4.2 Existing Mitigation Measures

Measures to mitigate the impacts of TAPS were incorporated in the original design and in the operational procedures for the pipeline system. These measures include design features; a trained, experienced operating staff; and organized surveillance, monitoring, preparedness, and contingency response programs.

Furthermore, TAPS has been subject to oversight and regulation by the U.S. Congress, the State of Alaska, state and federal regulatory agencies, and the public since construction was proposed in early 1969. Regulation and oversight of TAPS began with creation of the Federal Division of Pipeline in 1971 to oversee construction of TAPS.

The 1974 Federal Grant and State Lease contain environmental and technical stipulations to mitigate impacts of both construction and operation of TAPS (see Appendix F for a copy of the Federal Grant. State Lease stipulations are essentially the same as the federal ones, and all references to stipulations below are to the Federal Grant.) Since these stipulations are part of the original agreement, they will continue to provide mitigation during the renewal period.

The Federal Grant named an Authorized Officer in the Department of Interior to oversee construction and operation of the pipeline on federal lands. In 1974, the State Pipeline Coordinator's Office (SPCO) was also established to ensure best available environmental and engineering practices were applied to the design and construction of TAPS on state land. From 1974 to 1979, the federal Authorized Officer was supported by the Alaska Pipeline Office (APO), which consisted of personnel from several federal agencies and from consultants. In October 1979, the APO was reorganized as the Office of Special Projects in BLM. The SPCO was disbanded and reconstituted several times between the end of construction and 1990. After the *Exxon Valdez* spill, both state and federal agencies were joined to form the Federal/State Joint Pipeline Office (JPO) in 1990. The JPO now includes the following agencies:

State of Alaska Agencies:

- Department of Natural Resources
- Department of Environmental Conservation
- Department of Fish and Game
- Department of Labor
- Division of Governmental Coordination
- Department of Transportation/Public Facilities

Federal Agencies:

- Bureau of Land Management
- Department of Transportation/Office of Pipeline Safety
- Environmental Protection Agency
- U.S. Coast Guard
- U.S. Army Corps of Engineers

The BLM and the Alaska Department of Natural Resources jointly manage the JPO, which is charged with overseeing pipeline operations to ensure compliance with the Federal Grant and State Lease and with applicable laws and regulations. Agency representatives conduct unannounced inspections of facilities, review permit applications, and oversee every aspect of TAPS operations.

Alyeska has programs and procedures in place to comply with the stipulations and other applicable requirements, including laws, agreements, codes, standards, and regulations. These systems monitor and maintain TAPS, provide for feedback and analysis, and document environmental threats requiring mitigation. This process guides maintenance and repair of TAPS and helps to reduce environmental impact.

Numerous changes to the pipeline system have been made in response to information gained from over 20 years of operation. Existing mitigation measures discussed here include the most important of those changes, as well as original measures that are still used.

Separate from mandated mitigation measures, technological progress often facilitates implementation of measures that can reduce impacts. For TAPS, examples of such advancements are the development of more advanced ultrasonic "pigs" to measure pipeline corrosion more accurately, the availability of more exact data analysis, and improved cathodic protection systems (APSC, 1997b). For ANS development, technological advances have included closer wellhead spacing, reduction in area of gravel pads, construction from ice roads and pads, etc. (It is possible that not all new technological advances can be incorporated into all new developments because of technical, environmental, or economic considerations.)

The following discussion of mitigation measures assumes that the TAPS design functions as intended and the TAPS operations and maintenance follow the procedures and programs outlined. Where appropriate, known problems are discussed.

This section is divided into three main subsections:

- Design features,
- Operational programs and procedures, and
- Spill contingency planning.

4.2.1 Design Features

Designing and constructing a warm-oil pipeline in arctic and subarctic environments requires special design features to mitigate the effect of heat transfer to the environment. Seismically active zones in the southern part of the pipeline route require special designs to mitigate risk from earthquake damage. Environmentally sensitive stream crossings coupled with sparse flood records create special design challenges. Crude vapor control designs are required to mitigate the effect of tanker loading operations on air quality. Treatment of tanker ballast water mitigates the effect of discharge on water quality in Port Valdez. TAPS is designed to detect leaks and to minimize the amount of oil that could be released in the event of a pipeline spill.

Most design features that mitigate the effects of TAPS on the environment were required by special stipulations in the Federal Grant and State Lease. The following sections describe some of the major design features with emphasis on environmental mitigation.

4.2.1.1 Special Foundation Designs for Permafrost Soils

By R. Dugan

Construction and operation of a buried warm-oil pipeline tend to induce thaw in permafrost soils. The strengths of different soil types vary widely in response to thawing. Granular soils with little excess ice are considered "thaw-stable" because they do not lose significant volume or strength when thawed. Fine-grained, ice-rich permafrost, however, may undergo a large volume decrease upon thaw and have a very low shear strength during and after thaw. Subsidence of the ground surface, downslope movement of the thawed mass, and susceptibility to liquefaction can result. These soils are considered "thaw-unstable."

Warm oil flowing in a buried pipeline results in thawing of permafrost and creation of a "thaw bulb" around the pipe Figure 4.2-1). The thaw bulb grows with time at a rate affected primarily by the temperature of the pipe, temperature and water content of the surrounding soils, and climate, but eventually stabilizes. Special designs were developed to deal with the problems imposed by the subsurface conditions and climate.

Stipulation 3.3.1 sets criteria governing which construction mode was used at any given location.

Conventional Buried Pipe

In areas where the ice content of the permafrost is very low or absent, or where no permafrost exists, the pipe is buried in a conventional below-ground mode (Figure 4.2-2). Three hundred seventy-six miles of TAPS pipe are buried in this manner.

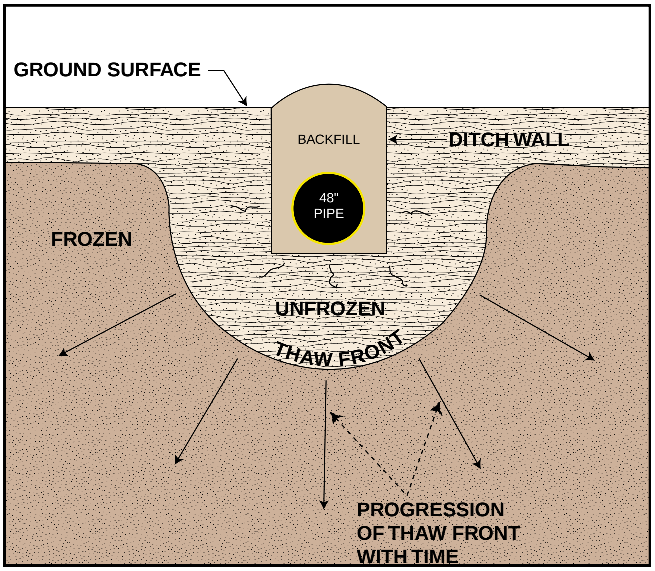


Figure 4.2-1. *Below-ground thaw bulb.*

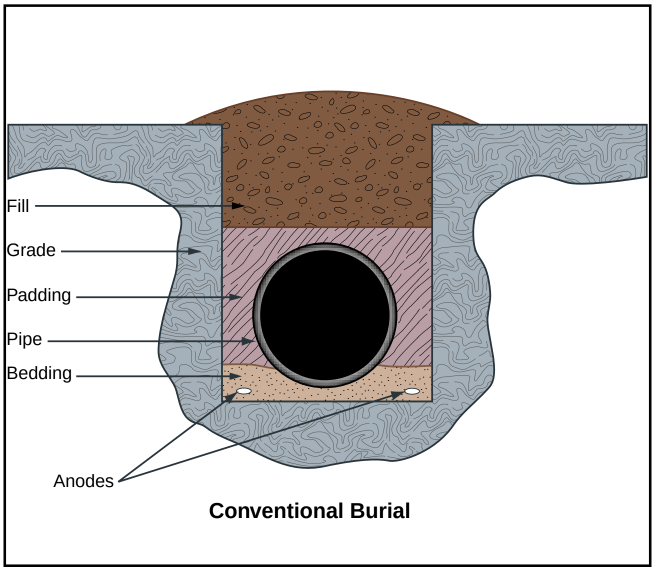


Figure 4.2-2. *Typical pipeline details for conventional burial.*

Buried Animal Crossings

Buried-pipe animal crossings are provided where there are long sections of above-ground pipe to ensure free passage of big game animals (Stipulation 2.5.4.1). The animal crossings typically consist of about 50 feet of level buried pipe in thaw-unstable soils. The buried pipe has an insulated jacket and is installed in an insulation-lined trench.

Special Burial

At three locations, sections of the pipeline are buried in a “special burial” (refrigerated) mode for a total of about 4 miles. This mode involves insulation and active refrigeration of the pipe in thaw-unstable permafrost. Refrigerated brine lines are installed under the pipe to keep the underlying ice-rich soils from thawing (Figure 4.2-3).

Insulated Box

In a few places, the pipe is installed in an insulated box at locations where the underlying soils are thaw-unstable (Figure 4.2-4). This mode is used primarily where avalanches would threaten the pipe if it were above-ground.

Conventional Elevated Pipe

In areas where soils are typically thaw-unstable and thus unfavorable for conventional burial, the pipe is elevated on crossbeams attached to vertical support members (VSMs) (Figure 2.1-1 in Section 2). The VSMs consist of 18-inch-diameter steel pipe embedded deep enough to support the loading and to resist frost heave. Several types of VSMs are used, each designed for special soil and loading conditions.

South of the Brooks Range, designers expected a high potential for thawing the permafrost around the VSMs, thus leading to potential instability. Movement of VSMs due to settling or jacking can cause the crossbeam to tilt or to move up or down at one support relative to adjacent supports (Figure 4.2-5). Either case may cause non-uniform loading of the pipeline. Tilting of VSMs due to settling or lateral earth pressures causes the crossbeam to move longitudinally so that the shoe may not be adequately supported by the crossbeam. To avoid this instability, many VSMs are equipped with thermal devices called *heat pipes* (or *thermo-siphons*), which use non-mechanical circulation of ammonia in a pressurized tube to remove heat from the soil during winter when the air is colder than the soil (Figure 4.2-6).

Other Facilities

Numerous other facilities associated with TAPS have foundations in permafrost. These include refrigeration plants, the fuel gas line, pump station facilities, storage

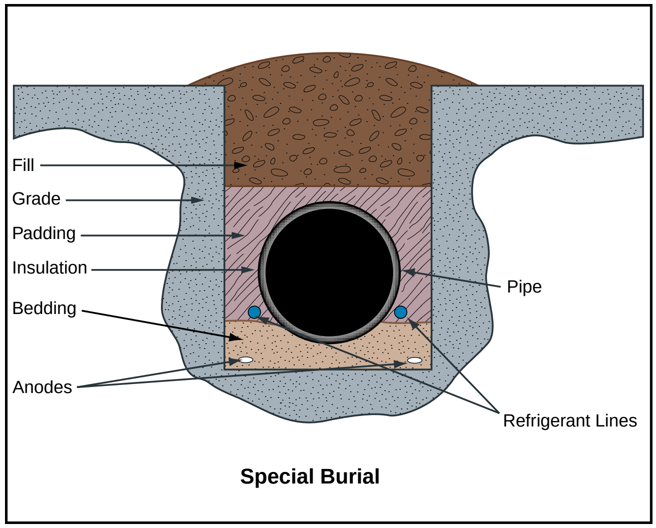


Figure 4.2-3. *Typical pipeline details for special burial.*

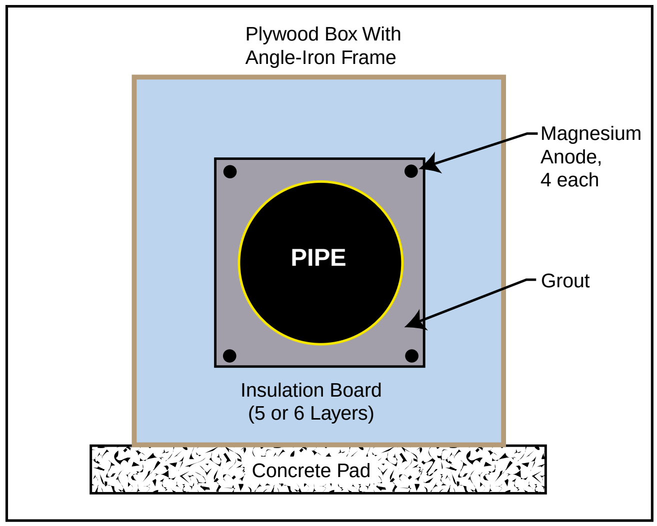


Figure 4.2-4. *Typical insulated box.*

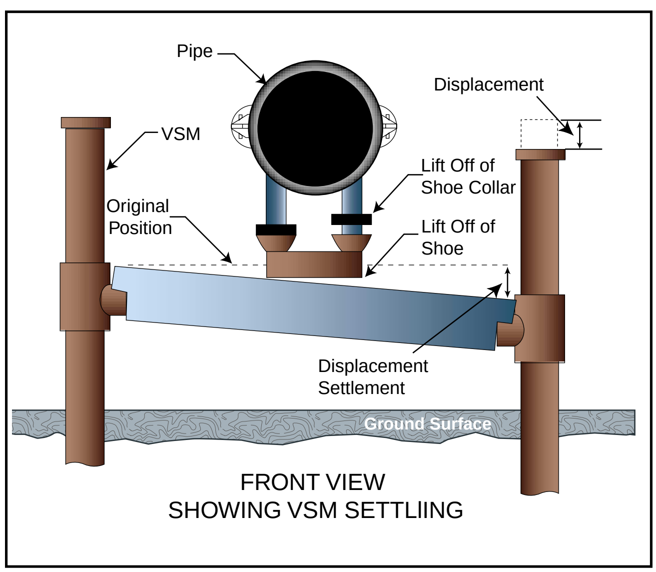


Figure 4.2-5. *Potential VSM movement (APSC, MS-31, 1995).*

buildings, communications sites, and others. Foundation designs for these structures include active and passive refrigeration in thaw-unstable soils and more conventional designs in thaw-stable soils (Stipulation 3.9.1).

