground moves as the wave passes by. The amplitude of an ocean wave is one-half the distance between the peak and trough of the wave.

anadromous fish: Fish (e.g., salmon and steelhead) that spend their adult lives in the sea but swim upriver into fresh water to breed. They usually return to the area where they were born.

anaerobic: Referring to an environment in which oxygen is absent; a biological process that occurs in the absence of oxygen; an organism that lives in the absence of oxygen.

anode: The positive electrode in a battery, diode, or other electrical device.

anoxic: Greatly deficient in oxygen; without oxygen.

anthropogenic: Human made; produced as a result of human activities.

Antiquities Act: See Chapter 9.

aquifer: A *permeable* underground formation that will yield usable amounts of water to a well or spring. The formation could be sand, gravel, limestone, and/or *sandstone*.

Archeological District: A significant concentration, linkage, or continuity of sites important in history or prehistory.

archeological resources: Any material remains or physical evidence of past human life or activities that are of archeological interest, including the record of the effects of human activities on the environment.

Archeological Resources Protection Act: See Chapter 9.

archaeological site: Any location where humans have altered the terrain or discarded *artifacts* during prehistoric or historic times.

area of critical environmental concern: Places within *Bureau of Land Management* public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes or to protect life and safety from natural hazards.

armoring: Placing *riprap* to control erosion.

aromatic hydrocarbons: A group of *hydrocarbon* compounds containing one or more six-carbon rings characteristic of the benzene series. They are called aromatic because of the strong odor that many of them have (e.g., turpentine and wintergreen oil).

arsenic: A highly toxic, naturally occurring metal. In the past, it was used in pesticides.

artifacts: An object produced or shaped by human beings and of archaeological or historical interest.

asbestos: A mineral fiber that can pollute air or water and cause cancer or asbestosis when inhaled. The EPA has banned or severely restricted the use of asbestos in manufacturing and construction.

aspect: The direction toward which a slope faces with respect to the compass or the rays of the sun.

assemblage (aquatic): An association of interacting populations of organisms in a given body of water; for example, a fish assemblage.

atomize: To break up a liquid into extremely fine particles.

attainment area: An area considered to have air quality as good as or better than the *National Ambient Air Quality Standards* for a given pollutant. An area may be in attainment for one pollutant and in *nonattainment* for others.

aufeis: New ice that continues to form on top of older ice. These ice-forming situations occur wherever there are continuous sources of water and freezing temperatures.

autoclaving: Sterilization via a pressurized, high-temperature steam process.

Bald and Golden Eagle Protection Act: See Chapter 9.

ballast water: Water taken on board a ship to improve the ship's stability.

barrel: A liquid-volume measure for petroleum products equal to 42 U.S. gallons at 60°F.

barrens: A level area with poor soil that is sparsely forested or unable to support normal vegetative cover and that generally has a low level of productivity. Plants growing in barrens are usually smaller and stunted in comparison to those grown on more fertile soils.

barrier islands: Elongated, narrow *landforms* composed of sand and other loose *sediments* transported by waves, currents, and winds.

base: A liquid with a *pH* of greater than 7.

bathymetry: The measurement ocean depths in order to determine the locations and depths of underwater hills, plains, valleys, etc. The equivalent land term is *topography*.

bedload: *Sediment* moving on or near the streambed and frequently in contact with it.

bedrock: A general term for the solid rock that is underneath the *soil* and other unconsolidated material or that is exposed at the surface.

belemnites: A group of extinct *cephalopods* with an internal, bullet-shaped shell, related to squids, octopuses and cuttlefish.

benches (mitigation): Surface configurations added to storm-water basins that create flat edges, usually installed for safety and to minimize erosion.

benthic: Occurring at the bottom of a body of water, such as a seabed, river bottom, or lake bottom. The presence or absence of certain benthic organisms can be used as in indicator of water quality.

berm: An elongated earthen structure that acts to control the flow of a liquid (for example, surface water or an oil spill).

berth: The water area, terminal, or wharf and mooring facilities used by a ship.

biennial: Occurring every two years.

bilge water: Water generated in the bilge of the ship's machinery spaces and thereby contaminated with oil and other substances, some of which may be harmful.

bioaccumulation: The process by which chemicals are retained in fatty tissue and increase in concentration over time.

biochemical oxygen demand (BOD): A measure of the amount of oxygen needed by *aerobic* bacteria to break down organic materials in water at a certain temperature over a specified time. Higher organic loads in the water require larger amounts of oxygen and may reduce the amount of oxygen available for fish and other aquatic life to below acceptable levels.

biochemical oxygen demand over 5 days (BOD_5): The biochemical oxygen demand measured over five days. This value is used by regulatory agencies for monitoring wastewater treatment facilities and monitoring surface water quality.

biodegradation: Breaking down of substances by bacteria.

biodiversity: The number and variety of different organisms in an *ecosystem*. It is used to describe species richness, ecosystem complexity, and genetic variation.

biohazard: Material of biological origin that presents a risk or potential risk to the well-being of humans, other animals, or plants, either directly through infection or indirectly through disruption of the environment.

biomagnification: The process by which some chemical contaminants become more concentrated in the tissues of organisms (through diet) at higher levels in the food chain. The contaminants are stored in the fatty tissues of animals and are passed along to their predators. The concentration of these contaminants eventually reaches harmful levels at the top of the food chain.

biota: The living organisms in a given region.

bivalve: A *mollusk* whose body is enclosed by two hinged shells (e.g., mussels, clams, and oysters).

block valve: A valve that can block the flow of oil in a pipeline in both directions. Block valves include manual gate valves and *remote gate valves*.

bluff (landform): A high bank with a broad, precipitous, and sometimes rounded cliff face overlooking a plain or body of water.

body burden: The amount of a chemical stored in the body at a given time, especially a potential toxin present in the body as the result of exposure.

bog: Waterlogged, spongy ground consisting primarily of mosses and containing acidic, decaying vegetation that may develop into *peat*.

boom: A temporary floating barrier used to contain oil on a body of water.

boreal: Related to or growing in northern regions.

boreal forest: A subarctic forest that is dominated by *conifers,* stretching across North America, Europe, and northern Asia. It is found south of the *tundra* in the Northern Hemisphere and often contains peaty or swampy areas.

borrow pit: A pit or excavation area used for gathering earth materials (borrow) such as sand or gravel.

borrow sites: An area that is used for excavating earthen material.

bounding: A condition, consequence, or risk that provides an upper limit that is not exceeded by other conditions, consequences, or risks. The term is also used to identify conservative assumptions that will likely overestimate actual risks or consequences.

brachiopods: A group of marine invertebrates with an asymmetrical two-valved shell. During adult life, many brachiopods are attached to the seabed by a stalk or by one shell. They were very abundant in the oceans of the *Paleozoic Era.*

brackish: Water that is salty, but not as salty as seawater.

braided river or stream: A river or stream consisting of a network of interwoven small channels and resembling the strands of a complicated braid.

browse (noun): Shrubs, trees, and herbs that provide food for wildlife.

bryozoa: Microscopic aquatic animals that live in large colonies of interconnected individuals. Because these colonies are usually made of secreted calcite, they commonly form *fossils*. Bryozoa are abundant in modern marine environments and are also an important part of the *fossil* record. They are commonly referred to as sea mats, moss animals, or lace corals.

Bureau of Land Management (BLM): An agency of the U.S. Department of the Interior that is responsible for managing public lands.

cache: A deliberate store of equipment, food, furs, or other resources placed in or on the ground or raised above the ground on a platform.

catchment area: An area that “catches” rainfall or snow to supply a river, aquifer, or lake.

caldera: A large, basin-shaped volcanic depression, formed by explosion and/or collapse, that surrounds a volcanic vent; a crater.

calving: The breaking away of ice from the front of a *glacier* when it ends in a lake or an ocean. Calving produces icebergs.

Cambrian Period: The period of geologic time from 500 to 570 million years ago.

candidate species: Species for which the U.S. Fish and Wildlife Service has substantial information on hand to support the biological appropriateness of proposing to list the species as *endangered* or *threatened*.

canopy: The upper forest layer of leaves consisting of tops of individual trees whose branches sometimes cross each other. (See c*losed canopy* and *open canopy*.)

carbon dioxide (CO_2): A colorless, odorless, nonpoisonous gas that is a normal part of earth's atmosphere. Carbon dioxide is a product of fossil-fuel combustion as well as other processes. It is considered a *greenhouse gas* because it traps heat radiated into the atmosphere and thereby contributes to the potential for *global warming.*

carbon monoxide (CO): A colorless, odorless gas that is toxic if breathed in high concentrations over an extended period. Carbon monoxide is one of the six *criteria air pollutants* specified under Title I of the *Clean Air Act*.

carcinogenic: Capable of causing cancer.

carrying capacity (animals): The maximum average number of animals that can be sustained on a long-term basis in a given area. It can vary throughout the year and from year to year depending on conditions within the *habitat*.

cathode: The negative electrode in a battery, diode, or other electrical device.

cathodic protection: A technique to prevent corrosion of a metal surface by making it the cathode of an electrochemical cell.

Cenozoic Era: A geologic era dating from approximately 65 million years ago to the present. It is known as the age of mammals.

census blocks: Census blocks are defined by the U.S. Bureau of the Census and are the smallest geographic unit for which that agency tabulates data.

census block groups: Geographic entities consisting of groups of individual census blocks. Census blocks are grouped together so that they contain between 250 and 550 housing units.

centistoke (cSt): A unit of measure representing 1/100th of a stoke (S), which is the fundamental unit of *kinematic viscosity*.

cephalopods: A class of marine *mollusks* with an internal or external shell and tentacles that includes nautiloids, squids, octopuses, cuttlefish, and other extinct *belemnite*s.

channel morphology: The general shape of a stream channel.

check valves: Check valves operate one way and prevent the reverse flow of oil in a pipeline. They are designed to be held open by flowing oil and to drop closed automatically when the flow of oil stops or is reversed.

chert: A very fine-grained *sedimentary rock* made of quartz with excellent fracturing properties, producing good cutting edges on stone tools.

chlordane: A pesticide made up of about 10 major components.

chlorofluorocarbons (CFCs): A family of chemicals commonly used in air conditioners and refrigerators as coolants. They are also used as solvents and aerosol propellants. CFCs drift into the upper atmosphere, where their chlorine components destroy *ozone*. The CFC Halon 1301™ (bromotrifluoromethane) is used in fire-suppression systems at pump stations and at the Valdez Marine Terminal.

chronic effect: A (health) effect resulting from long-term exposure to a substance or persistent (months, years, or permanent) adverse effects resulting from a short-term (acute) exposure.

circumpolar: Surrounding or found in the vicinity of the North or South Pole.

cirque: A semicircular recess with steep walls located at the head of a mountain valley. The upper edges have the steepest slopes, approaching vertical, and the base may be flat or hollowed out and occupied by a small lake or pond.