The fuel gas line is buried in cold permafrost throughout its length, and the temperature of the gas is regulated to keep it below freezing. The line was constructed in winter from an ice road, and there is no workpad. A typical burial diagram is shown in Figure 4.2-7.

4.2.1.2 Design Features to Mitigate Earthquake Effects

By D. Nyman

Stipulation 3.4.1.1 of the Federal Grant sets criteria governing the design features to mitigate the effects of earthquakes and fault displacement. The stipulation divides TAPS route into five seismic zones (Figure 3.1-10) based on studies by the U.S. Geological Survey (USGS), with independent validation by engineering experts engaged for the pipeline project. A design earthquake magnitude (based on the Richter scale) has been established for each seismic zone. Design parameters (i.e., ground motions and design response spectra) also were established for each zone (APSC, 1973b).

Faulting that results in surface rupture is an important consideration for pipelines, because pipelines crossing fault zones must deform longitudinally and in bending to accommodate ground-surface offsets. A comprehensive fault study was conducted to identify and delineate active faults that cross the pipeline route (Cluff et al., 1974). The study involved a review of pertinent available data and technical literature, as well as extensive field investigations, including review of aerial photographs, low-sun-angle photography, and reconnaissance by fixed-wing aircraft and helicopters.

Three active faults that cross the pipeline alignment were identified: Denali (MP 589), McGinnis Glacier (MP 587), and Donnelly Dome (MP 558). The McGinnis Glacier and Denali fault crossings are located within 3 miles to the south of Pump Station 10. The Donnelly Dome fault crosses the pipeline where it passes east of Donnelly Dome, about 15 miles south of Pump Station 9 (Figure 3.1-10).

The main objective of TAPS seismic design is to prevent environmental damage and to provide life/safety protection from the effects of seismic activity. Other important objectives include minimizing capital loss and disruptions of pipeline operations. A 1995 review of the adequacy of the TAPS seismic criteria confirmed that the specified earthquake magnitude and design ground motions are adequate

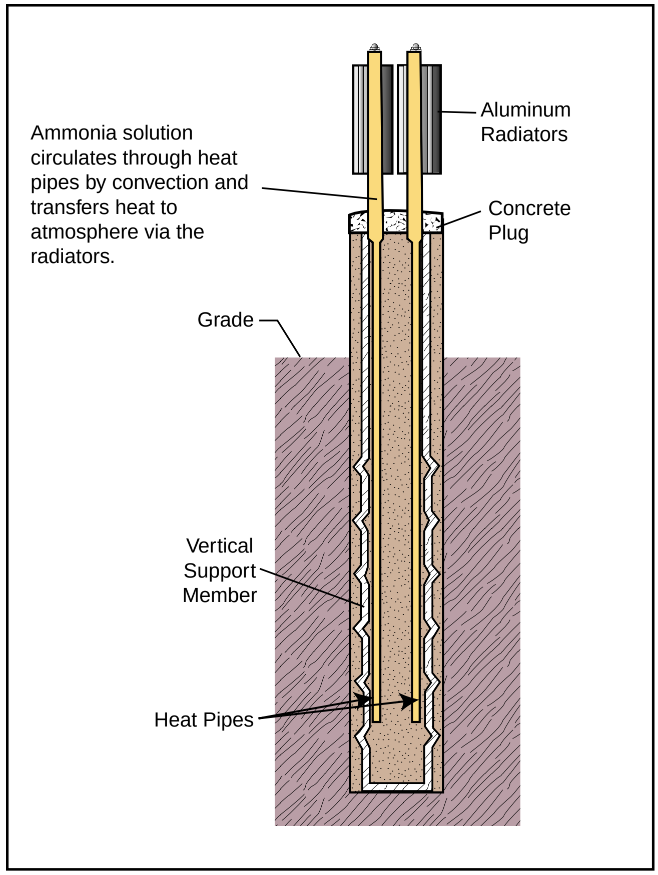


Figure 4.2-6. *Typical thermal VSM (APSC, MR-48, 1998).*

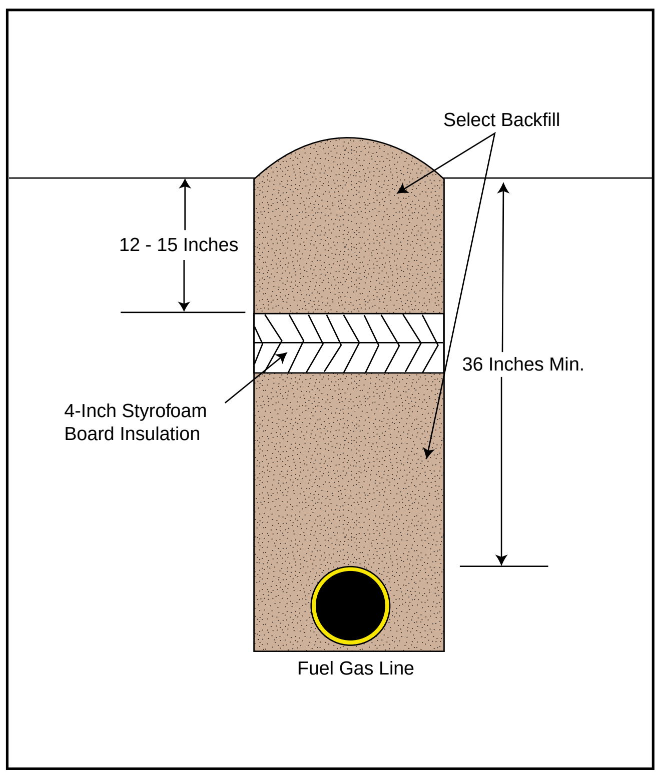


Figure 4.2-7. *Typical cross-section of fuel gas line (APSC, MS-31, 1994).*

in the most seismically active regions along the pipeline route — i.e., Valdez and in the Alaska Range — and are conservative for other areas along the route (Nyman et al., 1995). The analysis and design procedures originally used for TAPS remain consistent with current building codes and widely accepted practice in seismic engineering.

The seismic design of TAPS includes two levels of earthquake hazards: the *design contingency earthquakes* (DCE) and the *design operating earthquakes* (DOE). The DCE, which corresponds to the design earthquake magnitude specified in Stipulation 3.4.1.1 for the five seismic zones along the pipeline route, is a rare, intense earthquake with an estimated return period of several hundred years or more. The DOE is a lower-intensity earthquake that has ground motion amplitudes one-half those associated with a DCE and is more likely to occur during the design life of the pipeline than a DCE.

The philosophy underlying the original design of TAPS was that for the DCE, considerable inelastic behavior and limited damage would be expected, but that there should be no structural collapse, loss of function of essential facilities, or release of crude oil or hazardous substances. The amount of permissible damage varies according to the type of structure or component and its function. The functionality of essential control, communications, and emergency systems should be maintained without interruption during and after a DCE. In the event of a DOE, the pipeline and facilities should be capable of withstanding the prescribed seismic motions without damage, significant deformation, or interruption in operation.

The pipeline, pump stations, terminal facilities, remote gate valve facilities, and control and communication systems were originally designed to withstand the effects of earthquake ground-shaking and permanent ground deformation. In addition, the tanker loading berths at the VMT have been designed for estimated maximum tsunami wave and wave run-up conditions that can be expected at Jackson Point (Stipulation 3.7). Where possible, the pipeline was routed to avoid areas having significant potential for large ground displacement; otherwise, the pipeline was engineered to accommodate permanent ground movements without rupture. At the three fault crossings — Denali, McGinnis Glacier, and Donnelly Dome — the pipeline was placed above ground with oversize pipe shoes and support beams to accommodate design movements. To accommodate extraordinarily large design movements of 20 feet horizontal slip and 5 feet vertical slip at the Denali Fault crossing, the pipeline was placed on beams embedded in a gravel berm (Photo 4.2-1).

Seismic integrity will be sustained for the ROW renewal period because of Alyeska's engineering design control programs and standard maintenance. The cumulative effect of damaging earthquakes is not a factor, because no earthquakes approaching the DOE level have occurred since startup. If a DCE occurs in the future, it may be necessary to shut down the pipeline for inspection, repair, and possible replacement of pipe and hardware before resuming operation. The ramping-down of pump stations reduces the exposure of TAPS facilities to seismic hazards, particularly considering that Pump Station 10, which is about 3 miles from the Denali Fault, has been placed on standby.

4.2.1.3 Mitigation of Effects of Stream Crossings and Instream Alignments

By W. Veldman

The pipeline crosses 80 major rivers in either buried or above-ground mode and is in or adjacent and parallel to a number of river valleys. These crossings were designed to accommodate foreseeable erosion, scour, ice conditions, and river meanders (Stipulation 3.6.1.1). The USGS undertook surveys primarily before operation to assess the rate of bank erosion and bed scour, (USGS, 1972, 1975, 1976, 1977). About 12 percent of the pipeline consists of buried or elevated river crossings, instream alignments, or alignments near major river channels, especially the Sagavanirktok, Atigun, Dietrich, Middle Fork Koyukuk,

Alyeska Pipeline Service Company

Photo 4.2-1. *Pipeline crossing of Denali Fault showing beams embedded in a gravel berm to allow large pipe movements.*

Delta, and Phelan rivers. Pipeline design at river crossings and in floodplains was based on quantitative assessments of flow and scour and a qualitative analysis of potential channel changes over the life of the system. The pipeline was designed for the *pipeline design flood* (PDF), a theoretical flood magnitude computed for every significant river and creek crossing (Stipulation 3.6.1.1.1.2). South of the Brooks Range, the flow was computed using 50 percent of the *probable maximum precipitation* (PMP), whereas 100 percent of the PMP was used north of the Brooks Range, reflecting that little flow data for the North Slope existed at the time of construction. The flows thus computed using the U.S. Army Corps of Engineers' HEC-1 model were calibrated to known and existing major floods along the pipeline route. The flow data now available are considerably more extensive. These data, combined with the lessons learned during operation of the pipeline, are valuable for the continued safe operation of TAPS.

Figures 4.2-8 and 4.2-9 illustrate the magnitude of floods experienced to date, compared to the 1:200 year flood event. (Although the PDF computed for TAPS does not have a specific return period, the 1:200 year flood was used by regulators as a check on flood flows computed for the recently completed Badami project on the North Slope).

The August 1992 flood on the Sagavanirktok River was the highest recorded flow since construction of TAPS. From a post-flood hydrologic analysis, it was apparent that rainfall in the Ivishak River watershed was the major reason for the very high flows in the lower Sagavanirktok River system. As the Ivishak enters the Sagavanirktok downstream from the USGS flow-monitoring station near Sagwon, the relative magnitude of the 1992 flood on the lower Sagavanirktok was even significantly greater than that illustrated on the graphs on Figures 4.2-8 and 4.2-9.

The flood necessitated the immediate placement of riprap, and large, gravel-filled bags and a short rock spur at MP 47 to protect the overland buried pipeline from bank erosion. In the winter of 1992-93 , three gravel spurs with rock-armored ends were built to permanently deflect the main channel from the eroding west bank.

The 1992 flood of record illustrated that:

- Where the pipeline is close to, or in or parallel to, a wide river system for a long distance, there could be a number of locations where bank erosion and channel changes require the construction of remedial measures. (In wide river systems such as the Sagavanirktok, there will also be numerous locations where the river changes affect the opposite bank and are therefore of no concern for the pipeline.)
- Various emergency measures can be constructed after the flood peak recedes. Even on a large system such as the Sagavanirktok, the flood peak generally recedes after several days.
- From a river-engineering viewpoint, the integrity of the pipeline has been protected, particularly in view of the TAPS monitoring program during major floods and Alyeska's ability to respond quickly to an emergency — for example, gravel bags and/or stockpiles of riprap are available at a number of locations along the line.

At several locations, pipeline exposure has occurred as a result of flow. In the early 1980s in the Tiekel River area near MP 752, trees stockpiled from clearing for an adjacent, parallel and uphill powerline blocked a small unnamed creek. This caused the flow in the creek to be diverted onto the TAPS ROW. The relatively steep downhill grade of the ROW toward the south caused erosion and pipe exposure for hundreds of feet. Coating repairs were necessary, but the integrity of the pipeline was not a concern. The 1992 flood on the Sagavanirktok River caused bank erosion and pipeline exposure in a small overflow channel in the MP 25 area. The short exposed pipeline section was protected after the flood. Pipeline integrity was not a concern due to the short length of exposure that occurred. In the 1990s, a short length of pipe was exposed in a small alluvial fan in the Pump Station 10 area. Bank and bed armoring was undertaken in a timely fashion, and the pipe was not damaged.