Class I landfill: A landfill that accepts for disposal 20 tons or more of municipal solid waste daily (based on an annual average); or one that does not qualify as a Class II or Class III municipal solid waste landfill.

Class II landfill: A landfill that (1) accepts less than 20 tons daily of municipal solid waste (based on an annual average); (2) is located on a site where there is no evidence of groundwater pollution caused or contributed by the landfill; (3) is not connected by road to a Class I municipal solid waste landfill, or, if connected by road, is located more than 50 miles from a Class I municipal solid waste landfill; and (4) serves a community that experiences (for at least 3 months each year) an interruption in access to surface transportation, preventing access to a Class I landfill, or a community with no practicable waste management alternative.

Class III landfill: A landfill that is not connected by road to a Class I landfill or a landfill that is located at least 50 miles from a Class I landfill. Class III landfills can accept no more than an average of 1 ton daily of ash from incinerated municipal solid waste or less than 5 tons daily of municipal solid waste.

clastic: Pertaining to rocks or *sediment* made up primarily of fragments of preexisting rocks or *minerals*.

clay: A rock or mineral fragment of any composition that is smaller than very fine *silt* grains, having a diameter of less than 0.00016 inch (1/256 millimeter).

Clean Air Act: See Chapter 9.

Clean Water Act: See Chapter 9.

climax: The final stage of succession in an *ecosystem*. Also, a community that reached a steady state under a particular set of environmental conditions.

closed canopy: A forest *canopy* that is dense enough that the tree crowns fill or nearly fill the canopy layer so that light cannot reach the forest floor directly.

closed forest: A forest with a tree canopy coverage of 60 to 100%. (See *closed canopy*.)

Coastal Zone Management Act: See Chapter 9.

Code of Federal Regulations (CFR): A compilation of the general and permanent rules published in the *Federal Register* by the executive departments and agencies of the federal government of the United States of America. It is sometimes referred to as the "United States Code"or "USC."

colluvial: Pertaining to or composed of *colluvium*.

colluvium: Loose deposits of rock, usually located at the foot of a slope or cliff, having been brought there under the influence of gravity (a process known as *mass wasting*).

commercial waste: Waste that originates from wholesale, retail, or service establishments.

conditionally exempt small quantity generator: A waste generator who, in a calendar month, generates no more than 100 kilograms (200 pounds) of hazardous waste in that month.

confluence (of a stream or river): The meeting of junction of two or more streams or rivers; the place where these streams meet.

congener: Any of two chemical substances composed of the same elements in the same proportions but which have difference properties because of different molecular structures.

conglomerate: A coarse-grained, *clastic sedimentary* rock composed of rounded rock fragments mixed with sand and finer material.

conifer: Cone-bearing trees, mostly evergreens, that have needle-shaped or scale-like leaves.

convergence line: A line on the water surface where floating objects and oil collect. A convergence can be the interface between two different types of bodies of water, or it can be caused by a significant depth change, tidal changes, or other common phenomena.

corrosive: A chemical agent that reacts with the surface of a material causing it to deteriorate or wear away.

corrosivity: One of the characteristics of *hazardous waste*. A liquid waste exhibits the characteristic of corrosivity if it is strongly acidic or strongly basic (pH $\leq$2.0 or $\geq$12.5).

Council on Environmental Quality (CEQ): The President's Council on Environmental Quality was established by the National Environmental Policy Act and is the agency responsible for the oversight and development of national environmental policy.

Cretaceous Period: A period of geologic time lasting from 65 to 145 million years ago.

crinoids: Also known as feather-stars and sea-lilies, they are a class of *echinoderms* with many movable arms and often attached to the sea floor by a long stalk. They have a long *fossil* history extending back to the *Cambrian Period.*

criteria air pollutants: Six common air pollutants for which N*ational Ambient Air Quality Standards* have been established by the EPA under Title I of the *Clean Air Act*. They are *sulfur dioxide, nitrogen oxides*, *carbon monoxide, ozone, PM_{10}, $PM_{2.5}$*, and *lead*. Standards for these *pollutants* were developed on the basis of scientific knowledge about their health effects.

critical habitat: Specific areas within the geographical range of a *threatened or endangered species* that are formally designated by the U.S. Fish and Wildlife Service under the *Endangered Species Act* as essential for conservation of the species.

crustacean: A diverse group of arthropods (jointed-legged animals, such as centipedes, millipedes, insects, crustaceans, and spiders), mostly aquatic, that includes crabs, lobsters, shrimps, and wood lice. They have an exoskeleton, a pair of often modified appendages on each segment, and two pairs of antennae.

cryogenic: Related to the production and effects of extremely low temperatures. Cryogenic conditions are conditions under which temperatures are low enough for gases to condense to become liquids or solids.

cultural resources: *Archaeological sites*, architectural structures or features, traditional-use areas, and Native American sacred sites or special-use areas that provide evidence of the prehistory and history of a community.

cumulative impacts: The impacts assessed in an *environmental impact statement* that could potentially result from incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency (federal or nonfederal), private industry, or individual undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.

cushion plants: A low-growing mat formed by tightly massed individuals of the same species of plant. Generally associated with *tundra* or high alpine communities.

dabbling: A means of foraging for food (often used by ducks) whereby the body is tipped into the water, bill first, tail in the air.

deadweight: The carrying capacity of a ship in terms of the weight in tons of the cargo, fuel, provisions, and passengers that the vessel can carry.

decennial: Occurring every 10 years.

decibel (dB): A standard unit for measuring sound-pressure levels based on a reference sound pressure of 0.0002 dyne per square centimeter. This is the softest sound a human can hear. In general, a sound doubles in loudness with every increase of 10 decibels.

decibel, A-weighted (dBA): A measurement of sound approximating the sensitivity of the human ear and used to characterize the intensity or loudness of sound.

deciduous: Plants having structures that are shed at regular intervals or at a given stage of development, such as trees that shed their leaves in the autumn.

deciduous forest: A forest of trees that shed their leaves at some season of the year.

delta: An *alluvial deposit* at the mouth of a river where it discharges into the sea or a lake. Deltas occur when a sediment-laden current enters an open body of water. At this point, the reduction in velocity of the current results in the rapid deposition of sediment.

demographics: Specific population characteristics such as age, gender, education, and income level.

denuded: Stripped of all vegetative cover.

depleted stock: A species or population that is below its optimum sustainable population.

dermal exposure: Exposure to a substance through the skin.

design contingency earthquake: A rare, intense earthquake with an estimated occurrence frequency (return period) of 500 years.

design operating earthquake: A lower intensity earthquake that has ground motion *amplitudes* one-half of those associated with the *design contingency earthquake*.

Devonian Period: A period of geological time from 365 to 408 million years ago.

dewater: To remove or drain water from an area.

diatom: A one-celled plant with a silica framework that grows in oceans and lakes.

dike (containment): An embankment to confine or control water or other liquid, such as spilled oil.

direct impact: An effect that results solely from the construction or operation of a proposed action without intermediate steps or processes. Examples include habitat destruction, soil disturbance, air emissions, and water use.

dispersion (of spilled oil): The break-up of an oil slick into small droplets that are mixed into the water column by breaking waves and other turbulence at the water surface.

dispersion model (air): A mathematical prediction of how pollutants from a discharge or emission source will be distributed in the surrounding environment under given conditions of wind, temperature, humidity, and other environmental factors.

domestic wastewater: See sanitary wastewater.

double-hulled tanker: A hull construction technique in which a ship has an inner and outer bottom or hull separated by a void space, usually several feet in width.

draft: The depth of a loaded vessel in the water, taken from the level of the waterline to the lowest point of the hull of the vessel; the depth of water, or distance between the bottom of the ship and waterline.

drag-reducing agent: A substance that, when dissolved in crude oil, reduces the friction of the flowing oil along the wall of a pipe, making the oil easier to pump.

drainage lakes: Lakes fed primarily by streams and with outlets into streams or rivers.

dust shadow: A darkened, often linear, patch where the ground was exposed to settling dust. The dust may accumulate, leaving a permanent stain.

dynamic volume (related to spills): The quantity of oil that would be pumped through the section of the pipe where the break occurred from the time of the break until the pumps upstream are shut down and the mainline valves are closed.

echinoderms: A group of marine invertebrates with skeletal plates in the skin and often five axes of symmetry (e.g., sea urchins, sea cucumbers, sea stars, and sea lilies).

ecological succession: The chronological sequence of vegetation and associated animals in an area; or, continuous colonization, extinction, and replacement of species populations at a particular site, due either to environmental changes or to the properties of the plants and animals themselves.

ecology: The study of the interrelationships between organisms and their natural environment.

ecosystem: A group of organisms and their physical environment.

effects range–low: Concentration of a chemical in sediment below which toxic effects are rarely observed among sensitive species.

effluent: A gas or fluid discharged into the environment, treated or untreated. Most frequently, the term applies to wastewater discharged from a *point source* (such as a pipe) to *surface waters.*

egalitarian: Referring to societies in which all people are equal in terms of economic and political rights.

elevation: The distance above or below mean sea level.

Emergency Planning and Community Right-To-Know Act: See Chapter 9.

emergent (vegetation): Erect plants rooted underwater that grow above (emerge from) the surface of the water (e.g., cattails).

emergent wetlands: Wetlands, commonly called marshes and wet meadows, that are dominated by grasses, sedges, and other nonwoody plants.

emissions: Substances that are discharged into the air from industrial processes and vehicles as well as living organisms.

emulsification: The formation of a water-in-oil mixture. An emulsified mixture of water in oil is commonly called *mousse*. The presence of mousse indicates that a spill has been on the water for some time.

endangered species: Any species (plant or animal) that is in danger of extinction throughout all or a significant part of its range. Requirements for declaring a species endangered are found in the *Endangered Species Act*.