Figure 4.2-10 illustrates the time and location of major maintenance and new works constructed along TAPS (minor repairs are not included). Major widely distributed floods such as the 1992 Sagavanirktok flood may necessitate repairs at a number of locations. Work required in 1998 and 1999 on the Dietrich River and Middle Fork Koyukuk River at several locations was due, at least in part, to the river changes induced by the major 1994 flood. Other floods, like the high flows in the Pump Station 4 area in July 1999, have a very local effect. In that case, only a few creeks in the immediate area south of the station had very high runoff for several days.

In summary, large segments of TAPS are in or close to the rivers, the pipeline crosses numerous rivers and streams, and many areas are influenced by aufeis, glacier-dammed lakes, and major bedload movement in alluvial fans. However, most TAPS river crossings and floodplain segments have experienced no significant change and have required no repairs or new structures despite experiencing a number of high-flow events. The TAPS river and floodplain design methodology — as well as the annual and post-flood monitoring and maintenance — have been successful in protecting the pipeline.

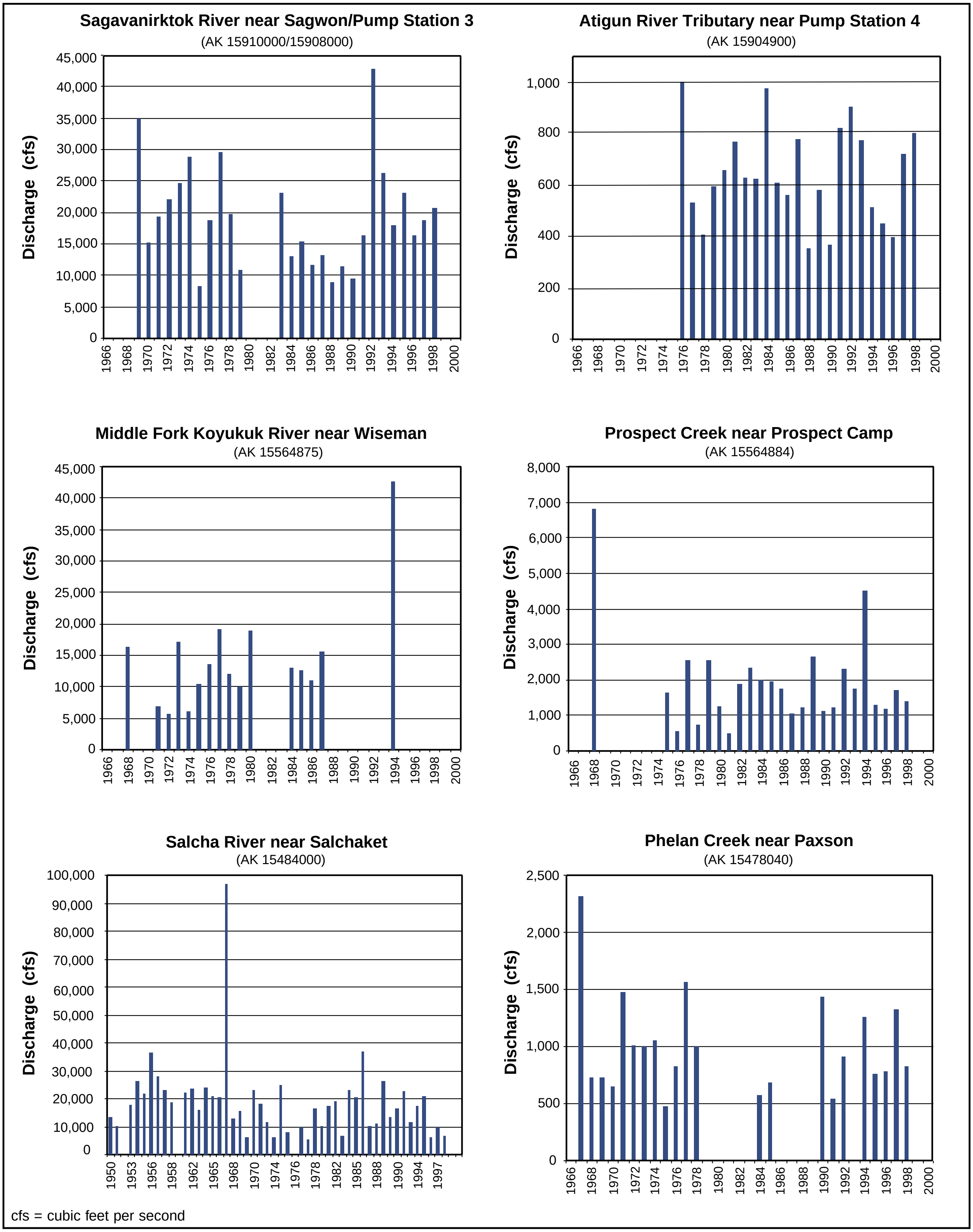


Figure 4.2-8. *Comparison of maximum annual peak flows.*

4.2.1.4 Hydrocarbon Emissions Control

By E. Haas

Major sources of crude-oil vapor emissions are controlled through vapor recovery systems at Pump Station 1 and at the VMT. At Pump Station 1, a vapor recovery system routes displacement vapors from the two receiving tanks (Tanks 110 and 111) to a vapor incineration flare. The tanks receive crude from the various North Slope production areas. The tanks also function as crude breakout or pressure-relief tanks when crude has to be diverted during pipeline upsets or slowdowns. In those cases, large amounts of crude have to be diverted into Tanks 110 and 111. The vapors are collected in a common vapor header and routed to the tank-vapor incineration flare. During 1994-95, Alyeska installed a new flare tip and a gas-assist combustion system. This upgrade helped improve the combustion characteristics of the flare in all cases except during full tank inrush situations resulting in occasional exceedances of the permitted opacity limit.

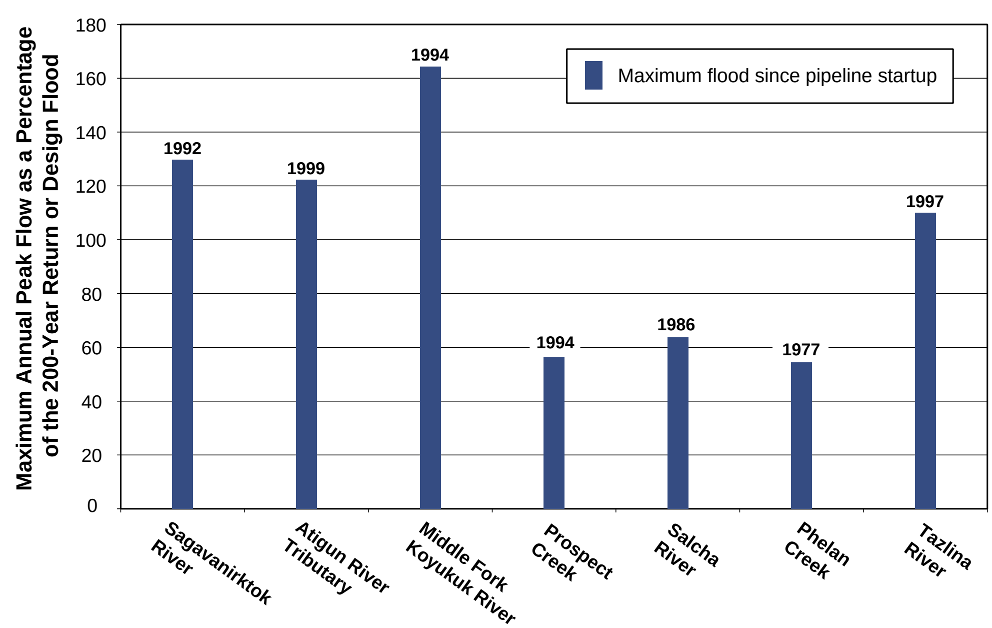
The VMT is equipped with a system that controls the crude oil vapors from both the onshore tank farm and the marine loading operations. Crude vapors are generated when fresh crude enters the tanks and displaces an equal amount of the internal tank vapor space. The tank displacement vapors are controlled by low-pressure vapor collection lines and are primarily used for vapor balancing to replace tank vapors when tanks are being emptied. Excess tank vapors are used as fuel gas in the VMT power boilers. Surplus vapors are incinerated in one of the three vapor incinerators.

The tanker vapor control system operates in a similar fashion to capture vapors during tanker loading operations at two of the four existing tanker berths. It was built and tied in with the existing system in 1997.

4.2.1.5 Ballast Water Treatment

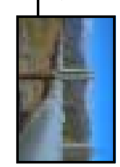
By B. Jokela and V. Gates

Oily ballast water from tankers and other wastewaters from the VMT are treated at the Ballast Water Treatment Facility (BWTF). When originally built in 1976 as required by Section 23B of the Federal Grant, the BWTF used three 18-million-gallon steel primary gravity-separator tanks and six 240,000-gallon secondary dissolved-air-flotation cells to remove oil before discharging the saline ballast water to Port Valdez under the terms of a National Pollutant Discharge Elimination System (NPDES) permit. The waste discharge limitations imposed on the BWTF in the NPDES permit were later revised to include a limit on benzene,



Notes: 1. 200-year flood from Jones and Fahl (1994).
2. Tazlina River ratio relative to the pipeline design flood of 110,000 cubic feet per second (cfs).

Figure 4.2-9. *Comparison of maximum flood since startup to 200-year return or design flood.*



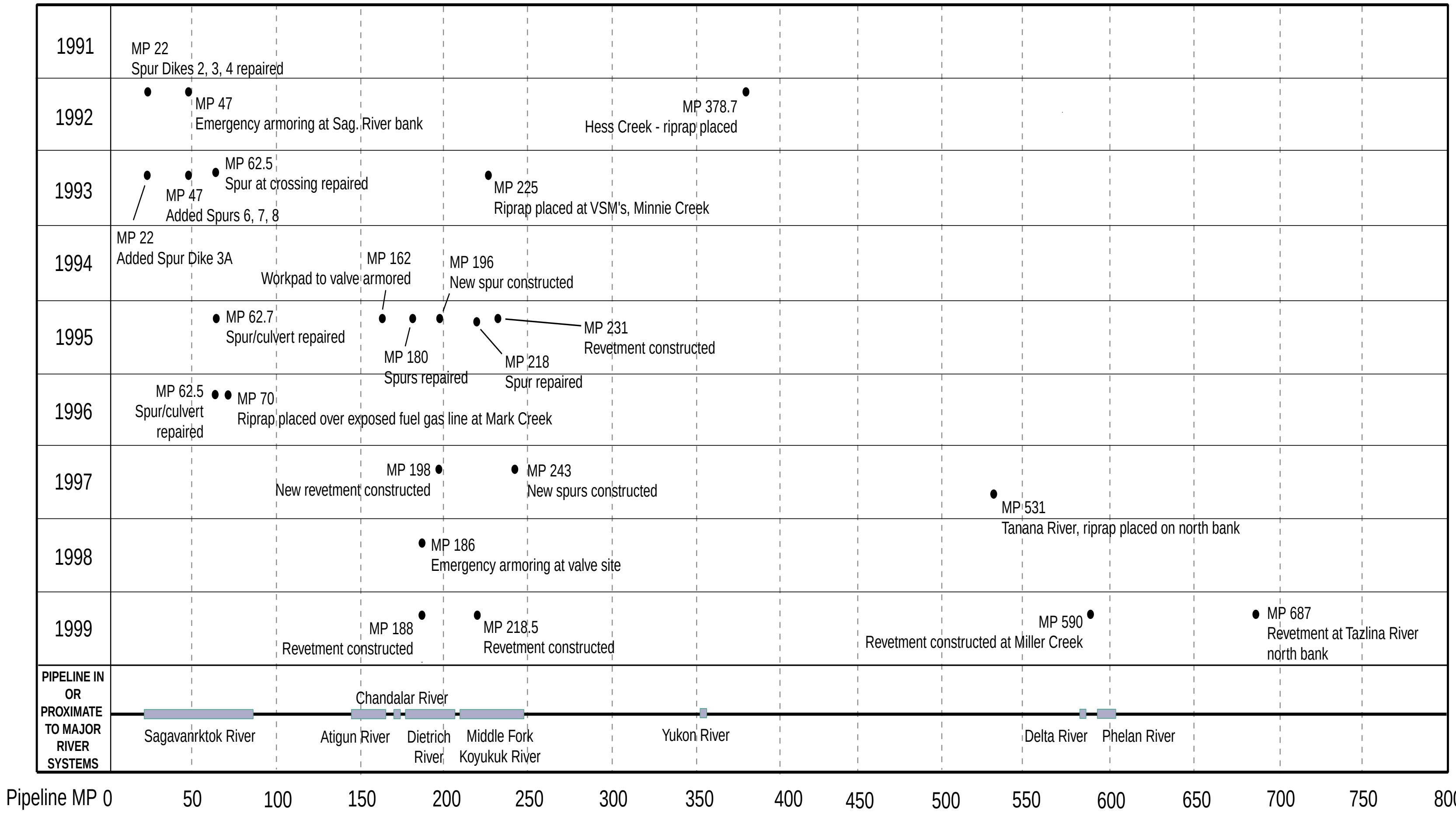


Figure 4.2-10. *Timeline of the major repairs and new structures for river training structures along TAPS, 1991-1999.*

toluene, ethylbenzene, and xylene (BTEX). In response, two aerated impound basins were replaced in 1990 by a permanent biological treatment facility consisting of two 5.5-million-gallon concrete aeration tanks equipped with a submerged-jet aeration and mixing system (Rutz et al., 1991. To provide additional reliability, a polishing air stripper was installed downstream of the aeration tanks to remove occasional spikes of BTEX in the event of biological upset (Rutz et al., 1992; Norton et al., 1991). The entire BWTF is controlled by a computerized supervisory control and data acquisition system in a centralized control room (see Section 4.3.1.2).

4.2.1.6 Pipeline Spill Control

By J. Riordan, J. Endell, and J.D. Norton

Valves

Valves controlling the operational functions of TAPS are located on the mainline, in pump stations, and at the VMT. Pipeline valves have three purposes: to minimize spills in the event of a leak in the mainline, to prevent overpressure of the pipeline, and to isolate pump station and terminal facilities.

During design of TAPS, the maximum static oil-spill volume was set at 50,000 bbl of crude oil. Valve locations were selected based on this volume and sensitive-area factors. If a valve "leaks through," the leakage must not result in an increase over the initial design spill volume (Weber and Malvick, 2000; Aus et al., 2000.).

The pipeline valve system of 177 valves includes 63 remote gate valves (RGVs)[1] and 81 check valves (CKVs). Where the oil flows uphill, CKVs prevent backflow in the event of a rupture or break. RGVs prevent flow in either direction. (CKVs are preferred over RGVs on uphill slopes. They are more economical while serving the same purpose, but more importantly, they are less complicated than RGVs and require less maintenance.)

Nine manual gate valves (MGVs) are placed near CKV sites to provide more positive isolation when required. They are included for pipeline maintenance and secondary spill response.

Battery limit valves comprise the final 24 pipeline valves. These gate valves are located on either side of each pump station to isolate the station from the pipeline in the event of a pump station fire or other emergency.

All mainline valves are subject to annual preventive maintenance to refurbish lubricants and ensure mechanical functionality. In addition, all mainline valves are subject to performance testing to ensure that the valves maintain the ability to seal off flow (minimum "leak through") (Jackson and White, 2000). This function is key to minimizing the amount of oil that could theoretically leak from any pipeline segment (Stipulation 3.2.2.1).

Valves that do not meet minimum sealing-performance standards are replaced or repaired (Pomeroy and Norton, 2000) Four mainline valves have been replaced or repaired because of sealing-performance deficiencies: two aboveground gate valves and two below-ground check valves. Similar repair or replacement of other valves may be expected to occur in the future, although currently there is not enough data to estimate timing or numbers of valves to be addressed. Currently, all valves have been tested and all deficient valves have been addressed.

Leak Detection

The TAPS leak detection systems, which provide early notification of potential pipeline leaks, consist of three independent networks: deviation alarms for pressure and flow rate, line volume balance (LVB), and transient volume balance (TVB). Each capitalizes on unique leak characteristics. The intent is to detect leaks as early and as small as possible to minimize environmental damage. To supplement leak detection systems, regular and frequent visual field observations are performed both from the air and from the ground.

Deviation Alarms: Two types of deviation alarms are used: pressure and flow rate. The leak detection system looks for deviations from preset values or sudden changes in flow or pressure. This tool has been in service since 1977 to rapidly detect large leaks. The leak-loss sensitivity threshold is about 10,000 bbl per day (1 percent of flow), with a response time of 1 to 5 minutes.

The *pressure deviation alarm* is based on pump station suction and discharge pressure readings. Approximately every 3 to 4 seconds, the SCADA host computer retrieves pressure readings at each pump station. The current pressure reading is compared against the previous one. A drop in pressure greater than one percent of range generates a deviation alarm, as does a value outside the acceptable range of pressures. This method would detect large leaks between adjacent pump stations and between Pump Station 12 and the VMT.

Flow rate deviation alarms are based on readings from each pump station's leading-edge flow meter (LEFM) and the incoming meters at the VMT, all of which are scanned approximately every 10 seconds by the SCADA system. Each new reading is compared against the previous one.

[1] One ball valve, at Pump Station 11, performs the same function as the RGVs and is included in the count of 63 RGVs used throughout this report.

Any deviation greater than one percent of range causes an alarm to sound. Flow rates outside preset limits also generate an alarm. This method would detect large leaks between adjacent pump stations and between Pump Station 12 and the VMT.

Line Volume Balance: LVB leak detection is based on readings from the custody-transfer meter at Pump Station 1 and incoming meters at the VMT. The SCADA computer gathers LEFM readings approximately every 3 to 4 seconds and calculates a real-time average flow rate at each end of the pipeline. With this data, the LVB system calculates every 30 minutes the average oil volume entering the pipeline at Pump Station 1 and the average volume leaving it at VMT and into the breakout tanks at the pump stations.

LVB leak detection compares the relative volumes of oil in and out of the pipeline to detect a leak. If more oil is entering the pipeline than exiting, a leak is declared. LVB is a long-term, sensitive leak detection system good for finding small leaks. The leak-loss sensitivity threshold is about 2,000 bbl per day (0.2 percent of flow), and the response time is 6 to 24 hours. For larger leaks, the system can be used to identify the pipeline segment (section between pump stations) of concern. This system has been employed since just after pipeline startup.

Transient Volume Balance: A 1998 enhancement to TAPS leak detection capabilities, the TVB system is a computerized method that uses mathematical models to detect leaks based on field measurements.

Every 60 seconds, the TVB system calculates flow characteristics derived from actual field pressures, temperatures, flow rates, and crude oil properties. Based on this information, the TVB system can produce a reliable flow-rate model. This information is compared against the actual line flow rates measured by the LEFMs. Deviations between the modeled flow and measured flow indicate potential leaks. This method takes just minutes to detect a spill that the LVB system requires hours to detect. The leak-loss sensitivity threshold is about 4,000 bbl per day (0.4 percent of flow). The response time is about 30 minutes depending on leak size, and the system is used to identify the milepost location of the leak. TVB has become Alyeska's primary leak detection system.

4.2.1.7 Designated Big Game Crossings

By H.A. Whitlaw and M. Cronin

Several Federal Grant stipulations pertain to the conservation of terrestrial mammals and require mitigation of wildlife impacts associated with TAPS construction, operation, and maintenance. For example, concerns for the free passage of terrestrial mammals were addressed in Section 2.5.4.1 (Big Game Movements), which states: "(the contractor) shall construct and maintain the Pipeline, both buried and above ground sections, so as to assure free passage and movement of big game animals."

Concern for potential obstruction to the migration patterns and local movements of caribou, moose, and bison resulted in construction of designated big-game crossings (DBGCs) (JSFFWAT, 1977). DBGCs constructed as elevated pipes were a minimum of 10 feet high and 60 feet long. Also, many were built as short buried sections (i.e., sagbend crossings), or as long refrigerated buried sections. A total of 554 DBGCs were constructed along the pipeline in areas known by state and federal biologists to be regularly used by bison, moose, and/or caribou, based on traditional use and/or habitat characteristics. Studies in the 1970s and 1980s showed no indication that large mammals were selectively crossing in these areas; however, it was hypothesized that the DBGCs would be necessary for big-game movement during winters with severe snow depth (Carruthers and Jakimchuk, 1987; Eide et al., 1986; Sopuck and Vernam, 1986a, b; Van Ballenberghe, 1978) (see Section 4.3.2.5).

4.2.2 TAPS Monitoring, Surveillance, and Maintenance Programs

By J.D. Norton and J. Harle

The purpose of TAPS monitoring, surveillance. and maintenance programs is to ensure reliability of the system while complying with applicable laws, regulations, and right-of-way agreements (Stipulations 1.18, 1.20, and 1.21).

Alyeska's *Procedure Manual for Operations, Maintenance, and Emergencies* (OM-1) provides procedures for operating and maintaining the pipeline during normal and critical conditions in accordance with the ROW agreements and federal DOT requirements. A similar manual (FG-78) addresses operation of the fuel gas line.

The Alyeska *Quality Program Manual* (QA-36) provides overall policy and guidance for ensuring quality in critical TAPS systems (Section 9 of the Federal Grant and Section 16 of the State Lease). The individuals performing work are responsible for the quality of the work and for complying with the procedures governing the work. Each supervisor and manager is responsible for ensuring that all work done under their supervision satisfies applicable requirements, including laws, agreements, codes, standards, and regulations. Individuals performing quality functions have the authority to report conditions adverse to quality.

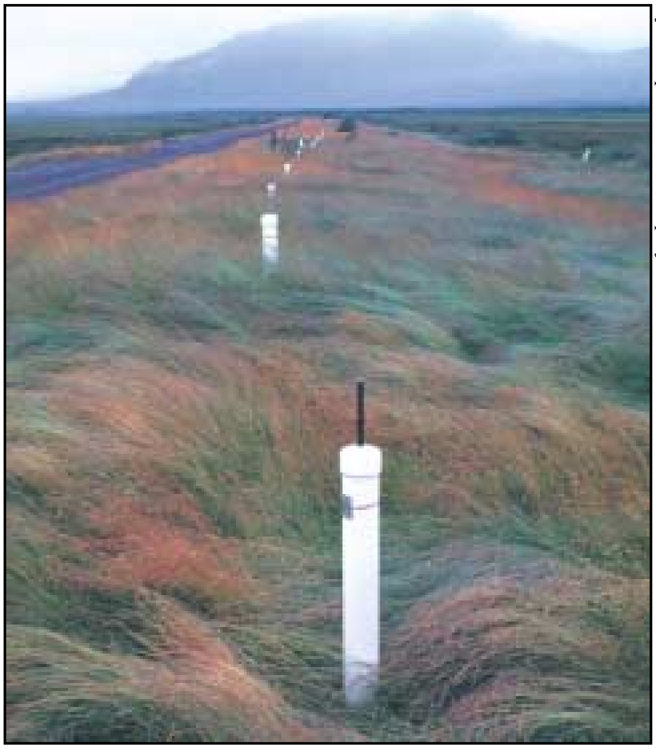

Alyeska Pipeline Service Company

Photo 4.2-2. *Settlement monitoring rods along buried section of TAPS.*


Alyeska Pipeline Service Company

Photo 4.2-3. *Smart pig.*

QA-36 describes the responsibilities, methods, and processes to comply with this policy.

Alyeska's *Inspection Services Manual* (IP-218) provides inspection procedures for modifications or additions to critical TAPS systems (Stipulation 3.2.2.4). Work done on TAPS is inspected to provide independent verification that the work conforms to requirements of instructions, procedures, specifications, and drawings. These inspections are performed by qualified inspectors who are independent of responsibility for the cost or schedule of the work being performed. The inspectors work in accordance with established inspection and implementing procedures. The Inspection Group maintains the necessary records that document work which has been accomplished.

The *TAPS Engineering Manual* (PM-2001) provides overall policy and guidance to engineers that produce project designs for modifications or additions to critical TAPS systems. In addition, the *Alyeska Design Basis Update* (DB-180) requires that such changes receive prior approval of the Alyeska engineering standards manager.

4.2.2.1 Integrity Monitoring Programs

Alyeska's *System Integrity Monitoring Program Procedures* (Manual MP-166) cover planned monitoring of critical TAPS systems. The goal is to determine the integrity of the facility being observed. Pipeline elements are monitored to ensure that the features perform within predefined engineering limits. This monitoring is accomplished on predetermined schedules to identify performance trends which determine when maintenance intervention is required (Hart et al., 1998). When the monitoring results identify trends which would jeopardize integrity of a pipeline facility, a maintenance project is prepared to repair the deficiencies (APSC, 2000c).

The following systems have monitoring programs to ensure their integrity:

Mainline Pipeline Integrity Monitoring

Systematic monitoring is done for the above-ground pipeline support system and below-ground pipeline for movements which may jeopardize pipeline integrity. Above-ground pipeline is monitored by field crews who rebalance pipe loading on key supports and look for out-of-tolerance supports. Below-ground monitoring is done by field observations, surveys of monitoring rods attached to the pipe (Photo 4.2-2), and periodic inspections by inline inspection tools called "smart pigs" which travel through the pipe on the flow of the oil (Photo 4.2-3).

Integrity monitoring and repair consist of inline corrosion monitoring using "smart pigs" (which monitor corrosion and curvature/deformation), integrity assessment and investigation, and maintenance based on pigging information. A smart pig is an instrumented device that travels through the pipeline to detect corrosion, deformation, or wall thinning. When Alyeska began using smart pigs, a large number of digs were performed to investigate potential corrosion (see Figure 4.1-1). New smart pigs which

came into use in 1989 provide more accurate wall-thickness measurements. The number of corrosion pig "features" to be investigated has dropped as more and more sites are investigated (a feature is an anomaly in the pipeline wall that is reported by a smart pig and interpreted as a potential pipe-wall defect). Consequently, the inventory of potential pits and the number of digs have dropped. This drop also reflects more exact data analysis and improved cathodic protection.

Instrumented pigs provide data on corrosion, curvature, and dents and buckles (deformation) (Stevick et al., 1998). For the mainline, the corrosion pig is run one year, the curvature pig the next year, and the deformation pig the following year. Then the cycle repeats. For the fuel gas line, corrosion pigs currently run on a 5- to 10-year cycle.