Endangered Species Act: See Chapter 9.

entrainment (oil spill): The loss of oil from containment when it is pulled under a *boom* by a strong current.

environment: All external conditions that affect an organism during its lifetime.

environmental impact statement (EIS): A document required of federal agencies by the *National Environmental Policy Act* for major proposals or legislation that will or could significantly affect the environment.

environmental justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Environmental Protection Agency (EPA): The EPA is responsible for working with state and local governments to set standards that help control and prevent pollution and minimize the potential health effects in areas of solid and hazardous waste, pesticides, water, air, drinking water, and toxic and radioactive substances. It was created in 1970.

Eocene: A geologic *epoch* early in the *Cenozoic Era*, dating from approximately 56 to 34 million years ago.

eolian: Pertaining to the wind or deposits that have been laid down by the wind.

eolian deposits: Sand, silt, or clay-sized *clastic* material transported and deposited primarily by wind.

eon: The longest unit of geologic time.

EPA Region 10: The Pacific Northwest region of the EPA, serving Alaska, Idaho, Oregon, Washington, and Native Tribes.

epicenter: The point on the Earth's surface directly above the focus of an earthquake.

epilithic: Living on rocks or other stony matter.

epoch: A division of geologic time next shorter than a *period.*

era: A division of geologic time shorter than an *eon* and larger than a period.

ericaceous: Of, or relating to, the heath family of plants, which are mostly shrubby and often evergreen plants that thrive on open, barren soil that is usually acidic and poorly drained.

erosion: The wearing away of the land surface by running water, wind, ice, or other geological processes.

essential fish habitat (EFH): Those waters and substrate necessary for fish to spawn, breed, feed, or grow to maturity.

estuarine: Pertaining to or found in an *estuary*.

estuary: A region between rivers and near-shore ocean waters, where tidal action and river flow mix fresh and salt water. Estuaries include bays, mouths of rivers, salt marshes, and *lagoons*.

ethnography: A method of studying and learning about a person or group of people. Typically, ethnography involves the study of a small group of subjects in their own environment.

ethnohistory: The ethnographic study of cultures through historical records.

euphotic zone: The upper layer of water that receives enough light for photosynthesis and the growth of green plants.

evapotranspiration: The combined loss of water from the soil both by evaporation and by transpiration from plants growing in the soil.

extant: Currently existing.

extirpate: To destroy or eliminate completely. Extirpate is not necessarily synonymous with extinction, since the term may be applied to certain populations within the range of a given species.

factor of 10: To increase something by a factor of 10 is to increase it 10 times.

facultative biological decomposition: Decomposition that occurs either with oxygen (aerobic) or without oxygen (anaerobic). Facultative bacteria can be found in aerobic or anaerobic environments.

family: In the hierarchy of taxonomy, the rank or category below order and above genus. Families consist of a number of similar genera. (See *genus*.)

fast-ice: Sea ice that is attached or fastened to the shoreline or seafloor.

fatigue life: Number of cycles of stress and strain of a specified nature that a material will sustain before failure occurs.

fauna: Animals, especially those of a specific region, considered as a group.

faunal remains: Animal remains.

fault (geologic): A fracture in rock along which movement of one side relative to the other has occurred.

Federal Cave Resources Protection Act: See Chapter 9.

Federal Land Policy and Management Act: See Chapter 9.

fen: A marshy, low-lying *wetland* covered by shallow, usually stagnant, and often alkaline water that originates from *groundwater* sources; waterlogged, spongy ground containing alkaline decaying vegetation that develops into peat.

Fiber-optic cable: Cables consisting of thin filaments of glass (or other transparent materials), which can carry beams of light.

fjord: A former glacial valley with steep sides now occupied by the sea.

fledge: To leave the nest, usually with the ability to fly or run.

flocculent: A chemical that causes a dispersed colloidal system (such as clay) to coagulate and form flocs (coagulated masses of particles in a liquid).

flocculation: The process by which clays, polymers, or other small charged particles become attached and form a fragile structure, called a floc.

floodplain: Mostly level land along rivers and streams that may be submerged by floodwater.

floral analysis: Analysis of the remnants of past vegetation found in archaeological sites.

fluvial: Pertaining to rivers or to deposits laid down by rivers.

footslope: The hillslope position that forms the inner, gently inclined surface at the base of a slope.

forbs: Nonwoody plants that are not grasses or grasslike.

fossil: An impression or trace of an animal or plant of a past geologic age that has been preserved in the earth's crust.

fossil fuel: Natural gas, petroleum, coal, and any form of solid, liquid, or gaseous fuel derived from such materials for the purpose of creating useful heat.

frost creep: Slow *mass movement* of soil downslope caused by *frost heaving* and subsequent settling after thawing (freeze-thaw action).

frost heave or jacking: Expansion in soil volume due to the formation of ice; generally expressed as an upward movement of the ground surface.

frost mound: A localized uplift of land surface caused by *frost heaving* or by groundwater pressure. (See *hummock* and *pingo*.)

fugitive dust: The dust released from activities associated with construction, manufacturing, or transportation.

fugitive emissions: Emissions (air pollutants) released to the air other than those from stacks or vents. They are often due to equipment leaks, evaporative processes, and windblown disturbances.

full-time equivalent worker (FTE): The equivalent of a full-time worker. For example, two people who each work half time correspond to one FTE.

fungi: Plural of *fungus*.

fungus: Colorless (lacking chlorophyll) plant with practically no differentiation of cell structure (e.g., yeasts and molds).

fur-bearers: Species that are of primary economic importance for their fur rather than as a food source.

gabion: Wire mesh baskets (filled with cobblestones that range in size from 4 to 8 inches) used to control erosion.

gastropods: A large class of aquatic and terrestrial *mollusks*, usually with a univalve shell or no shell, including slugs and snails.

gelifluction: Form of *mass movement* in a periglacial environment where a *permafrost* layer exists. It is characterized by the movement of soil material over the permafrost layer and the formation of lobe-shaped features.

genera: Plural of *genus*.

General Accounting Office: The arm of Congress that investigates the performance of the federal government, including the use of public funds.

genus: A grouping of one or several species that possess common characteristics; a classification above *species* and below family.

geographic information system (GIS): A computer hardware and software system designed to collect, manipulate, analyze, and display spatially referenced data for solving complex resource, environmental, and social problems.

geology: The science that deals with the study of the materials, processes, environments, and history of the earth, including the rocks and their formation and structure.

geomorphic processes: Processes (physical, chemical, or biological) at the earth's surface that shape the landscape and result in specific deposits.

gigawatt (GW): A measurement of power equal to a thousand million *watts.*

glacial: Involving *glaciers* and moving ice.

glacial surge: A period of unusually rapid movement (tens of meters a day) of a *glacier*.

glacial till: Material (e.g., sand, pebbles, and boulders) deposited by a *glacier*.

glacier: A large mass of ice, formed by the compaction of snow, that persists all year and flows slowly over the surface of the ground or down a valley. Glaciers originate in snow fields and end at lower elevations in a warmer environment, where they melt. They vary in size from small valley glaciers to huge ice sheets that cover large parts of continents.

glaciofluvial: Pertaining to meltwater streams flowing from *glaciers* or to the deposits made by such streams.

glaciolacustrine: Pertaining to, or characterized by, *glacial* and *lacustrine* processes or conditions. The term is applied especially to deposits made in lakes.

global warming: The progressive, gradual rise of the earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns.

gradient: The slope, expressed as a percentage of change in elevation per unit of distance traveled.

gram-atoms: The mass of one *mole* of an element equal in grams to the atomic weight of the element. (A gram-atom of oxygen is 16 grams.)

graminoid plants: Grasses and grasslike plants, such as sedges.

greenhouse gases: Heat-trapping gases that cause global warming. Natural and human-made greenhouse gases include water vapor, *carbon dioxide*, methane, *nitrogen oxides*, *ozone*, and *chlorofluorocarbons*.

gross state product (GSP): The sum of value added in the production of all goods and services in the state in a year. It is a measure of the level of economic activity in the state.

ground ice: A general term used to describe all bodies of ice in the ground surface of the permafrost layer.

groundwater: The supply of water found beneath the earth's surface, usually in porous rock formations (*aquifers*), which may supply wells and springs; generally, all water contained in the ground.

guillotine (pipeline) break: A break in the pipeline that involves the entire circumference of the pipe.

habitat: The place, including physical and biotic conditions, where a plant or animal lives.

halons: Bromine-containing compounds that are used in firefighting. They have long atmospheric lifetimes, and their breakdown in the stratosphere causes depletion of *ozone.*

halophytic: Referring to a plant that can tolerate or thrive in alkaline soil rich in sodium or calcium salts; tolerant of saline (salty) conditions.

hanging glacier: A glacier that terminates at or near the top of a cliff.

hanging valley: A glacial valley whose mouth is at a relatively high level on the steep side of a larger glacial valley.

haulout areas: Areas where seals and other marine mammals climb up out of the water.

hazard index: The sum of the *hazard quotients* for all chemicals to which an individual is exposed. A hazard index of less than one indicates that adverse health effects (noncancer) are unlikely.

hazard quotient: A comparison of the estimated intake level or dose of a chemical in air, water, or soil with its reference dose or concentration, expressed as a ratio. A hazard quotient of less than one indicates that the exposure is unlikely to cause adverse noncancer health effects.

hazardous material: Any material that poses a threat to human health and/or the environment. Hazardous materials are typically toxic, corrosive, ignitible, explosive, or chemically reactive.

hazardous substance: See hazardous material.

hazardous waste: According to the *Resource Conservation and Recovery Act*, this term refers to a waste that because of its characteristics may (1) cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness or (2) pose a substantial hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed. Hazardous wastes possess at least one of the following characteristics: *ignitability, corrosivity*, *reactivity*, or *toxicity*. Hazardous waste is nonradioactive.

heavy metals: A metallic element with a high specific gravity, such as antimony, bismuth, cadmium, copper, gold, lead, mercury, nickel, silver, tin, and zinc. These metal are toxic even in low concentrations. They persist in the environment and can accumulate to levels that stunt plant growth and interfere with animal life.

herbaceous plants (herbs): Nonwoody plants.

herbicides: Chemicals used to kill undesirable vegetation.

high-centered polygons (landform): A polygon with a center that is higher than its margins.

historic context: Information about historic trends and properties grouped by an important theme in the prehistory or history of a community, state, or the nation during a particular period of time. Historic contexts are organized by theme, place, and time and link properties to important historic trends.

historic district: A geographically definable area with a significant concentration of buildings, structures, sites, or objects unified by past events.

historic site: The site of a significant event, prehistoric or historic occupation or activity, or structure or landscape (existing or vanished), where the site itself possesses historical, cultural, or archeological value apart from the value of any existing structure or landscape.

historic structure: A standing structure that has historic significance.

hummock: A small hill of broken ice which has been forced upward by pressure.

hydraulic: Related to water or other liquid in motion.

hydraulic head: The force per unit area exerted by a column of liquid at a height above a depth (and pressure) of interest. Fluids flow down a hydraulic gradient, from points of higher to lower hydraulic head.

hydrocarbon: A naturally occurring *organic compound* made up of carbon and hydrogen atoms arranged in chains or rings. *Fossil fuels* are made up of hydrocarbons; some hydrocarbons are major *air pollutants*.

hydrology: The study of water relating to the occurrence, properties, distribution, circulation, and transport of water, including groundwater, surface water, and rainfall.

hydrophytic vegetation: Plants that have adapted to living in aquatic (water) environments.

hydrostatic testing: A method of leak-testing components by pressurizing them inside with water.

hypoxic: Deficient in oxygen.

ice field: An extensive area of interconnected *glaciers* in a mountain region, or of pack ice at sea.

ice surge: The fast advance of a *glacier* in response to melting.

ice wedge: A buildup of ice in frozen soil that is wedge-shaped in cross-section.

igneous rock: Rock formed by solidification of molten magma from deep in the earth. Volcanics (e.g., basalt) are formed by the cooling of lava from a volcano; intrusives (e.g., granite) are formed when molten material is forced into cracks or between layers of preexisting rocks.

ignitability: A liquid exhibits the characteristic of ignitability if it has a flash point less than 140ºF.

impoundment: A natural or artificial body of water confined by a dam, dike, floodgate, or other barrier.

increased lifetime cancer risk: An upper-bound estimate of the likelihood that an individual will develop cancer as a result of exposure to a cancer-causing chemical.

Indian Reorganization Act of 1934: See Chapter 9.

indigenous: A species that occurs naturally in an area; native.

indirect impact: An effect that is related to but removed from a proposed action by an intermediate step or process. An example would be changes in surface-water quality resulting from soil erosion at construction sites.

industrial waste: Liquid, gaseous, solid, or other waste substance or a combination of them resulting from processes of industry, manufacturing, trade, or business or from the development of natural resources.

influent: Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

infrastructure: The basic facilities, services, and utilities needed for the functions of an industrial facility or site. Transportation, water supply, and electrical systems are part of the infrastructure.

ingestion: The taking in of a substance through the mouth.

in-situ: In its natural position or place.

intermontane basin: A generic term for a wide structural depression between mountain ranges that is partly filled with *alluvium*. Commonly called a valley.

intertidal zone: Shoreline area occurring between the highest normal tide and the lowest normal tide.

intrusive (rock): *Igneous rock* formed when molten material is forced into cracks or between layers of preexisting rocks and does not reach the earth's surface.

inundation: The covering by water of lands normally not covered.

Jurassic Period: A period of geologic time lasting from 145 to 210 million years ago.

kilowatt (kW): A measurement of power equal to 1,000 *watts*.

kinematic viscosity: The time required for a fixed amount of an oil to flow through a capillary tube under the force of gravity. The unit of kinematic viscosity is the stoke or centistoke ($1/100^{th}$ of a stroke). Kinematic viscosity may be defined as the quotient of the absolute viscosity divided by the specific gravity of a fluid, both at the same temperature.

kinematics: The study of objects in motion.

krill: Small *crustaceans* similar to small shrimp but with bristled tails. They are generally 1 to 6 centimeters long and are found at depths of up to 2,000 meters in the ocean.

L_{dn}: A 24-hour average sound level that gives additional weight to noise that occurs during the night (10:00 p.m. to 7:00 a.m.).

L_{eq}: For sounds that vary with time, L_{eq} is the steady sound level that would contain the same total sound energy as the time-varying sound over a given time.

lacustrine: Pertaining to, produced by, or living in lakes.

laden tanker: A tanker that is carrying cargo.

lagoon: A shallow body of water that is near or connected to a larger body of water.

lagoon (for wastewater treatment): A shallow, artificial pond where sunlight, bacterial action, and oxygen work to purify wastewater.

laminar flow: A flow in which fluid moves smoothly in parallel layers or sheets. It is characteristic of the movement of groundwater.

land use: The way land is developed and used by humans.

landfill: An area of land, or an excavation, in which solid wastes are placed for permanent disposal; a method for final disposal of solid waste on land.

landform: Any physical, recognizable form on the earth's surface, having a characteristic shape and produced by natural causes.

leachfield: The area of land into which a septic tank drains or wastewater is discharged.

lead (Pb): A gray-white metal that is listed as a *criteria air pollutant*. Health effects from exposure to lead include brain and kidney damage and learning disabilities.

lichen: An organism consisting of a *fungus* and an alga living together in symbiotic association.

limnetic: Pertaining to lakes or to other bodies of standing fresh water.

line volume balance: A leak detection system that compares the volume of oil entering the line with the volume leaving the line.

lipids: A general term for fats, waxes, and related products in living tissues.

liquefaction: A process by which water-saturated sediment temporarily loses strength and acts as a fluid. This effect can be caused by earthquake shaking.

littoral: The region along the shore of a nonflowing body of water. It corresponds to *riparian* for a flowing body of water.

littoral zone: The shallow area near the shore of a nonflowing body of water where light penetration is sufficient for the growth of plants.

loam: A soil consisting of an easily crumbled mixture of *clay*, *silt,* sand, and organic matter. It is rich soil, typically good for plant growth.

loess: Material transported and deposited by wind. Loess is usually composed of unstratified fine sand or silt.

low-centered polygon: A polygon whose center is depressed (low) relative to its boundary.

Magnuson-Stevens Fishery Conservation and Management Act: See Chapter 9.

Marine Mammal Protection Act: See Chapter 9.

marsh: A wetland where the dominant vegetation is nonwoody plants, such as salt grasses and *sedges*, as opposed to a swamp, where the dominant vegetation is woody plants such as trees and shrubs.

mass movement: General term that describes the downslope movement of sediment, soil, and rock material.

mass wasting: A general term used to describe geologic processes that are primarily driven by the action of gravity.

material safety data sheets (MSDS): Material safety data sheets provide details on chemical and physical dangers, safety procedures, and emergency responses for chemicals.

mean (statistical): The sum of a set of observations divided by the number of observations.

meander: The winding of a stream channel.

median value: The point that divides the distribution of values in half. Numerically, half of the values are equal to or larger than the median and half of the values are equal to or smaller than the median.

medical waste: Medical waste is generally defined as any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals.

megawatt (MW): A measurement of power equal to one million *watts*.

mélange: Rock that includes fragmented blocks of all sizes embedded in a fragmented and fine-grained matrix.

memorandum of agreement (MOA): A formal memorandum defining and explaining agreements and decisions reached on specific issues by two or more parties.

memorandum of understanding (MOU): An agreement between organizations defining the roles and responsibilities of each organization in relation to the other.

mercury (Hg): A naturally occurring shiny, silver-white, liquid metal. It enters the air from mining ore deposits, burning coal and waste, and from manufacturing plants and is known to *bioaccumulate* in the food chain. The nervous system is very sensitive to all forms of mercury, and effects include irritability, shyness, tremors, changes in vision or hearing, and memory problems. Exposure to high levels of mercury can permanently damage the brain, kidneys, and lungs.

mesic: Intermediate in moisture, without extremes; neither wet (hydric) nor dry (xeric).

Mesozoic Era: An era of geologic time lasting from 65 to 248 million years ago.

metal fatigue: Cracking and/or breaking of metal parts because of repeated stresses, such as flexing or bending.

metamorphic rock: Preexisting rock that is restructured by high temperature and pressure. Examples are slate (formerly shale) and marble (formerly limestone).

meteorology: The science dealing with the atmosphere and its phenomena, especially as relating to weather.

Migratory Bird Treaty Act: See Chapter 9.

millimole: One-thousandth of a *mole*.

Mineral Leasing Act: See Chapter 9.

mineral: A component of rocks; a naturally occurring inorganic solid with a crystalline structure and a specific chemical composition. More than 2,000 types of minerals have been classified.

mineral lick: A naturally occurring mineral source, which supplies animals with critical nutrients.

mitigation: Actions taken to avoid, minimize, rectify, or compensate for any adverse environmental impact.

mixing height: The depth through which pollutants released to the atmosphere are typically mixed by dispersion.

mixing layer: See mixing height.

mole (unit of measure): A unit of mass equal to the molecular weight of the substance. The amount of pure substance that contains the same number of elementary entities as there are atoms in exactly 12 grams of the isotope carbon-12.

mollusk: An organism whose soft, unsegmented body parts are frequently enclosed in a shell (e.g., snails, clams, or squids).

moment magnitude: A measure of earthquake size (magnitude) in which the stiffness of the rock, the average slip on the rupture plane, and the area of the rupture plane are taken into account.

moraine: A mound or ridge of rock consisting of boulders, stones, or other debris carried and deposited by a glacier.

mousse: An emulsified mixture of water in oil. It ranges in color from dark brown to nearly red or tan and typically has the consistency of pudding. (See *emulsification.*)

mulching: Covering an area loosely with some material (e.g., straw or bark) to hold soil in place and facilitate revegetation.

muskeg: A type of *bog* that has developed over thousands of years in depressions, on flat areas, and on gentle to steep slopes. They have poorly drained, acidic, or organic soils.

mutagenic: Causing mutation, or the abrupt change in the genotype of an organism.

National Ambient Air Quality Standards (NAAQS): Air quality standards established by the *Clean Air Act,* as amended. The primary NAAQS are intended to protect the public health with an adequate margin of safety, and the secondary NAAQS are intended to protect the public welfare from any known or anticipated adverse effects of a pollutant.

National Environmental Policy Act: See Chapter 9.

National Historic Preservation Act: See Chapter 9.

National Landmark Status: The highest recognition that the U.S. Department of Interior gives an historic property. (Note: National historic landmarks are buildings, sites, districts, structures, and objects that have been determined by the Secretary of the Interior to be nationally significant in American history and culture.)

National Park Service (NPS): An agency in the U.S. Department of the Interior responsible for protection and preservation of natural and cultural units throughout the United States.

National Petroleum Reserve-Alaska: The area currently known as the National Petroleum Reserve-Alaska was originally designated in 1923 as Naval Petroleum Reserve No. 4. It was one of four U.S. regions thought to contain significant amounts of oil that were to be reserved for national crises.