Corrosion pigs detect pit dimensions, distinguish between corrosion defects and laminations, and determine whether the corrosion is external or internal wall loss. Pig data track many types of corrosion: at girth welds, under insulation, at transitions, and general corrosion of TAPS mainline pipe. Pigs record information about how well the other program aspects are working but do not treat the pipe in any way.

Corrosion has historical and active components. Historical corrosion, which can be stopped by remedial methods, is not a current concern. Active corrosion beyond minimal acceptable rates, if not mitigated, could threaten the safety and longevity of the pipeline. To identify areas of potential integrity threats, Alyeska uses tools such as database management programs to determine areas of statistically active corrosion changes from one pig run to the next.

The corrosion data management system is a database containing millions of data points — pipe-to-soil potential readings, coupon readings, geophysical data, pig data, and ultrasonic testing data (potentials are a measurement of the difference in electrical voltage between two materials). The system enables engineers to track pipe corrosion changes over time and thus aids them in making maintenance decisions.

In 2000, pipe curvature and dent data will be added to the records to integrate mechanical records with corrosion data. The scope of future programs will be broadened to include all integrity-related issues. Since startup, 56 corrosion and curvature/deformation pigs have been run through the pipeline (Hackney, 2000, pers. comm.).

Corrosion Control

Mainline pipeline corrosion is controlled based on Alyeska's *Corrosion Control Management Plan* (CCMP). The CCMP provides a five-part program of corrosion protection in accordance with Stipulation 3.10 (Cederquist, 1999).

- The corrosion data management system supports monitoring and maintenance decisions.
- Corrosion protection monitoring uses cathodic protection coupons, close interval survey, and conventional test-station monitoring to assess the level of corrosion protection on TAPS.
- Integrated monitoring methodology combines pig data, cathodic protection data, and mitigation history to guide decisions on remediation and pipe refurbishment.
- Enhanced or impressed-current cathodic protection is placed on TAPS to improve the corrosion protection coverage.
- The pipeline integrity component uses corrosion pig data to find and repair any corrosion defects that could potentially affect system integrity.

External pipeline corrosion is controlled through pipe coatings and cathodic protection. Coatings prevent water and/or soil from making direct contact with the pipe steel, thus eliminating the electrolytic path necessary for corrosion to occur. Where the coating is damaged, disbonded, or otherwise compromised, the pipeline can experience external corrosion. To mitigate this, cathodic protection is installed. Cathodic protection interferes with the electrical current that causes corrosion.

Alyeska's cathodic protection program consists of both galvanic and impressed-current systems. Twin zinc ribbon anodes were placed in the mainline pipeline ditch and connected to the pipe during construction on the 376 miles of conventionally buried pipeline. During operation, approximately 250 miles of supplemental impressed-current cathodic protection has been placed (Johnson and Bieri, 1998). Criteria used to assess the adequacy of cathodic protection are standard for the industry.

Supplemental cathodic protection has been placed on approximately 250 miles of TAPS as part of a five year, $23 million cooperative program between TAPS Owners and the State of Alaska. The program also includes research to address long-term performance issues. Upon program completion in late 2000, the results will establish future corrosion protection strategies for TAPS.

Impressed-current cathodic protection (ICCP) provides a low-level electrical current between remote anodes and the pipeline. This is now the corrosion-control remediation method of choice for TAPS. Alyeska has focused on this system because it can protect several miles of pipe per installation. Also, the level of electrical current can be easily adjusted if corrosion rates do not diminish. Such fine-tuning is not possible with anodes.

ICCP is not optimum everywhere because it requires a reliable source of electric power. Pump stations have had ICCP systems since construction because they have power supplies. Providing power at more remote sites is difficult and expensive.

Another problem with ICCP in permafrost and bedrock foundations is high variability in soil resistivity. Highly resistive soils do not conduct current well. These soils limit the cathodic protection currents' effectiveness to a few miles.

Cathodic-protection monitoring of mainline pipeline takes place annually. Data are gathered from test stations, buried corrosion coupons, cased road crossings, the Atigun reroute, and the fuel gas pipeline (Stears et al., 1998). Cathodic-protection data gathering also occurs at buried propane tanks, pump stations, and the VMT. Rectifiers are checked six times a year.

Inhibitors are used to control corrosion in isolated and low-flow or seldom-flow piping in pump stations and in road-crossing casings. Internal coupons, which verify the effectiveness of the inhibitors, are removed and analyzed twice yearly. Pigs are used to monitor corrosion and curvature on the mainline pipeline. Data are collected, stored, evaluated, and trended.

Bridge Monitoring

Bridges for the pipeline, access roads, and workpads provide access for oil spill and maintenance personnel. The bridges are periodically evaluated for structural integrity and safety issues by engineering personnel.

Workpad and access-road vehicular bridges are maintained to state highway secondary road standards, and load limits for bridges are posted. Recently a program to evaluate all vehicular bridges required for oil spill response access was completed. Several bridges were reinforced for expected loads, and several bridges were raised to allow for increased flood flow.

Pipeline bridges were designed to accommodate static and dynamic loading combinations that included the weight of the pipe, fluid, insulation, snow and ice, wind, thermal expansion and contraction, and earthquakes. Pipeline bridges are located so that adequate clearance is provided between the bridge low chord and the pipeline design flood-level and to provide clearance for ice ride-up, aufeis buildup, and navigational traffic.

The relatively few modifications that have occurred on pipeline bridges have been engineered and documented. Alyeska monitors pipeline bridge performance through routine surveillance as well as third-party inspections. Currently, there are no known conditions that represent a concern or threat to the integrity of pipeline bridges.

Pipeline bridges are inspected annually in accordance with Alyeska bridge inspection manuals. To evaluate their integrity, pipeline bridges are inspected at intervals not exceeding five years by a professional engineer registered in the State of Alaska. The purpose of these inspections is to verify that each structure is performing as expected, to note needed maintenance, to notify appropriate personnel of improvement needs, and to serve as an independent monitor to verify the effect of maintenance, design, and construction procedures. Future annual and five-year inspections of pipeline bridges are expected to remain at current levels. Security surveillance is provided by remote video and motion sensor for the Yukon, Tanana, Gulkana, and Tazlina River bridges.

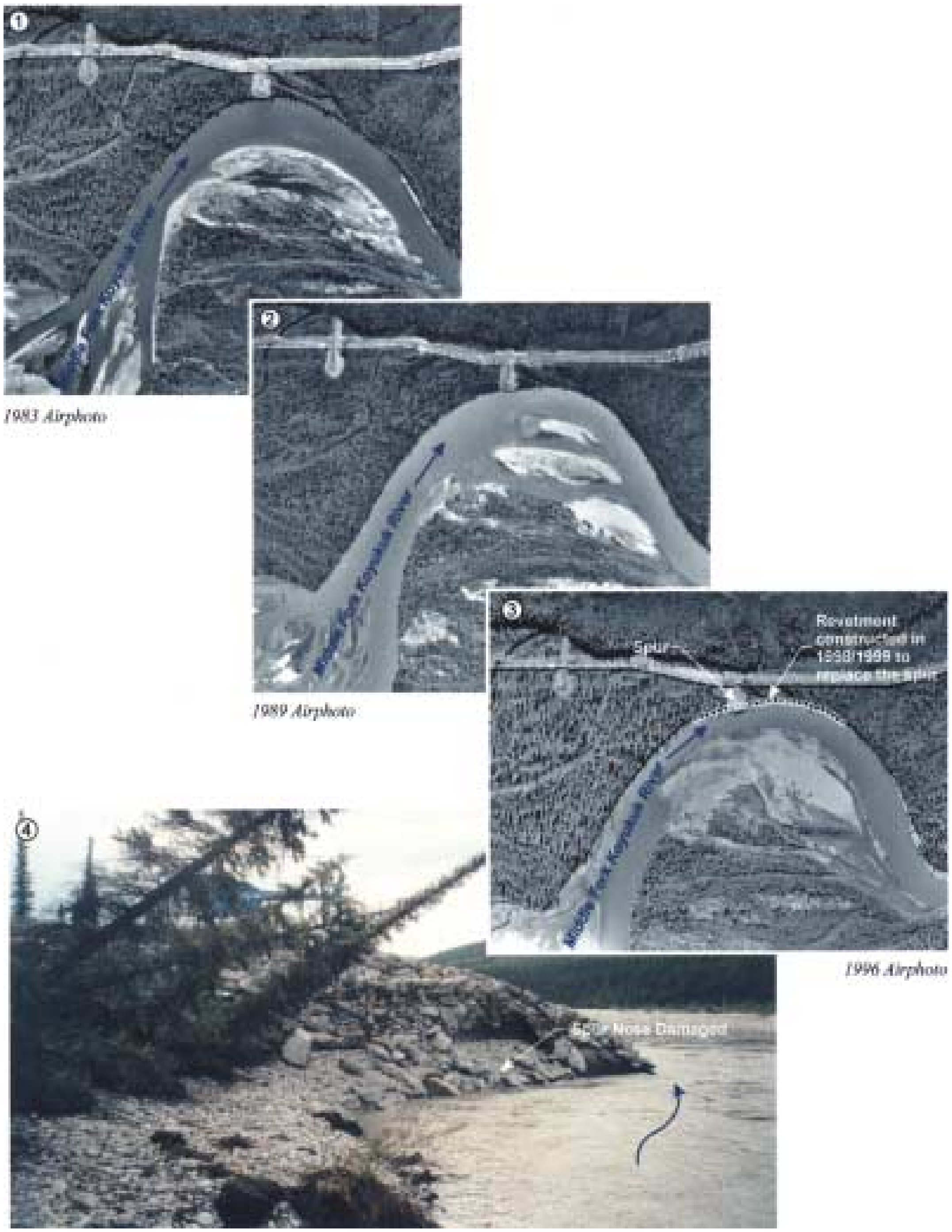
During 1997, inspections were performed on each plate-girder bridge and the Gulkana River Bridge. No significant discrepancies were noted. Due to lack of access at the Gulkana River Bridge during the 1997 professional engineer's inspection, a full reinspection was conducted in 1999. The Tazlina River suspension bridge was also inspected in 1999. The Tanana River Bridge is scheduled for inspection in 2001.

Rivers and Floodplains Monitoring

By W. Veldman

The rivers and floodplains along TAPS are monitored annually by engineering personnel using aerial photography and on-site evaluations, and are complemented by weekly surveillance flights by TAPS observers. These observations identify erosion areas and other anomalies or regime changes which may require continued observation or repair (Figures 4.2-11 through 4.2-13). Survey posts have been installed at a number of key locations so that aerial or ground reconnaissance can detect changes.

Monitoring occurs during and after floods, and annual river surveillance is conducted. In addition, comparative aerial photos are assessed. At some locations, survey stakes are used to accurately identify channel changes and the remaining river-to-pipeline buffer. River engineers use this information to assess the need for remedial measures. Detailed river-engineering assessments are undertaken to determine the need for and scope of remedial measures or new structures as a result of major floods. Examples of this are the detailed studies and designs done following high flows in 1992 on the Sagavanirktok, in 1994 and 1998 on the Middle Fork Koyukuk, and in 1999 at Miller Creek and in the Pump Station 4 area.



1998 Site photo

At this location, bank erosion towards the spur and elevated pipeline was minor until 1994. A major flood in 1994 necessitated repair of the spur, and high flows in 1998 necessitated construction of a new revetment in the winter of 1998/99. (Compare conditions in Photos 1, 2, and 3). Although the minimum pipeline-to-bank buffer was still about 80 feet in 1998 and the spur (Photo 4) was still partially effective in controlling the rate of and location of the erosion, delaying the work while more erosion occurred would have resulted in minimal pipeline-to-bank buffer and thus would have required “moving” the river (an extensive undertaking) rather than armoring the existing bank.

CONCLUSION: Routine, annual, and event-driven monitoring and follow-up engineering assessments are effective means to establish the need for additional structures and to ensure they are constructed in a timely manner.