National Pollutant Discharge Elimination System (NPDES): A federal permitting system controlling the discharge of effluents to surface waters of the United States and regulated through the *Clean Water Act*, as amended.

National Register of Historic Places: A comprehensive list of districts, sites, buildings, structures, and objects that are significant in American history, architecture, archeology, engineering, and culture. The National Register is administered by the National Park Service, which is part of the U.S. Department of the Interior.

Native American Graves Protection and Repatriation Act: See Chapter 9.

naturally occurring radioactive material (NORM): Material containing no significant amounts of radionuclides other than naturally occurring radionuclides.

nautical mile: A nautical mile is equal to 1,852 meters (about 6,076 feet).

nitrate (NO_3): A nitrogen-containing compound that is water soluble and mobile in the environment. Nitrates are toxic at elevated concentrations.

nitrite (NO_2): The product in the first step of the two-step process of conversion of ammonium (NH_4) to nitrate (NO_3).

nitrogen oxides (NO_x): The oxides of nitrogen, primarily nitrogen oxide (NO) and nitrogen dioxide (NO_2), that are produced in the combustion of fossil fuels. Nitrogen dioxide emissions constitute an air pollution problem, as they contribute to acid deposition and the formation of ozone. Nitrogen oxides are one of six *criteria air pollutants* specified under Title I of the *Clean Air Act*.

Noise Control Act as Amended by the Quiet Communities Act: See Chapter 9.

nonattainment area: The U.S. *Environmental Protection Agency's* designation for an air quality control region (or portion thereof) in which ambient air concentrations of one or more criterial pollutants exceed *National Ambient Air Quality Standards.*

Occupational Safety and Health Administration (OSHA): Congress created OSHA under the Occupational Safety and Health Act on December 29, 1970. Its mission is to prevent work-related injuries, illnesses, and deaths.

Oil Pollution Act: See Chapter 9.

oil seep: A natural flow of oil to the earth's surface.

old-growth: Referring to an ecosystem or community (particularly a forest) that has not experienced intense or widespread disturbance for a long time relative to the life span of the dominant species and that has entered a late successional stage. It is usually associated with high diversity of species, specialization, and structural complexity.

oleophilic: Having a strong affinity for oil.

omnivorous: Eating both plants and animals.

open canopy: A canopy with frequent openings between the tree crowns (leaves). An open forest has a tree canopy coverage of 25 to 60%.

open forest: See open canopy.

operational material sites (OMSs): See borrow pit.

organic compounds: Natural or synthetic compounds based on carbon. They also usually contain hydrogen, nitrogen, and oxygen. All living organisms are made up of organic compounds.

oriented thaw lake: A lake or pond in a permafrost area formed by the thawing of ground ice and enlarged by wind currents.

ostracods: A group of small marine or freshwater *crustacean* with a bivalved shell. There are more than 2,000 species of living ostracods and many that are known as fossils. They are also called "seed shrimp."

outfall: The discharge point of a drain, sewer, or pipe into a body of water.

outwash: A *glaciofluvial sediment* that is deposited by meltwater streams from a *glacier*.

outwash fan: A fan-shaped body of *sediment*s deposited by streams of a melting *glacier*.

oxbow lake: A lake formed in the channel of an abandoned *meander* or river bend. The river forms a new channel, isolating the bend or meander and forming a lake.

ozone (O_3): A strong-smelling, pale blue, reactive toxic chemical gas consisting of three oxygen atoms chemically attached to each other. It is the product of the photochemical process involving the sun's energy and ozone precursors, such as hydrocarbons and oxides of nitrogen. Ozone is one of six criteria air pollutants specified under Title I of the *Clean Air Act* and is a major constituent of smog.

pack ice: Floating ice that has been driven together into a single mass.

packline conditions: A pipeline flow condition in which the oil stream completely fills the pipe cross-section. (See *slackline*.)

paleontology: The study of plant and animal life that existed in former geologic times, particularly through the analysis of *fossils*.

Paleozoic Era: An era of geologic time lasting from 248 to 570 million years ago.

palustrine: Pertaining to wet or marshy habitats.

parameters: Data, or values, that are input to computer codes or equations.

particulate matter (PM): Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. The size of the particulates is measured in micrometers (µm); a micrometer is 1 millionth of a meter (0.000039 inch). Particle size is important because the *Environmental Protection Agency* has set standards for PM_{10} and $PM_{2.5}$ designed to protect human health and welfare.

particulates: Solid or solid particles such as dust, smoke, mist, or smog small enough to become airborne.

parts per million (ppm): One ppm equals one unit of measurement per million units of the same measurement. The equivalent to microgram per gram or milliliter per liter.

passerine: Perching birds or songbirds.

patterned ground: A mosaic of polygons (up to 20 feet in diameter) at the surface of unconsolidated, weathered rock, that are formed by freeze/thaw cycles. Patterned ground is found in the *tundra*.

peak acceleration: The largest acceleration recorded by a particular station during an earthquake.

peat: Unconsolidated soil material consisting largely of undecomposed, or slightly decomposed, organic matter accumulated under conditions of excessive moisture.

pelagic: Referring to or occurring in the open sea.

pelecypods: Bivalved *mollusks* such as oysters, clams, and mussels.

per capita: Per person.

perched lake: A lake that is isolated above the *groundwater* table by a layer of rock or organic material.

perched saturated zone: A saturated zone held above a lower body of *groundwater* by an unsaturated zone.

percolation: The downward movement of water through porous material such as soil or rock.

period: In the geologic time scale, a unit of time less than an *era* and greater than an *epoch*.

permafrost: Ground that has remained continuously frozen for two or more years.

Permian Period: A period of geologic time from 248 to 290 million years ago.

permeable: Able to transmit water or other fluids.

permissible exposure limit (PEL): The maximum amount or concentration of a chemical that a worker may be exposed to under OSHA regulations.

petrified: Turned to stone through a process that replaces organic molecules with inorganic minerals.

petroleum hydrocarbons: Liquids that are generated through the action of time and temperature on organic matter buried below the earth's surface.

pH: A measure ranging from 0 to 14 that describes the acidity or alkalinity of a solution based on the concentration of hydrogen ions in the solution. A pH of 7 is neutral; values below 7 are acid, and above 7 are alkaline (bases).

phenols: A group of organic compounds that are by-products of petroleum refining, tanning, and other manufacturing processes. In very low concentrations they produce a taste and odor problem in water; in higher concentrations they are toxic to aquatic life.

physiographic province: A region in which the *landforms* are similar in geologic structure and differ significantly from the landform patterns in adjacent regions.

physiography: The physical geography of an area, or the description of its physical features.

phytoplankton: Minute plant life (e.g., algae), usually containing chlorophyll, that passively drifts or weakly swims in a body of water.

pigs: Instrumented probes in a pipeline used to determine the condition and operation of the pipeline.

pingo: A rounded or conical mound containing ice at its core. It is formed when the hydrostatic pressure of freezing *groundwater* causes the upheaval of a layer of frozen ground. Pingos are commonly 30 to 50 meters high and up to 400 meters in diameter.

pinnacle: A tall, slender, tapering pillar of rock.

pioneer species: The first species or community to colonize or recolonize a barren or disturbed area.

placer: *Glacial* or *alluvial* deposits of sand or gravel that contain gold particles or other valuable minerals.

placer mining: The removal of ore from *placers.*

plankton: Animals and plants (especially minute organisms) floating in the water of seas, rivers, ponds, and lakes.

Pleistocene: The *epoch* of the *Quaternary Period* of geologic time from 1.6 million to 10,000 years ago; the "Ice Age."

Pliocene: The last epoch of the *Tertiary Period*, from 1.6 to 5.2 million years ago.

PM_{10}: *Particulate matter* with a diameter less than 10 micrometers (0.0004 inch). Particles less than this diameter as small enough to be breathable and could be deposited in the lungs. PM_{10} is one of the six *criteria air pollutants* specified under Title I of the *Clean Air Act.*

$PM_{2.5}$: *Particulate matter* with a diameter less than 2.5 micrometers (0.0001 inch). A standard for this material as a *criteria air pollutant* has been defined but has not yet been implemented.

point source: A source of *effluents* that is small enough in dimensions that it can be treated as if it were a point. A point source can be either a continuous source or a source that emits effluents only in puffs for a short time.

pollutant: Any material entering the environment that has undesired effects.

pollution: The addition of an undesirable agent to the environment in excess of the rate at which natural processes can degrade, assimilate, or disperse it.

polychlorinated biphenyls (PCBs): A group of manufactured *organic compounds* made up of carbon, hydrogen, and chlorine. They were used in the manufacture of plastics and as insulating fluids for electrical equipment. Because they are very stable compounds and are also fat-soluble, they accumulate in ever-higher concentrations as they move up the food chain. The use of PCBs was banned in the United States in 1979.

polycyclic aromatic hydrocarbons (PAHs): *Organic compounds* that include only carbon and hydrogen with a fused ring structure containing at least two benzene (six-sided) rings. PAHs are commonly found in petroleum oils (e.g., gasoline and fuel oils) and are emitted from various combustion processes (e.g., automobile exhausts). Some PAHs are potent human carcinogens.

polygonal ground: A type of *patterned ground* outlined by cracks that are filled with *ice wedges* and produced by frost action.

polynuclear aromatic hydrocarbons: See polycyclic aromatic hydrocarbons.

ponding: Runoff that collects in depressions and cannot drain out, creating a temporary pond.

potable water: Water that can be used for human consumption.

potlatches: A ceremonial feast where one's property is given away in order to repay debts or achieve a position of status in the community.

ppm: See parts per million.

prehistoric: That part of the past beginning with the emergence of human beings and continuing until the introduction of written records.

primary waste treatment: Mechanical separation of solids, grease, and scum from wastewater.

proglacial lake: A lake formed by the damming action of *moraines* in front of a *glacier* as the glacier melts.

protected species: Species that are protected by law, including the *Endangered Species Act*. This includes all *threatened*, *endangered*, and *candidate* species.

Proterozoic Era: An *era* of geologic time lasting from 570 to 2,500 million years ago.

Public Money, Property or Records: See Chapter 9.

putrescible waste: Solid waste that contains organic matter capable of being decomposed by microorganisms and of such a character and proportion as to cause obnoxious odors and to be capable of attracting or providing food for birds or animals.

Quaternary Period: The period of the *Cenozoic Era* of geologic time extending from about 1.8 million years ago to the present. It is noted for numerous major ice sheet advances in the Northern Hemisphere.

radioactive waste: Materials that are radioactive or are contaminated with radioactive materials, and for which use, reuse, or recovery are impractical.

radionuclide: An atom that exhibits radioactive properties. Radionuclides can be man-made or naturally occurring, can have a long life, and have potentially *mutagenic* or *carcinogenic* effects on the human body.

raptor: Bird of prey.

reach (of a river): Any specified length of a river; a relatively homogeneous section of a river having a repetitious sequence of physical characteristics and habitat types.

reactivity: A substance exhibits the characteristic of reactivity if it reacts violently, forms explosive mixtures, or emits significant quantities of toxic vapors when mixed with water.

recreation opportunity spectrum (ROS): A system for planning and managing recreation resources that categorizes recreation opportunities into three classes: semi-primitive, roaded natural, and rural.

recycling: The process by which a material that would otherwise be destined for disposal is collected, reprocessed, and then reused.

reef: A ridge of rock or coral lying at, near, or beneath the surface of the water.

reference concentration: The concentration of a chemical in air that is very unlikely to have adverse effects if inhaled continuously over a lifetime.

reference dose: The oral intake level of a chemical that is very unlikely to have adverse effects. It is measured in units of milligrams per kilogram of body weight per day.

relict permafrost: Permafrost that persists in places where it could not presently form. Relict permafrost reflects past climatic conditions, usually colder temperatures, that differ from current conditions.

remediation: The cleanup, removal, containment, isolation, treatment, or monitoring of hazardous substances released into the environment.

remote gate valves: A remotely controlled *block valve* used primarily to protect segments of a pipeline in the event of a catastrophic pipeline break.

Resource Conservation and Recovery Act (RCRA): See Chapter 9.

return period: Recurrence interval; a statistical parameter used in frequency analysis as a measure of the average time interval between the occurrence of a given quantity and that of an equal or greater quantity.

revetment: A facing of stone, concrete, or other material placed on a riverbank to protect it from erosion. Revetments are used to prevent further movement of rivers towards a pipeline.

Richter Scale: A logarithmic scale used to express the total amount of energy released by an earthquake. The scale has 10 divisions, from 1 (not felt by humans) to 10 (nearly total destruction).

riparian: Relating to, living in, or located on the bank of a river, lake, or tidewater.

riprap: Material, usually large, blocky stones, placed to stabilize and prevent erosion along a riverbank or shoreline.

riverine: Relating to or formed by a river.

rookery: A breeding or nesting place for some gregarious mammals and birds.

runoff: Water on land (usually from precipitation) that runs off to a body of water.

Safe Drinking Water Act: See Chapter 9.

salinity: A measurement of the amount of dissolved salts in water.

sandstone: *Sedimentary* rock containing mostly sand-sized *clastic* materials.

sanitary (domestic) wastewater: Wastewater, including toilet, sink, shower and kitchen flows, originating from human domestic activities. It is collected from residences, commercial buildings, institutions, or similar structures.

schist: A crystalline metamorphic rock that can be readily split into thin flakes or slabs.

scientific notation: For example, 4,900 = 4.9×10^3 = 4.9E+03, or 0.049 = 4.9×10^{-2} = 4.9E-02.

scour: Erosion that occurs underwater, as in the case of a streambed.

scrub-shrub: Woody vegetation less than about 20 feet tall. Species include true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions.

secondary wastewater treatment: Biological removal of organics and solids from wastewater.

sedges: Perennial nonwoody plants (genus Carex) common to most fresh water *wetlands*; they resemble grasses.

sediment: Materials that sink to the bottom of a body of water or materials that are deposited by wind, water, or *glaciers*.

sedimentary rock: Rock formed at or near the earth's surface from the consolidation of loose sediment that has accumulated in layers through deposition by water, wind, or ice, or deposited by organisms. Examples are *sandstone* and limestone.

sedimentation: The removal, transport, and deposition of *sediment* particles by wind or water.

seismic: Pertaining to any earth vibration, especially that of an earthquake.

semidiurnal tides: Tides having cycles of approximately 12 hours. The predominant type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day.

sensitive species: A plant or animal species listed by the state or federal government as *threatened*, *endangered*, or as a *species of special concern*.

sewage: The water-carried human or animal wastes from residences, buildings, industrial establishments, or other places, together with groundwater infiltration and surface water that may be present.

shallow sills: A bedrock ridge at a shallow depth near the mouth of a *fjord*. It separates the deep water of the fjord from the deep ocean water.

sheen: A very thin layer of oil (less than 0.0001 inch thick) floating on the water surface. Depending on thickness, sheen ranges in color from dull brown for the thickest sheens to rainbows, grays, silvers, and near-transparency for the thinnest sheens.

shrub wetlands: Wetlands, including shrub swamps and bogs, that are represented by medium-height (less than 20 feet tall) woody plants.

silt: A *sedimentary* material consisting of fine mineral particles intermediate in size between sand and *clay*.

siltation: The deposition or accumulation of *silt*.

skimmers: Devices used to remove oil from the water's surface.

slackline conditions: A pipeline flow condition in which the oil stream does not completely fill the pipe cross-section. (See *packline*.)

slick: Oil spilled on the water, which absorbs energy and dampens out surface waves, making the oil appear smoother – or slicker – than the surrounding water.

slope factor: An upper-bound estimate of a chemical's probability of causing cancer over a 70-year lifetime.

slopewash: The action of water from rain or melted snow carrying (washing) soil down a slope.

slough: A swamp, *marsh*, or muddy backwater.

sludge: The residue (solids and some water) produced as a result of raw or wastewater treatment. Also, oil residues normally found at the bottom of oil tanks.

slumps: A generic term for various types of landslides.

small quantity generator: A waste generator who generates less than 1,000 kilograms (2,200 pounds) of hazardous material in a calendar month.

smolt: The stage in life of salmon and similar fishes in which the subadult individuals migrate down the river to begin their adult lives in the open sea.

soil: The unconsolidated material on the surface of the earth that serves as a natural medium for the growth of land plants.

solid waste: All unwanted, abandoned, or discarded solid or semisolid material whether or not subject to decomposition, originating from any source.

solifluction: The slow creeping of fragmented material such as soil down a slope caused by a combination of *frost creep* and downslope movement of wet, unfrozen soil.

sorbents: Substances that take up and hold water or oil.

spawning: In aquatic organisms, the act of producing eggs.

special waste: Waste (not hazardous) that requires special handling considerations during disposal.

species: A group of organisms formally recognized as distinct from other groups. Members of a species are genetically similar and normally mate only with other members of the same species.

species of special concern: Any species or subspecies of fish or wildlife or population of mammal or bird native to an area that has entered a long-term decline in abundance or is vulnerable to significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

spit: A sandy bar built out from the land into a body of water.

spur dikes: Elongated structures having one end on the bank of a stream and the other end projecting perpendicularly into the current, used to protect eroding stream banks.

squalene: An oil (hydrocarbon) that was traditionally obtained from shark liver.

squall: A sudden, intense wind storm of short duration, often accompanied by rain.

staging area: A traditional area, usually a lake, where birds that migrate in flocks rest and feed either immediately before or during migration. Many flocks may use the same staging area.

strangmoor ridges: Alternating ridges and hollows oriented perpendicular to water flow.

State Historic Preservation Officer (SHPO): The State officer charged with the identification and protection of prehistoric and historic resources in accordance with the *National Historic Preservation Act*.

static volume (related to spills): The amount of oil spilled from a break in a pipeline because of hydraulic heads established at elevations higher than the break location.

streamers: A narrow line of oil, *mousse*, or *sheen* on the water surface, surrounded on both sides by clean water. Streamers result from the combined effects of wind, currents, and/or natural convergence zones. Streamers are also called “fingers” or “ribbons.”

subalpine: The zone just below the treeline on temperate mountains, usually dominated by a *coniferous* forest ecologically similar to *boreal* forest. The elevation of this zone increases as latitude decreases.

subsidence: The process of sinking or settling of a land surface because of natural or artificial causes.

subsistence: The noncommercial acquisition of naturally occurring renewable resources harvested for traditional and customary uses. Subsistence activities can involve hunting, fishing, trapping, and collecting.

subtidal: The *benthic* ocean environment below low tide that is always covered by water.

succession: See ecological succession.

sulfur dioxide (SO_2): A compound of sulfur produced by the burning of sulfur-containing compounds and considered to be a major air pollutant. Sulfur dioxide is one of six *criteria air pollutants* specified under Title I of the *Clean Air Act*.

suprapermafrost water: Free water in the ground above the *permafrost*.

surface water: Water on the earth’s surface that is directly exposed to the atmosphere, as distinguished from water in the ground (groundwater).

surfactant: A substance, such as a detergent, wetting agent, or emulsifier, that breaks oil into small droplets by reducing surface tension among liquids and solids.

taiga: A subarctic, evergreen *coniferous* forest located just south of the *tundra* and dominated by firs and spruces. It is sometimes referred to as a *boreal forest*.

taliks: Unfrozen zones that occur beneath lakes and rivers that are either underlain by *permafrost* at depth or completely open to subpermafrost groundwater.

talus: Accumulation of rock debris at the base of cliffs.

tanker: A ship designed to carry liquid cargo in bulk. The cargo space consists of many tanks.

tarballs: Weathered oil that has formed pliable balls or patches that float on the water. Tarballs range in diameter from a few millimeters to a foot.

teratogen: Any substance that causes growth abnormalities in embryos, genetic modifications in cells, etc.

terrestrial: Living or growing on land rather than in water or air.

Tertiary Period: The first period of the *Cenozoic Era*, from 1.8 to 65 million years ago. It was marked by formation of high mountains and the dominance of mammals on land.

thaw bulb: In permafrost, an area of thawed ground below a building, pipeline, river, or other heat source.

thermokarst: A landscape characterized by shallow pits and depressions caused by selective thawing of *ground ice* or *permafrost*.

thermokarst lake: A lake formed in a depression by the thawing of *ground ice* in soil above *permafrost.*

threatened species: Any species that is likely to become an *endangered* species within the foreseeable future throughout all or a significant portion of its range. Requirements for declaring a species threatened are contained in the *Endangered Species Act*.

throughput: The amount of material that can be handled or processed by a facility in specified period of time.

tide rips: A heavy boil on the sea surface often accompanied by breaking waves. Rips are produced by strong tidal currents over irregular sea bottoms.

till: Unstratified *glacial* material deposited directly by the ice and consisting of *clay*, sand, gravel, and boulders.

topography: The shape of the earth's surface. The relative position and elevations of natural and human-made features of an area.

topping unit: A mini-refinery that draws crude oil from a pipeline and produces turbine fuel to power a pump station.

total suspended solids (TSS): A measure of the suspended solids in *wastewater*, *effluent*, or water bodies, determined by tests for total suspended nonfilterable solids. Suspended solids are particles of soil, *sediment*, living material, or dead organisms suspended in water.

toxic equivalency factor: A numerical index that is used to compare the toxicity of different *congeners* and substances.

toxicity: The ability of a substance to cause damage to cells or tissues of living organisms when the substance is inhaled, *ingested*, or absorbed by the skin.