Figure 4.2-11. *Middle Fork Koyukuk River, MP 218.5. Monitoring led to follow-up remedial action consisting of bank armoring.*

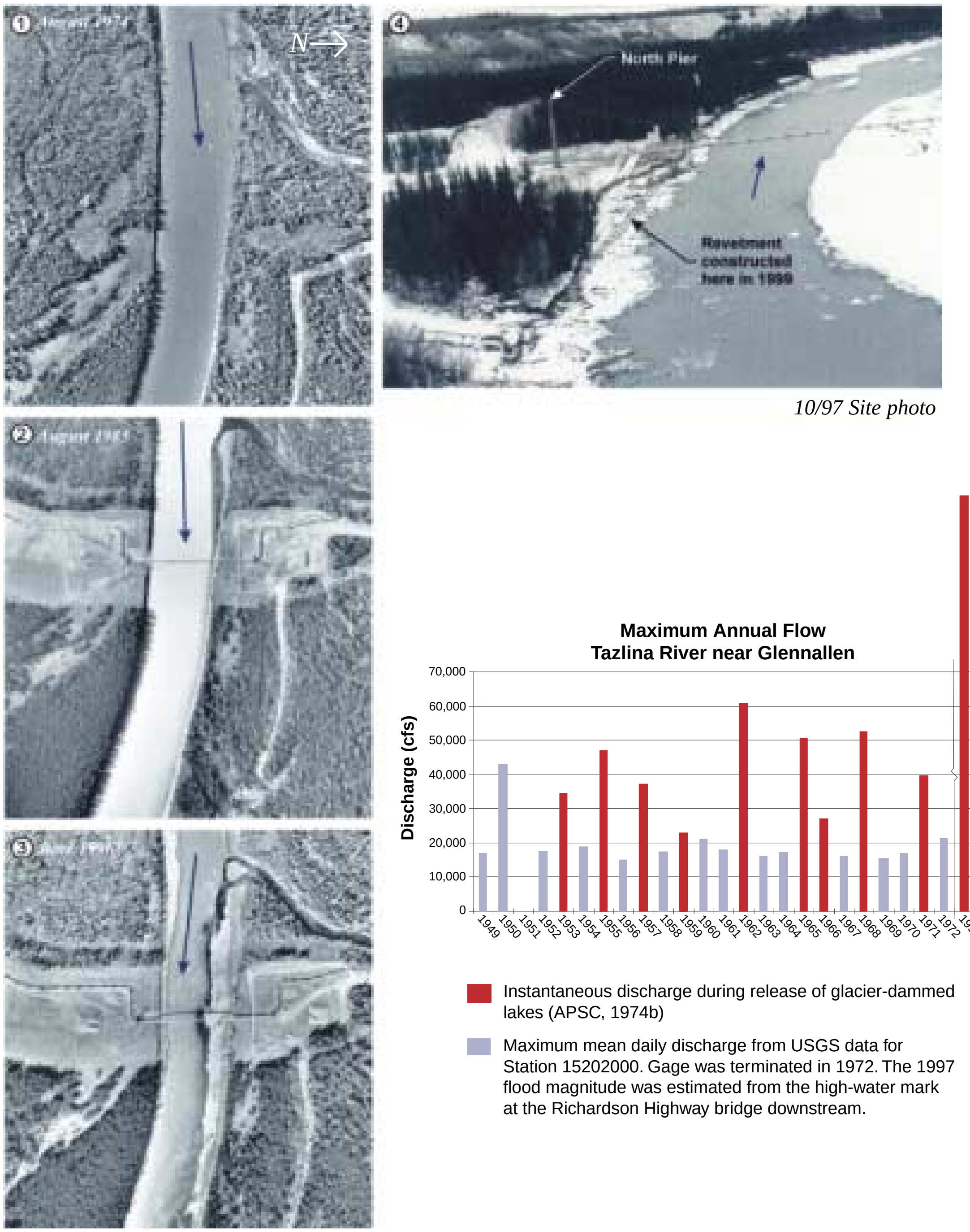
1996 Air photo

6/30/98 Site photos

The bank at this large bend is eroding towards the pipeline and RGV 39. The bank was 25 to 30 feet high with a minimum buffer of about 155 feet in 1998. The rate of erosion of the bank, even during major floods, compared to the remaining buffer, did not warrant armoring of the bank at the time of the assessment in 1998. Depending on the timing of the next major flood (the majority of bank erosion is caused during high-flow periods), a revetment may need to be constructed within 5 years, or nothing may be required for 10 to 20 years.

CONCLUSION: Monitoring and assessments can track long-term river changes which may not require immediate remedial measures, but warrant close attention on an ongoing basis.

Figure 4.2-12. *Middle Fork Koyukuk River, MP 217. Monitoring did not lead to immediate follow-up action.*



Major river crossings such as the 650-foot-long Tazlina River bridge undergo extra monitoring — a video camera on site relays images to a nearby Security station. The flood magnitude and potential for river changes on the Tazlina River are related to the release of glacier-dammed lakes which typically produce flows two times as large as normal peak summer runoff. The flood of record, estimated to be about two times the size of the previous record in 1962, occurred in October 1997 as a result of heavy rains which triggered the release of all four lakes impounded by the Nelchina and Tazlina glaciers. At the centerline of the bridge, a buffer of about 150 feet remained on the north bank after the 1997 flood. Although this buffer would have been adequate for a considerable period of time and probably even the next major flood, and is considerably more than the total erosion experienced since startup, the potential consequences of another large flood on this major structure resulted in the decision to armor the bank in early 1999.

Figure 4.2-13. *Tazlina River Bridge, MP 686.7. Monitoring led to bank armoring to prevent any further erosion.*

In some instances during high flows, immediate protection measures are taken, such as reinforcing or adding to existing river training structures. More substantial and permanent works, such as new revetments or additional spurs, also may be built. Repairs are performed as necessary to protect the line within or near the major river systems as natural channel changes occur.

Seismic/Earthquake Monitoring

By D. Nyman

An earthquake monitoring system has been part of the pipeline control system since startup in 1977 (Stipulation 3.4.1.2). The monitoring system consists of 11 remote digital strong motion accelerograph (DSMA) stations located at Pump Stations 1, 4 through 12 (including the Pump Station 11 site), and the VMT. The system processes seismic data to evaluate the severity of earthquake ground shaking and to assess the potential for damage to TAPS. This assessment determines whether the pipeline should be shut down after an earthquake and delineates inspection requirements for the affected portion of the route.

The original earthquake-monitoring hardware and software were replaced in 1998 with a second-generation system. Each station consists of ground-motion-sensing instrumentation (accelerometers) and a computer that provides data acquisition, processing, recording, network communications, and output of alarms to the Operations Control Center (OCC) at Valdez. The pipeline controller determines the need for pipeline shutdown and field inspection through review of alarm displays from the earthquake monitoring system, as well as other control system information. Shutdown actions are initiated manually by the pipeline controller, but a shutdown sequence will occur automatically if seismic alarms are not acknowledged at the OCC within a preset period.

Stipulation 3.4.2.3 requires annual geodetic surveys of crustal deformation at active fault crossings. This requirement was based on the initial design assumption that the pipeline would cross faults in a buried mode and that relatively small movements could cause high stresses in the pipeline. However, at the three active faults along the pipeline route (Denali, McGinnis Glacier, and Donnelly Dome faults), the pipeline was built in an above-ground, unrestrained configuration.

In 1995, with the concurrence of the Joint Pipeline Office, annual fault monitoring by geodetic survey was discontinued (APSC, 1995d). Several factors led to this decision. First, survey measurements indicate no evidence of movement on any of the three faults during the monitoring period. Second, the above-ground pipeline was designed to withstand the maximum expected fault movements, such that the detection of small fault movements has no substantive benefit to pipeline integrity. Third, potential earthquake damage is not mitigated by fault monitoring, because fault movements occur over a matter of seconds during seismic events and generally are not preceded by periodic slip movements or creep. Survey benchmarks are maintained at each fault crossing to permit post-earthquake surveys of fault movements, if fault rupture occurs.

Slope Stability Monitoring

By R. Dugan

About 50 slopes along the ROW were identified during construction as having some potential for mass movements that could damage pipeline facilities. In accordance with Stipulation 3.5.1, these slopes are periodically monitored so that measures can be taken to prevent the occurrence of, or protect the pipeline against, the effects of such movements. The monitoring includes aerial observations and photography, site inspection, and direct measurements using a variety of instruments. The monitoring results are analyzed and documented, and additional monitoring, instrumentation, maintenance, or repair work is completed as needed.

Glacier Surge Monitoring

By R. Dugan

Glaciers near the pipeline are monitored by aerial photography for movement to ensure adequate notice is provided if a glacier approaches the pipeline or if outburst floods could occur from glacially dammed lakes (Stipulation 3.8). The pipeline would be shut down or major mitigation steps taken if glaciers jeopardized its integrity. Five glaciers are monitored on a 5-year schedule: Worthington, Canwell, Fels, Castner, and Black Rapids. The last monitoring work was completed in 1999. None of the glaciers has advanced since TAPS was built (APSC, 1999g).

Fuel Gas Line Monitoring

Monitoring is done to identify movement from frost heave, erosion, or ground disturbance. Maintenance or repair is conducted as necessary.

Buildings/Pump Station Structures

Survey monitoring is done on buildings and structures at the pump stations and at the VMT to identify movements

from permafrost thaw or ground subsidence. The information is used to develop maintenance programs and to arrest ground movement before foundation damage.

4.2.2.2 Surveillance and Maintenance Programs

Surveillance programs differ from monitoring programs on TAPS. Monitoring programs measure and report change from predetermined design limits such as survey elevation changes for VSMs or wall-thinning measurements from smart pigs. Surveillance programs are observations by trained observers of apparent changes that do not necessarily require direct measurements.

The Alyeska *Surveillance Manual* (MS-31) provides pipeline surveillance procedures for TAPS (Stipulation 1.18.1). Pipeline and civil surveillance activities are conducted to observe, identify, describe, quantify, and assess field conditions that may adversely affect the pipeline system, public safety, or the environment. Using ground vehicles, TAPS maintenance personnel conduct ROW surveillances in accordance with specific guidelines. Security and maintenance personnel also monitor the ROW by helicopter. Any observations or discrepancies are logged into a computer for future trending or preparation of a work order for maintenance or repair.

Alyeska's *Maintenance System Manual* (MP-167) provides maintenance procedures for critical TAPS systems (Stipulation 1.18.1). Planned maintenance programs ensure the reliability of critical equipment. These systematic programs use a work order process, which schedules and documents that the work was accomplished.

The TAPS maintenance strategy focuses on principles of reliability-based maintenance, which emphasizes developing an understanding of how equipment fails and identifying those failures before they have a negative impact. The maintenance system includes planning and scheduling work, condition monitoring, predictive maintenance tools, maintenance-performance measuring programs, and equipment-reliability analysis techniques.

4.2.2.3 Environmental Monitoring

The TAPS *Environmental Protection Manual* (EN-43) provides procedures and guidance for monitoring, testing, and working with TAPS systems to protect the environment. The Alyeska Environment Teams conduct environmental surveillances twice each year, using forms to record status of, and potential problems with, environmental issues. The surveillances are conducted by the Field Environmental Generalists (FEGs) at Alyeska facilities and along the pipeline ROW, and cover all of the subject areas included in EN-43. This program complies with Stipulation 1.18.1, Surveillance and Maintenance. The surveillances are followed by corrective actions that are tracked and confirmed when completed. The Alyeska Environment Team also uses an environmental management system based on American Petroleum Institute guidelines and on the International Organization for Standardization ISO 14001 standard for such systems.

Water Quality Monitoring

By B. Jokela

Water quality is monitored for compliance with state and federal laws and regulations. The monitoring provides a means of mitigating potential impacts to water resources by providing information on potential pollution to Alyeska and agencies. Monitoring is required for:

- Wastewater discharges to Port Valdez (EPA, 1997);
- Wastewater discharges along the pipeline (EPA, 1993a);
- Discharges from material sites covered under the EPA Multi-sector General Permit for Stormwater from Industrial Sites; and
- Drinking water quality.

State and federal agencies use permits, authorizations, and/or regulations to regulate wastewater discharges to land or to fresh or marine waters. In addition, Alyeska uses best management practices to minimize volumes of wastewater generated, as well as to ensure that the wastewater is handled and disposed of properly. Best management practices cover wastewater-generating activities along the pipeline and at the VMT.

Effluent monitoring is performed for the VMT BWTF and for all sanitary discharges. Tables 4.2-1 and 4.2-2 present permit-specific water quality monitoring requirements.

In response to stipulations of the 1989 re-issuance of the NPDES permit for the VMT and BWTF, a Technical Advisory Group was formed to: (a) allow technical experts and the public an opportunity to review and comment on draft monitoring reports prepared by Alyeska's consultants and (b) help agencies evaluate the operation of the BWTF and the reporting requirements of the NPDES permit. The original group included six members representing a broad range of expertise in environmental monitoring of marine systems. In 1993, ADEC established a broader work group to provide a forum for ADEC, EPA, the Technical Advisory

Table 4.2-1. *Requirements of the VMT NPDES permit.*

Discharge	Parameters	Frequency
Ballast Water Treatment Plant	Total Aqueous Hydrocarbons	Monthly
	BTEX	3/week
	Total Suspended Solids	3/week
	pH	Continuous
	Whole Effluent Toxicity	Quarterly
	Dissolved Inorganic Phosphorus	Monthly
	Ammonia	Monthly
	Flow	Continuous
	Density	Weekly
	Total Recoverable Zinc	Quarterly
Sanitary Waste	Biochemical Oxygen Demand	Monthly
	Total Suspended Solids	Monthly
	pH	Daily
	Fecal Coliform Bacteria	Quarterly
	Flow	Continuous

Table 4.2-2. *Requirements of linewide NPDES permit.*

Discharge	Parameters	Frequency
Excavation Dewatering	Turbidity	Daily (a)
	Settleable Solids	Daily (a)
	pH	Daily (a)
	Oil, Grease and Hydrocarbons	Monthly (b)
		As needed (c)
	Flow	Daily
	Visual (d)	Daily
Domestic Wastewater	Biochemical Oxygen Demand	Monthly
	Total Suspended Solids	Monthly
	Fecal Coliform	Monthly
	Total Residual Chlorine	Weekly
	pH	Weekly
	Flow	Daily
Hydrostatic Testing	Settleable Solids	Daily
	pH	Daily
	Visual	Daily
	Oil, Grease and Hydrocarbons	As needed (c)
	Flow	Daily

(a) Parameters monitored only if discharge reaches receiving water.
(b) Sampled only if excavation is within one-half mile of a pump station or other industrial facility.
(c) Sample collected if sheen is observed.
(d) Includes monitoring for sediment accumulation, impacts to vegetation, erosion, sheen and floating/other materials.

Group,[2] Alyeska, and the Prince William Sound Regional Citizens Advisory Council to build an understanding of BWTF issues and to make recommendations to oversight agencies. From 1990 to 1999, the work groups have met on 32 occasions and have initiated changes to plant operations and monitoring procedures, including institution of a pollution prevention framework and annual review process as part of the current NPDES permit (Kitigawa, 2000).

In addition, Alyeska monitors the receiving water environment in Port Valdez. This monitoring is focused on sediment chemistry, and benthic abundance and biological diversity and abundance (Section 4.3.1.2). The studies are designed to detect short- and long-term changes to the marine ecosystem and to understand any changes caused by natural variation and human influences (Feder and Shaw, 2000). Sediment hydrocarbon measurements are used to make comparative evaluations with nationally accepted standards. Biological studies provide a history of the types and abundance of organisms that inhabit the sediments.

Studies have generally shown that sediment concentrations of hydrocarbons are typically well below levels expected to cause environmental impact. However, recent sediment monitoring showed oiled sediments and alterations in the structure of the biological community (Shaw et al., 1999). The findings of the environmental monitoring assisted in developing refinements in the BWT operations in order to minimize future discharge of oily solids (Kitigawa, 2000, p. 16)

At material sites where earth disturbance could affect runoff water quality during rainfall, Alyeska performs the following stormwater monitoring and inspections in order to mitigate discharge of potentially polluted stormwater and to comply with the general stormwater permit:

- Evaluation of non-stormwater discharges at the site;
- Quarterly inspections of the site;
- Quarterly visual examinations of stormwater runoff (conducted during a storm event); and
- Analytical monitoring for total suspended solids (TSS), pH, and nitrate/nitrite as nitrogen (conducted quarterly during a storm).

In addition, comprehensive annual inspections are conducted of stormwater permitted sites to evaluate the effectiveness of the stormwater pollution prevention plan for the site. The plan outlines runoff management practices, sediment and erosion controls, and best management practices in place. Table 4.2-3 summarizes analytical monitoring requirements.

[2] The Technical Advisory Group was discontinued and was absorbed into the larger work group upon renewal of the permit in 1997.

With the exception of the VMT and Pump Station 1, water wells provide drinking water to Alyeska facilities outside of municipal and city boundaries. Under state regulations (18 AAC 80), all public drinking-water systems, including the VMT and Pump Station 1, must monitor the quality of water produced (Table 4.2-4).

Air Quality Monitoring

By E. Haas

All TAPS facilities are subject to both state and federal air quality regulations. ADEC issues air-quality construction and operating permits to each major facility. With the exception of Pump Station 5 — which is below the ADEC permitting threshold — all pump stations and the VMT have air-quality construction permits. Under Title V of the 1990 Clean Air Act Amendments, every major facility must obtain operating permits (“Title V” permits) from the state. Alyeska has applied for a Title V permit for all facilities including Pump Station 5. Until ADEC issues final Title V permits, each facility must operate in accordance with the conditions in the existing construction permits and in the Title V permit applications. The Title V permitting program requires that each facility periodically demonstrate compliance with all requirements in the existing permits and applicable regulations. Each Title V permit application contains a summary of all requirements the facility is subject to. The application also describes specific monitoring tasks pertaining to each permit requirement. Table 4.2-5 shows a summary of the key monitoring requirements. Extensive air quality impact data collected in the North Slope oil fields by the field operators and in Valdez by Alyeska show that both locations are in compliance with the state and federal ambient air quality standards and increments (see Table 4.3-7). Modeling results from Pump Stations 2 and 7 show that the stations are predicted to be in compliance with the ambient standards and increments under permitted conditions (see Section 4.3.1.3).

Table 4.2-3. *NPDES multi-sector permit requirements for operations material sites.*

Parameters	Frequency
Total Suspended Solids	Quarterly (a)
pH	Quarterly (a)
Nitrate/Nitrite as Nitrogen	Quarterly (b)
Visual Examination of Water Quality (includes color, odor, clarity, sheen, and other indicators of pollution)	Quarterly (a)

(a) Sampling performed during a storm event as defined by EPA.
(b) Storm event sampling, only in second and fourth year of multi-sector general permit (1997 and 1999).

Table 4.2-4. *State of Alaska drinking-water monitoring requirements.*

		Frequency	
	Parameter	Surface Water	Groundwater
Class A Systems	Inorganic Chemicals	Yearly	Every 3 years
	Asbestos	One Sample (d)	One Sample (d)
	Nitrate	Quarterly	Yearly
	Nitrite	One Sample (d)	One Sample (d)
	Lead and Copper	Varies (a)	Varies (a)
	Pesticides	Waiver Obtained (b)	Waiver Obtained (b)
	Volatile Organics	Varies (c)	Varies (c)
	Radioactivity	Every 4 Years	Every 4 Years
	Coliform Bacteria	Monthly	Monthly
	Turbidity	Daily	Not Applicable
	Disinfectant Residual	Daily	Daily
Class B Systems	Nitrate	Yearly	Yearly
	Nitrite	One Sample (d)	One Sample (d)
	Coliform Bacteria	Monthly	Monthly
	Disinfectant Residual	Daily	Daily

(a) Monitoring performed in 6-month to 3-year intervals, depending on compliance status. All Alyeska systems fall under reduced monitoring requirements.
(b) Waiver obtained after initial sampling was performed.
(c) Alyeska systems on annual or triennial sampling scheduled based on previous analytical results.
(d) Monitor once during the first compliance period of each compliance cycle, depending on previous Alyeska analytical results.

Table 4.2-5. *Some key TAPS federal and state air-quality monitoring requirements.*

Parameters	Frequency
Fuel consumption (all stationary fuel burning equipment)	Continuous, daily, monthly
Operating hours (certain fuel burning equipment)	Continuous
Engine speed, combustion temperature (MLU gas turbines only)	Continuous
Fuel heating value	Monthly
Opacity, NO_x and SO_2 emission rates (certain fuel-burning equipment)	Continuous, monthly
Periods and amounts of excess emissions (all fuel-burning equipment)	Upon each occurrence
Fuel sulfur and H_2S content	Monthly
Amount and type of waste incinerated	Daily
COTU overhead gas H_2S content (PS 6, 8,10 only)	Every four hours
Sewage stack injection parameters, amounts injected (pump stations)	Every four hours, daily
Storage tank cleaning times	Continuous
VMT – tanker loading amounts per berth	Continuous
VMT – marine tankers opacity	Continuous
VMT – vapor recovery waste gas heat content	Continuous
VMT – crude tanks vapor pressure	Continuous
VMT – crude tank farm vapor recovery system venting minutes	Continuous
VMT – soil vapor extraction amounts	Monthly, annually
VMT – crude tank bottoms processing rates	Continuous
VMT – marine tanker bunker fuel sulfur content	Each vessel
VMT – vapor incinerator destruction efficiency	Continuous
Dates and amount of fuel burned and for fire fighting training	Daily
Demolition activities, amounts of asbestos removed	Continuous
Oil spill in-situ burning – times and amounts of materials burned	When applied
Use of dust suppressants – type and amount of materials used	When applied

Biological Considerations for Operations and Maintenance

By H. Whitlaw, S. Haskell, and R. Senner

The Federal Grant and State Lease stipulations hold Alyeska to a high standard of environmental protection and cover all pipeline-related construction, operation, and maintenance activities. The intent was to ensure that Alyeska would incorporate measures to avoid, minimize, or otherwise mitigate adverse impacts of the pipeline at the initial planning stages and maintain them throughout the construction, operation, maintenance, and eventual decommissioning of TAPS (Brna, 1999, pers. comm.). Crabtree and Roseberry (1981) reported that this approach is the most effective way to mitigate potentially harmful effects of pipelines on the environment.

In addition to the stipulations, TAPS operations and maintenance activities conducted by Alyeska must comply with all applicable federal and state laws, regulations, and permit conditions, as well as with borough and local jurisdictional codes. Furthermore, Alyeska applies its own best management practices and standard operating procedures based on environmental knowledge acquired during TAPS operation and maintenance. These measures include, but are not limited to:

- Improved solid-waste management (e.g., prompt and thorough incineration of garbage, complete enclosure of pump stations with fences, use of bear-proof garbage containers);
- Enforcement of company policy that prohibits the intentional or unintentional feeding of wildlife and activities that may attract wildlife to work areas;
- Procedures for safely and humanely dealing with wildlife that occasionally become involved with TAPS facilities or activities (e.g., hazing, translocations, live-capture boxes);
- Training of Security personnel in hazing nuisance animals;
- Requiring prior written permission from Alyeska for public access to the ROW;
- Prohibiting firearms at Alyeska facilities and on the ROW;

- Installing screens on air intakes at pump stations to protect birds and turbines;
- Working with ADF&G to deal with problem beavers. This may involve removal of beavers, dams, or in some cases retention of beaver dams that provide fish overwintering habitat;
- Revegetation research and monitoring; and
- Improvements in ballast water treatment at the VMT.

Terrestrial Mammals. Alyeska has identified seasonal and locational sensitivities relevant to the planning and execution of pipeline maintenance activities to avoid disturbing wildlife during critical periods (APSC, 1993). The following considerations relate to the Stipulations 2.2.1.1, 2.2.6.2, 2.5.4.1, and 2.8.1:

- **Bison:** Avoid bison as much as possible due to their potentially aggressive nature. Ground activity and low-level aircraft flights should be minimized around calving areas from early May through mid-July. Aircraft should not circle over any wildlife.
- **Black Bear:** Avoid activities in areas with sows and cubs, including any identified denning areas from just prior to denning until shortly after the bears emerge in the spring. Follow all fencing and waste disposal procedures to prevent the attraction of bears and hazardous situations for workers.
- **Brown (Grizzly) Bear:** Follow waste disposal procedures to avoid attracting bears. Aircraft flights should be at least 1,000 feet above a den site and at least 500 feet above bears. Brown bears react more to helicopters than fixed-wing aircraft. Even small blasting charges, such as those used in seismic work, can disturb a denning bear 1.5 miles away. Increasing levels of existing background noise within 0.5 miles can influence selection of a winter den site.
- **Caribou:** Minimize ground and low-level aircraft activity in the presence of caribou during calving season and active migration along the pipeline system. Also, long segments of open ditch and intensive maintenance work in these important habitats should be minimized when caribou are present.
- **Dall Sheep:** Some sheep react strongly to noise, human presence, and aircraft, while others can develop a tolerance for regular noise and traffic. Ground activities such as blasting and rock crushing should be minimized near lambing areas between May 15 and June 20. Natural mineral licks should be excluded from new material sites and access roads, and work around artificially created mineral licks should be avoided when ewes and lambs are present.
- **Moose:** Minimize activities that would reduce climax riparian vegetation, especially willows. Sensitive periods include late winter, and calving and post-calving seasons. Work during these sensitive periods where moose are present should be minimized because additional stress could be fatal to adults or newborn/unborn calves.
- **Muskox:** Do not attempt to get close to muskoxen. Minimize low-level aircraft activity near muskoxen, especially by helicopters.
- **Wolf:** Stay away from known den sites and minimize activities that would prevent wolves from using these sites. Follow waste disposal procedures to avoid attracting wolves.
- **Fox:** Stay away from known den sites and minimize activities that would prevent foxes from using these sites. Follow waste disposal procedures to avoid attracting foxes.
- **Beaver:** Distribution is not influenced by existing pipeline facilities and operations, but population growth and expansion could result in blocked culverts and modified drainages along TAPS.

Birds. Most bird species along TAPS are migratory and therefore protected by federal law. Stipulation 2.5.3.1 [Zones of Restricted Activities (ZRAs)] addresses potential disturbance of peregrine falcons: "(Contractor's) activities in connection with the Pipeline System in key fish and wildlife areas may be restricted by the Authorized Officer during periods of fish and wildlife breeding, nesting, spawning, lambing or calving activity and during major migrations of fish and wildlife…" The following considerations for particular bird groups relate to Stipulations 2.2.1.1, 2.5.3.1, and 2.8.1:

- **Waterfowl:** Minimize activities that may cause nest abandonment or stress during the flightless molting period. Some species of waterfowl such as the Canada Goose and many ducks can become habituated to human activity, but increased levels of disturbance such as heavy equipment or blasting should be minimized near waterfowl that are nesting, molting, brood-rearing, or migrating. During these times, low-level flights, especially by helicopters, should be minimized. Minimize activities that may result in changing water levels where nesting waterfowl are present.
- **Raptors:** An occupied Peregrine Falcon nest, as designated by the U.S. Fish and Wildlife Service (FWS) through the Authorized Officer, constitutes a ZRA. Between April 15 and August 31, all ground activity within 1 mile of an occupied nest is prohibited, and aircraft must remain at least 1,500 feet above the nest.

All activities within 2 miles of the nest that may produce high noise levels are prohibited. Traffic on the Dalton and Elliot Highways is exempt. Other exemptions must be authorized by FWS. For example, exemptions were made for nests near Pump Station 2 (Ritchie, 1999, pers. comm.). The Authorized Officer may apply additional restrictions within 15 miles of nest sites. ZRAs are subject to annual change according to actual nesting. Bald and Golden eagles are protected under special federal laws. In addition, FWS Section 7 permits are required for some activities that may affect threatened and endangered species (e.g., eiders and peregrines [even with their recent delisting]). Certain ground and aerial activities are restricted in proximity to active nests as determined by disturbance potential. Prior to June 1 of each year, all nests are considered to be potentially active and treated accordingly. After this date, only active nests require compliance.