Trans-Alaska Pipeline Authorization Act: See Chapter 9.

transient volume balance: A leak-detection system that compares reported flow with calculated flow and can identify the probable location of a leak by pipeline section.

treeline: The upper limits of tree growth in mountains or at high latitudes.

Triassic Period: The first period of the *Mesozoic Era*, dating from approximately 210 to 246 million years ago.

trilobites: Ancient marine arthropods, abundant in the Early and Middle *Paleozoic Era*, but extinct since the *Permian Period.* They had three lobes running the length of the body and ranged in size from a few millimeters to about 90 centimeters.

trophic level: Describes the residence of nutrients in various organisms along a food chain ranging from the plants to the predatory carnivorous animals.

tsunami: A large, destructive wave caused by seafloor movements in an earthquake.

tundra: A level or rolling treeless plain in the arctic or subarctic regions. The soil is black and mucky, the subsoil is permanently frozen, and the vegetation is dominated by mosses, *lichen*, herbs, and dwarf shrubs.

turbidity: A measure of the cloudiness or opaqueness of water. Typically, the higher the concentration of suspended material, the greater the turbidity.

tussock: A compact tuft of grass or *sedges*, or an area of raised solid ground that is held together by roots of low vegetation. Tussocks are found in *wetlands* or *tundra*.

ungulate: Any four-footed, hoofed, grazing mammal (e.g., cattle, pigs, camels, horses, and elephants).

vagrants (species): Individuals of a species that move, by natural means, from one geographical region to another outside their usual range, or away from usual migratory routes, without establishing a new population in the region.

viscosity: A measure of the resistance to flow, or internal friction, of a fluid. Material with higher viscosity is more resistant to flow.

visual resource management (VRM) classification system: A process devised by the *Bureau of Land Management* to assess the aesthetic quality of a landscape and to design proposed activities in a way that would minimize their visual impact on that landscape. The process consists of a rating of site's visual quality followed by a measurement of the degree of contrast between the proposed development activities and the existing landscape.

visual resources: The composite of basic terrain, geologic features, hydrologic features, vegetative patterns, and land use effects that typify a land unit and influence the visual appeal that the unit may have.

volatile: Evaporating readily at normal temperature and pressures.

volatile organic compounds (VOCs): A broad range of *organic compounds* that readily evaporate at normal temperatures and pressures. Examples include certain solvents, paint thinners, degreasers (benzene), chloroform, and methyl alcohol. Such compounds can react with other substances, principally nitrogen oxides, to form *ozone*. They contribute significantly to photochemical smog production and certain health problems.

waste stream: A waste or group of wastes from a process or a facility with similar physical, chemical, or radiological properties.

watershed: An area from which water drains to a particular body of water. Watersheds range in size from a few acres to large areas of the country.

watt: A measurement of power, commonly used to define the rate of electricity consumption of an appliance.

weathering (of oil): A combination of physical and environmental processes, such as evaporation, dissolution, *dispersion,* and *emulsification*, that act on spilled oil to change its physical properties and composition.

wetlands: Areas that are soaked or flooded by surface or groundwater frequently enough or long enough to support plants, birds, animals, and aquatic life. Wetlands generally include swamps, *marshes*, *bogs*, *estuaries*, and other inland and coastal areas, and are federally protected.

Wild and Scenic Rivers Act: See Chapter 9.

Wilderness Act of 1964: See Chapter 9.

wind rose: A circular diagram showing, for a specific location, the percentage of time the wind is from each compass direction. A wind rose for use in assessing consequences of airborne releases also shows the frequency of different wind speeds for each compass direction.

year-class: Fish of a given species spawned or hatched in a given year.

zooplankton: Small, often microscopic, animals that drift in currents.

9. Glossary of Laws, Executive Orders, and Regulations Cited in This DEIS

The laws, executive orders, and regulations listed and described below are only those referenced in the text of this document. The descriptions are very brief explanations of what are often very complicated laws and regulations; readers wishing more information are directed to the source included in the description.

9.1 Federal Laws

Alaska National Interest Lands Conservation Act (16 USC §3101 et seq.) established more than 100 million acres of federal land in Alaska as conservation system units to preserve the land and associated resources for the national interest. The law also established a subsistence preference for rural Alaskans.

Alaska Native Allotment Act of 1906 (formerly 43 USC §270-1 to §270-3) provided for an allotment of up to 160-acre homesteads on nonmineral land to Eskimos or Alaska Indians of full or mixed blood, 21 years old, and heads of families. The Act was repealed by Section 18 of the Alaska Native Claims Settlement Act.

Alaska Native Claims Settlement Act (43 USC §1601 et seq.) was passed in 1971 to settle multiple Alaska Native land use claims by extinguishing all prior aboriginal land claims. The Act established 12 regional corporations, provided $962,500,000 in cash, and conveyed 44 million acres to the corporations.

Alaska Statehood Act of 1958 (48 USC note preceding Chapter 21) admitted Alaska to the United States as the 49th state.

American Indian Religious Freedom Act (42 USC §1996 et seq.) requires federal agencies to consult with Tribal officials to ensure protection of religious cultural rights and practices.

Antiquities Act (16 USC §431 et seq.) prohibits excavating, injuring, or destroying any historic or prehistoric ruin or monument or object of antiquity on federal lands without the prior approval of the agency with jurisdiction over the land.

Archeological Resources Protection Act (16 USC §470(aa) et seq.) requires a permit for excavation or removal of archeological resources from public or Native American lands.

Bald and Golden Eagle Protection Act (16 USC §668 et seq.) makes it unlawful to take, pursue, molest, or disturb bald and golden eagles, their nests, or their eggs. Permits must be obtained from the U.S. Department of the Interior in order to relocate nests that interfere with resource development or recovery.

Clean Air Act (42 USC §7401 et seq.) establishes national ambient air quality standards (NAAQS) and requires facility compliance with emission limits or reduction limits stipulated in state implementation plans (SIPs). The law requires construction and operating permits, as well as reviews of new stationary sources and major modifications to existing sources. It also prohibits the federal government from approving actions that do not conform to SIPs.

Clean Water Act (33 USC §1251 et seq.) requires National Pollutant Discharge Elimination System (NPDES) permits for discharges of effluents to surface waters, permits for storm-water discharges related to industrial activity, and notification of oil discharges to navigable waters of the United States. The State of Alaska certifies NPDES permits issued by the federal government.

Coastal Zone Management Act (16 USC §1451 et seq.) encourages states to develop management plans for the water and land of their coastal zones. Plans must identify the

boundaries of the area covered by the plan and permissible land and water uses.

Emergency Planning and Community Right-To-Know Act (42 USC §11001 et seq.) requires emergency planning, emergency release notification, hazardous chemical inventory reporting, and toxic chemical release inventory reporting by facilities, depending on the chemicals stored or used and their amounts.

Endangered Species Act (16 USC §1531 et seq.) requires consultation with the U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service to determine if endangered or threatened species or their habitats will be impacted by a proposed activity and what, if any, mitigation measures are needed to address the impacts.

Federal Advisory Committee Act (5 USC App1) outlines the appointment, recordkeeping, and meeting procedures applicable to committees established to provide advice to the federal government.

Federal Cave Resources Protection Act (16 USC §4301 et seq.) allows the collection and removal of resources from federal caves only with a permit authorized by the Secretary of Agriculture or the Secretary of the Interior.

Federal Land Policy and Management Act (43 USC §1701 et seq.) requires the Secretary of the Interior to issue regulations to manage public lands and the property located thereon for the long term.

Indian Reorganization Act of 1934 (25 USC §461 et seq.) authorized Indian tribes to organize, adopt constitutions and bylaws, and request charters of incorporation if desired, and it banned dividing reservation lands into private allotments.

Jones Act of 1920 (Merchant Marine Act of 1920) (46 USC §861 et seq.) requires that vessels used to transport cargo and passengers between U.S. ports be owned by U.S. citizens, built in U.S. shipyards, and manned by U.S. citizen crews.

Magnuson-Stevens Fishery Conservation and Management Act (16 USC §1801 et seq.) establishes regional fishery management councils to develop fishery management plans describing the conservation and management measures necessary to protect, restore, and promote the long-term health and stability of fisheries.

Marine Mammal Protection Act (16 USC §1361 et seq.) protects marine mammals through regulating takings of them.

Migratory Bird Treaty Act (16 USC §703) requires consultation with the U.S. Fish and Wildlife Service to determine the effects of a proposed activity on migratory birds and consider opportunities to minimize their effects. The list of migratory birds protected by the Act is found at 50 CFR 10.13.

Mineral Leasing Act (30 USC §185(h)(2)) allows the Secretary of the Interior to grant a right-of-way on federal land, such as that issued for the TAPS. A right-of-way is an authorization to use specific parcels of public land for specific facilities or operations for periods up to 30 years.

National Environmental Policy Act (42 USC §4321 et seq.) requires federal agencies to prepare a detailed statement on the environmental impacts of their proposed major actions significantly affecting the quality of the human environment.

National Historic Preservation Act (16 USC §470(a) et seq.) requires federal agencies to take into account the effects of their actions on historical and archaeological resources and consider opportunities to minimize their impacts.

Native American Graves Protection and Repatriation Act (25 USC §3001) establishes the priority for ownership or control of Native American cultural items excavated or discovered on federal or Tribal land after 1990 and the procedures for repatriation of items in federal possession. The act allows the intentional removal from or excavation of Native American cultural items from federal or Tribal lands only with a permit or upon consultation with the appropriate tribe.

Noise Control Act as Amended by the Quiet Communities Act (42 USC §4901 et seq.) requires that the noise levels of facilities or operations do not jeopardize public health and safety. States are authorized to establish their own noise levels.

Oil Pollution Act (33 USC §2701 et seq.) requires double-hulled vessels by 2014 and development of Area Contingency Plans to be implemented in conjunction with the National Contingency Plan described at 40 CFR 300.

Pollution Prevention Act of 1990 (42 USC §13101 et seq.) establishes a hierarchy of responses to waste to reduce pollution in the following descending order: source reduction, recycling, treatment, and disposal.

Resource Conservation and Recovery Act (42 USC §6901 et seq.) regulates the storage, treatment, and disposal of hazardous and nonhazardous wastes.

Safe Drinking Water Act (42 USC §300 et seq.) authorizes development of maximum contaminant levels for drinking water applicable to public water systems (i.e., systems that serve at least 25 people or have at least 15 connections).

Trans-Alaska Pipeline Authorization Act (43 USC §1651 et seq.) authorized the Secretary of the Interior to expedite the issuance of a Mineral Leasing Act grant of right-of-way on federal land for the TAPS. It provided broad oversight authority over the TAPS to the U.S. Department of the Interior.

Wild and Scenic Rivers Act (16 USC §1271 et seq.) allows rivers and their adjacent land areas to be designated as Wild, Scenic, or Recreational Areas. Water resource projects above or below a designated river can be approved if they will not invade the area or unreasonably diminish the values present in the area.

Wilderness Act of 1964 (16 USC §1131 et seq.) authorizes the U.S. Congress to designate federally owned areas as Wilderness Areas and defines the criteria for determining if an area qualifies as a Wilderness Area.

9.2 Executive Orders

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, requires federal agencies to identify and address, as appropriate, any disproportionately high and adverse human health or environmental effects of its actions on minority and low-income populations.

Executive Order 13007, Native American Religious Practices, requires federal agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and avoid adversely affecting the physical integrity of the sites to the extent practicable, allowed by law, and consistent with agency functions.

Executive Order 13175, Consultation and Coordination with Indian Tribal Governments, requires federal agencies to consult with Tribal officials in the development of policies with Tribal implications.

Executive Order 13211, Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use, requires federal agencies to prepare a Statement of Energy Effects for any significant energy action to present information on any adverse effects on the energy supply of the action.

9.3 Federal Regulations

40 CFR 50, National Primary and Secondary Ambient Air Quality Standards, establishes the primary standards that define the level of air quality judged necessary, with an adequate margin of safety, to protect the public health and the secondary standards that define levels of air quality judged necessary to protect the public welfare from known or anticipated adverse effects of a pollutant.

40 CFR 52.21, Prevention of Significant Deterioration of Air Quality, defines terms and establishes conditions for state implementation plans (SIPs) for the prevention of significant deterioration

(PSD) of air quality in portions of states where the existing air quality is better than the national ambient air quality standards.

40 CFR 60, Subpart E, Standards of Performance for Incinerators, establishes, for incinerators of more than 45 metric tons per day charging rate, standards for particulate matter, and the test method and procedures to determine compliance.

***40 CFR 81.402*, Alaska,** lists the areas in Alaska identified as mandatory Class I federal areas where visibility is an important value (Bering Sea Wilderness, Simeonof Wilderness, Tuxedni Wilderness, and Mt. McKinley National Park).

40 CFR 82 Subpart A, Protection of Stratospheric Ozone, implements the Montreal Protocol on Substances That Deplete the Ozone Layer and Clean Air Act provisions limiting the production and consumption of certain ozone-depleting substances according to listed schedules.

40 CFR 82 Subpart G, Significant New Alternatives Policy Program, establishes the acceptable and unacceptable substitutes for banned ozone-depleting substances.

40 CFR 122.26(b)(14)(ii), Stormwater Discharges Associated with Industrial Activity, defines conditions under which National Pollutant Discharge Elimination System (NPDES) permits are required.

40 CFR 144.6, Classification of Wells, lists and describes the five classes of injection wells authorized by the Safe Drinking Water Act.

40 CFR 145, State UIC Program Requirements, specifies the procedures that the U.S. Environmental Protection Agency will use in approving, revising, and withdrawing approval from states requesting or already having authority to operate their own underground injection control program.

40 CFR 261.3, Definition of Hazardous Waste, describes the bases for declaring a solid waste a hazardous waste.

40 CFR 261.4(b)(5), Solids Which Are Not Hazardous Wastes, excludes drilling fluids, produced waters, and other wastes associated with exploration, development, or production of crude oil, natural gas, or geothermal energy from being managed as hazardous waste.

40 CFR 261.5, Special Requirements for Hazardous Waste Generated by Conditionally Exempt Small Quantity Generators, describes requirements applicable when no more than 100 kg of hazardous waste is generated in a calendar month.

40 CFR 261.24(a), Toxicity Characteristic, defines the required test method to determine if a solid waste exhibits the toxicity characteristic and is therefore subject to the Resource Conservation and Recovery Act.

***40 CFR 262.34, Accumulation Time*, Subsections (a) and (b),** describe the conditions and timing under which hazardous wastes can be accumulated without subjecting the waste generator to the permit requirements of the Resource Conservation and Recovery Act.

40 CFR 300, National Oil and Hazardous Substances Pollution Contingency Plan, describes the notification requirements for oil discharge or hazardous substance releases and the response procedures that must be followed.

***40 CFR 370.2* (no title)** describes the terms used in regulation 40 CFR 370, Hazardous Chemical Reporting: Community Right-to-Know.

40 CFR 761.3(1), Small Capacitor, defines a capacitor as small if it contains less than 1.36 kg (3 lb) of dielectric fluid.

40 CFR 1508.7, Cumulative Impact, describes cumulative impact as the environmental impact resulting from incremental impacts of the action when added to other actions.

40 CFR 1508.25, Scope, requires that agencies preparing environmental impact statements under the National Environmental Policy Act take into account connected actions, cumulative actions, and similar actions; alternatives; and mitigation measures.

43 CFR 2881.1-1(f) (no heading) describes the conditions under which a right-of-way will be renewed and establishes the authority for modifying its terms and conditions.

49 CFR 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Standards, describes the following required features related to gas pipelines: material, pipe design, pipeline design components, welding, construction, corrosion control, testing, operations, maintenance, uprating, and pipeline personnel qualifications.

49 CFR 195.2, Definitions, defines breakout tanks by describing their use to either relieve surges in hazardous liquid pipeline systems or receive and store hazardous liquid transported by pipeline for subsequent reinjection and continued transportation.

9.4 State Laws

AS 16, Fish and Game, establishes state authority for fish and game management.

AS 16.05.789, Prohibition on Hunting Adjacent to Highway between Yukon River and Arctic Ocean, prohibits hunting with firearms north of the Yukon River in the area within 5 miles on either side of the highway between the Yukon River and the Arctic Ocean.

AS 16.05.840, Fishways Required, requires fishways, if necessary, for dams or obstructions of streams frequented by salmon or other fish.

AS 16.05.870, Protection of Fish and Game, authorizes the identification of the rivers, lakes, and streams important for spawning, rearing, or migration of anadromous fish and an approval process for activities that could affect them.

AS 16.05.940, Definitions, **Subsection (32),** defines subsistence uses as "the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural area of the state for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of nonedible by-products of fish and wildlife resources taken for personal or family consumption, and for the customary trade, barter, or sharing for personal or family consumption; in this paragraph, 'family' means persons related by blood, marriage, or adoption, and a person living in the household on a permanent basis."

AS 19.40.210, Prohibition of Off-Road Vehicles, prohibits off-road vehicles on land within 5 miles of the right-of-way of the Dalton Highway, with several exceptions.

AS 38.35, Right-of-Way Leasing Act, reserves to the State of Alaska right-of-way leasing of state land for pipeline construction, transmission, or operation within its boundaries. Subsection 38.35.100 describes the criteria for the State to make a decision on a right-of-way application.

AS 41.35, Alaska Historic Preservation Act, reserves to the State title to all historic, prehistoric, and archeological resources on land owned or controlled by the State. The Act requires permits for investigation, excavation, or removal of historic, prehistoric, or archeological resources of the State.

AS 46.40, Alaska Coastal Management Act, requires coastal resource districts to develop coastal management programs.

9.5 State Regulations

5 AAC 93.020, Endangered Species, lists the following as endangered species in Alaska: Eskimo curlew, short-tailed albatross, humpback whale, right whale, and blue whale.

5 AAC 95.010, Waters Important to Anadromous Fish, adopts, by reference, the *Catalog of Waters Important for Spawning, Rearing or Migration of Anadromous Fishes* and the *Atlas to the Catalog* to identify the rivers, lakes, and streams, or parts of them, that are important for the spawning, rearing, or migration of anadromous fish.

18 AAC 50.010, Ambient Air Quality Standards, establishes the State's standards for concentrations of contaminants in ambient air for PM_{10} (particulate matter), sulfur dioxide, carbon monoxide, ozone, nitrogen dioxide, lead, and ammonia.

18 AAC 50.020, Baseline Dates, Maximum Allowable Increases, and Maximum Allowable Ambient Concentrations, establishes standards for the prevention of significant deterioration (PSD) of air quality.

18 AAC 50.725 to 50.735, General Conformity: Incorporation by Reference of Federal Regulations, incorporates the federal conformity regulations at 40 CFR 51.850 to 51.859 into State of Alaska regulations and requires reporting of any mitigation measures intended to offset air quality impacts of federal actions.

18 AAC 60.300, Purpose, Scope, and Applicability; Classes of MSWLF, establishes the minimum standards for owners and operators of municipal solid waste landfills (MSWLFs); the MSWLF classes are described in 18 AAC 60.300(c).

18 AAC 70, State of Alaska Water Quality Standards, species the degree of degradation that may not be exceeded in a water body as a result of human actions by establishing an antidegradation policy, water quality criteria, protected water use classes and subclasses, and protocols for granting variances and establishing site-specific criteria.

18 AAC Chapter 75, Oil and Other Hazardous Substance Pollution Control, describes requirements related to oil pollution prevention, financial responsibility for discharges, discharge reporting and cleanup, oil discharge prevention and contingency plans, and civil penalties for petroleum dischargers. 18 AAC 75.341 describes soil cleanup levels for different soil types, geographic zones, and contaminants; 18 AAC 75.445(k) stipulates the criteria for determining if the oil discharge and contingency plan relies on the best available technology.

18 AAC 78, Underground Storage Tanks, establishes requirements for underground storage tanks, corrective actions for leaking tanks, and cleanup standards.

18 AAC 80, State of Alaska Drinking Water Standards, establishes minimum separation distances between drinking water sources and potential sources of contamination, classifications for public water systems, maximum contaminant levels (MCLs), sampling requirements, and public notice requirements for violations of MCLs, treatment techniques, variances, and exemptions.