- **Other Birds:** This category pertains mostly to ptarmigan and grouse species. It is recommended that disturbances near Sharp-tailed Grouse communal courtship displays (i.e., lek sites) be minimized.

Fish. Because the ROW includes approximately 800 stream or river crossings, the protection of fish habitats and maintenance of fish passage are high priorities (Stipulation 2.5.1). Grant and Lease stipulations and Alaska law require prior approval by the Alaska Department of Fish and Game (ADF&G) for activities that may disturb fish streams. In particular, any construction or maintenance activity along the ROW that could adversely affect anadromous or resident-fish-bearing waters must be permitted in advance by ADF&G under state law (AS 16.05). Sensitive periods for fish populations vary with species, life history, and habitat usage, and include migration and spawning activities occurring during open water. Streams with overwintering fish populations are considered sensitive year-round due to concentrations of fish in small areas stressed by winter, or because of incubation and rearing periods. Stipulation 2.5.3.1 identifies these areas as ZRAs.

Vegetation and Wetlands. All activities in wetland areas that require placement of gravel fill are subject to federal Section 404 permit regulations. Mitigation of impacts to vegetation is achieved by the following measures:

- Appropriate scheduling of maintenance activities to minimize stockpiling of soils that could impact underlying vegetation.
- Maintenance of natural drainage patterns in the landscape, to the greatest extent possible, to avoid erosion, sedimentation, dewatering of vegetation, and/or the formation of impoundments. This is achieved by proper placement and maintenance of culverts and by appropriate facility design and placement.
- Road maintenance and enforcement of appropriate driving speeds to reduce the dust load received by vegetation.
- Proper maintenance of facilities to ensure compliance with state and federal air quality regulations.
- Appropriate and timely response to all oil, fuel, or chemical spills.
- Revegetation, which along the TAPS ROW has been extensive and is the primary mitigation of impacts to vegetation in the ROW.

4.2.3 Spill Prevention and Response

By J. Lukin

Congress passed OPA 90 after the *Exxon Valdez* spill. Under OPA 90, tanker owners and operators are responsible for satisfying applicable federal response planning requirements in Prince William Sound. OPA 90 requires tanker owners and operators to provide and maintain the capability to conduct oil spill recovery up to 200 miles offshore in the Gulf of Alaska under federally stipulated weather conditions. To ensure personnel safety on the open sea in a response, tanker owners and operators have funded modifications to barges and purchased equipment to operate in the gulf, known for its severe storms. Among the provisions of OPA 90 are:

- Liability was increased for spills.
- Facility and tanker response plans were required.
- Regional Citizens' Advisory Councils were authorized in Prince William Sound and Cook Inlet.
- An oil spill recovery institute was established for Prince William Sound.
- Terminal and tanker oversight and monitoring were increased.
- A navigation light at Bligh Reef was mandated.
- Equipment and personnel requirements were specified under tanker and facility response plans.
- Prevention measures were implemented, including drug and alcohol abuse testing, licensing for mariners, vessel traffic systems, overfill monitoring devices, study of tanker navigation safety standards, tank vessel manning, pilotage, maritime pollution prevention training program study, and vessel communication equipment regulations.
- The act mandated a national planning and response system, including development of "Area Contingency

Plans" by the federal government.
- USCG vessel design standards were imposed requiring double-hulled tankers according to an established schedule and set of criteria.

In 1990, the Alaska Legislature passed House Bill 567 amending the state's oil-pollution-control statutes by significantly increasing standards for tankers, terminals, pipelines, and oil exploration and production facilities. ADEC subsequently issued major revisions to its oil spill regulations (18 AAC 75). Among the provisions of the new law were the following:

- Spill prevention requirements were added to spill contingency plan rules.
- Response planning standards were established for different types of facilities or vessels — i.e., volumes of oil a vessel or facility must plan to remove from the water within 72 hours of a spill. These are not cleanup standards that must be met by the holder of the contingency plan; they are planning standards that the planholder must use in the development of the contingency plan and identification of response equipment needs. For a discharge of crude oil from a tank vessel or oil barge, the plan holder must have the resources to contain or control, and clean up a response planning standard of a 50,000-bbl discharge within 72 hours (for a cargo volume less than 500,000 bbl) and a 300,000-bbl discharge within 72 hours (for a cargo volume greater than 500,000 bbl.
- Proof of financial responsibility was required ($300 per barrel of storage capacity of tank vessel or $100,000,000, whichever is greater).
- ADEC must review and approve oil discharge prevention and contingency plans every three years.

4.2.3.1 Pipeline

Operation of TAPS is governed by the *TAPS Oil Discharge Prevention and Contingency Plan* (CP-35-1) approved every three years by ADEC. The plan includes the following:

- Equipment and resources and field training for spill responders.
- Electronic leak-detection capabilities.
- Improved leak detection and leak prevention alarm systems for pump station tanks.
- More than 220 sites along the pipeline ROW designated as oil spill equipment staging and deployment areas, and dedicated oil spill contingency plan buildings and equipment at each pump station.
- Mutual aid agreements with villages near the pipeline to use residents and equipment in the event of a spill.
- Twelve spill scenarios covering a variety of terrain, oil products, spill volumes and seasonal conditions.
- Aerial photographs of the pipeline to aid in spill response planning.

Sections 4.2.1 and 4.2.2 above discusses the leak detection systems and the design features and operating procedures for reducing the likelihood of a spill and for minimizing its size should one occur. Table 4.2-6 summarizes the spill response equipment available along TAPS.

Prevention programs can be divided into two categories:

- **Equipment:**
  - Control system interlocks
  - Redundant system design
  - Secondary containment systems
  - Level gauges
  - Abnormal condition alarms
  - Valve system
- **Operational:**
  - Safe operating (including transfer) procedures
  - Operator training programs
  - Substance abuse program
  - Medical monitoring program
  - Security program
  - Corrosion monitoring and prevention programs
  - Preventative maintenance programs
  - Quality programs

Prevention programs involving equipment along the TAPS has been discussed in previous sections. However, operational systems are discussed in greater detail below.

Safe Operating and Transfer Procedures

Alyeska has a series of procedures to prevent spills from routine activities (Alyeska documents SA-38, SIM-215-3.5, PL-123, and PL-124). Among the activities that have received specific planning are: unloading propane, transferring gasoline to above-ground storage tanks, loading and unloading turbine fuels in remote locations, and fueling heavy equipment. Crude-oil breakout tanks at pump stations and above-ground storage tanks have additional operating procedures and protective measures.

Alyeska's Tank Preventative Maintenance Program includes the following protective measures that are described in more detail in the *Trans-Alaska Pipeline System Tank Manual* (TM-188). The procedures include inspection of tank-bottom thickness, tank-bottom structural repair, internal coating system, internal cathodic-protection system, external tank-bottom cathodic-protection system (as appropriate), and re-inspections at intervals designed to prevent the occurrence of tank-bottom penetration. Daily

Table 4.2-6. *TAPS oil spill contingency equipment.*

Category	Type/Description	Quantity
Vessels	Work barge w/trailer	2
	Riverboat w/trailer	13
	Airboat w/trailer	11
	Boat w/o trailer	1
	Inflatable rafts	13
	Anchors	30
	Personal flotation devices	>250
	½" line	42,000 ft
Boom	Fire-resistant boom	2,156 ft
	Protected-water boom	33,400 ft
	Palletized boom	32
Skimmers	Weir skimmers	22
	Manta Ray skimmers	12
	Skimpak skimmers	11
	Oleophilic skimmers	27
Storage	Tanks/Bladders	961,300 gal
	Drums (55-gal)	220
Miscellaneous	Mobile camp	1
	Communication modules	2
	Portable shelters	24
	Portable generators	24
	Helicopters	4
	Helitorch	1
	Vacuum trucks	11
	Space heaters	22
	Light tower/plant	22
	Pressure washers	11

inspections of tank farms are conducted and operations personnel record findings in facility data logs. Daily fuel accounting is performed at each location for all regulated tanks. If a discrepancy in volume greater than 0.05 percent is noted, an investigation is triggered. Alyeska's procedures meet or exceed industry standards recommended in API Standard 653.

Operational Prevention Programs

Training is a primary prevention program used to mitigate the risk of human error. Alyeska's training programs for operational-type activities involve qualification and certification standards, as well as licensing. Alyeska personnel receive training in safe operating procedures necessary to perform their duties. Contract workers involved in routine or project maintenance activities receive oil spill prevention training necessary to perform their duties. Contract maintenance and project work is controlled by a project work plan and work permit system.

In addition, Alyeska regularly holds safety meetings and communications meetings, and requires individuals to be proficient in safe operating procedures specific to their duties.

Substance Abuse Program

Alyeska employees and contractors who perform operations, maintenance, or emergency functions on oil handling or transfer facilities, or are operators of a commercial motor vehicle, are subject to a drug-testing program designed to meet federal requirements. Testing is conducted pre-employment, randomly, for cause, and post-accident.

Medical Monitoring Program

Medical monitoring programs are in place for Alyeska employees assigned to operations and maintenance or emergency response positions at field locations. The purpose of the program is to ensure that employees are medically and mentally capable of effectively performing the essential job functions to which they are assigned.

Security Program

Security for the pipeline system consists of required badges for employees and contract personnel that are preapproved, facility ingress/egress points that are manned 24 hours a day, fences at all facilities, Security patrols, and lighting strategically located to provide critical vision points for Security. Above-ground pipeline crossings of major rivers are fenced, alarmed, monitored by closed-circuit television, and patrolled.

4.2.3.2 Valdez Marine Terminal

Oil storage and transportation facilities at the VMT are designed to prevent spills. The more likely sources of spills at the terminal derive from maintenance and system integrity problems, including pinhole corrosion leaks in pipes, improperly installed fittings, leaking gaskets, or valve packings. Potential spills could also occur from equipment failure or operator error. The procedures, requirements and equipment in place include, but are not limited to, the following:

- Secondary containment and drainage into tertiary systems.

- Visual inspections (hourly during loading) and camera surveillance of both grounds and equipment.
- Overfill alarms.
- Locking valves.
- Back-pressure automatic shutdown devices.
- Tanker booming during loading.
- Training, drills and exercises.
- Ultrasonic corrosion testing.
- Maintenance and inspection procedures.

The following prevention programs are in place and are explained in Alyeska's ADEC-approved *Valdez Marine Terminal Oil Discharge and Prevention Plan* (CP-35-2):

- Prevention training.
- Substance abuse prevention.
- Medical monitoring.
- Security.
- Transfer procedures, including hourly volume/quantity comparisons to verify amount loaded.
- Inspection and maintenance of storage tanks and secondary containment.
- Safety inspections by VMT personnel.
- Rockwall monitoring.
- Corrosion control program for steel piping.
- Leak detection program.
- Preventive maintenance.
- Surveillance and monitoring.
- Earthquake monitoring.
- Fire wires for rapid pickup by a tug to tow a tanker from the dock.
- Work permit system.
- Tanker size limitations for berths.
- Minimum mooring line requirements for tankers.

The VMT is also equipped with spill response equipment to handle potential spills, and a 10-person spill response team is always on duty at the terminal. Major equipment includes five self-propelled skimmers (listed in SERVS inventory), several workboats, and about 6 miles of oil boom available for immediate use.

4.2.3.3 Tanker Trade

Mitigation measures associated with tanker operations are presented here for consideration in the cumulative effects analysis in Section 4.5. Since the *Exxon Valdez* spill in 1989, significant improvements have been made in procedures to prevent a spill from a tanker and to respond to any spill which might occur. Table 4.2-7 summarizes the changes in spill prevention and response preparedness for tanker traffic in Prince William Sound, while Figure 4.2-14 illustrates these measures.

Alyeska's Ship Escort/Response Vessel System

SERVS was established on July 10, 1989, to help tankers navigate through Prince William Sound and to provide response services to the VMT and Alaska crude-oil shippers. Alyeska SERVS is certified by the USCG as an oil spill removal organization and registered by ADEC as an oil spill primary response action contractor for an oil discharge.

The Alyeska SERVS Base is located at the Valdez Emergency Response Base, built in 1994. The base is located at the Valdez small boat harbor and contains the Valdez Emergency Operations Center. The base also has equipment storage, a docking facility, and a helicopter landing area. Table 4.2-8 lists Alyeska SERVS equipment.

Procedures for Tanker Operations

The USCG has established tanker lanes and rules, and tracks all tankers on its Vessel Traffic Service (VTS). State-licensed marine pilots are required from and to Bligh Reef. In addition, precautions are taken during periods of high winds and low visibility, and when ice presents a potential hazard. Once tankers reach the VMT, the entire transfer operation is monitored, and response equipment and personnel are on standby. Before departure, the tanker and escort vessel masters, SERVS response coordinator, and the harbor pilot hold a conference to discuss the upcoming laden tanker transit. The VTS radar tracks each laden tanker through the sound until the tanker is 17 miles into the Gulf of Alaska.

Docking and Loading Procedures. As soon as a tanker is moored at the VMT, oil spill containment boom is placed around the tanker before it begins unloading its ballast water for treatment in the Ballast Water Treatment Facility and taking on crude oil. USCG regulations govern all transfers of liquids between the VMT and tanker. Before any transfer, a conference is held to discuss unique transfer procedures and safety measures. A berthed tanker is inspected hourly for any sign of a spill or leak.

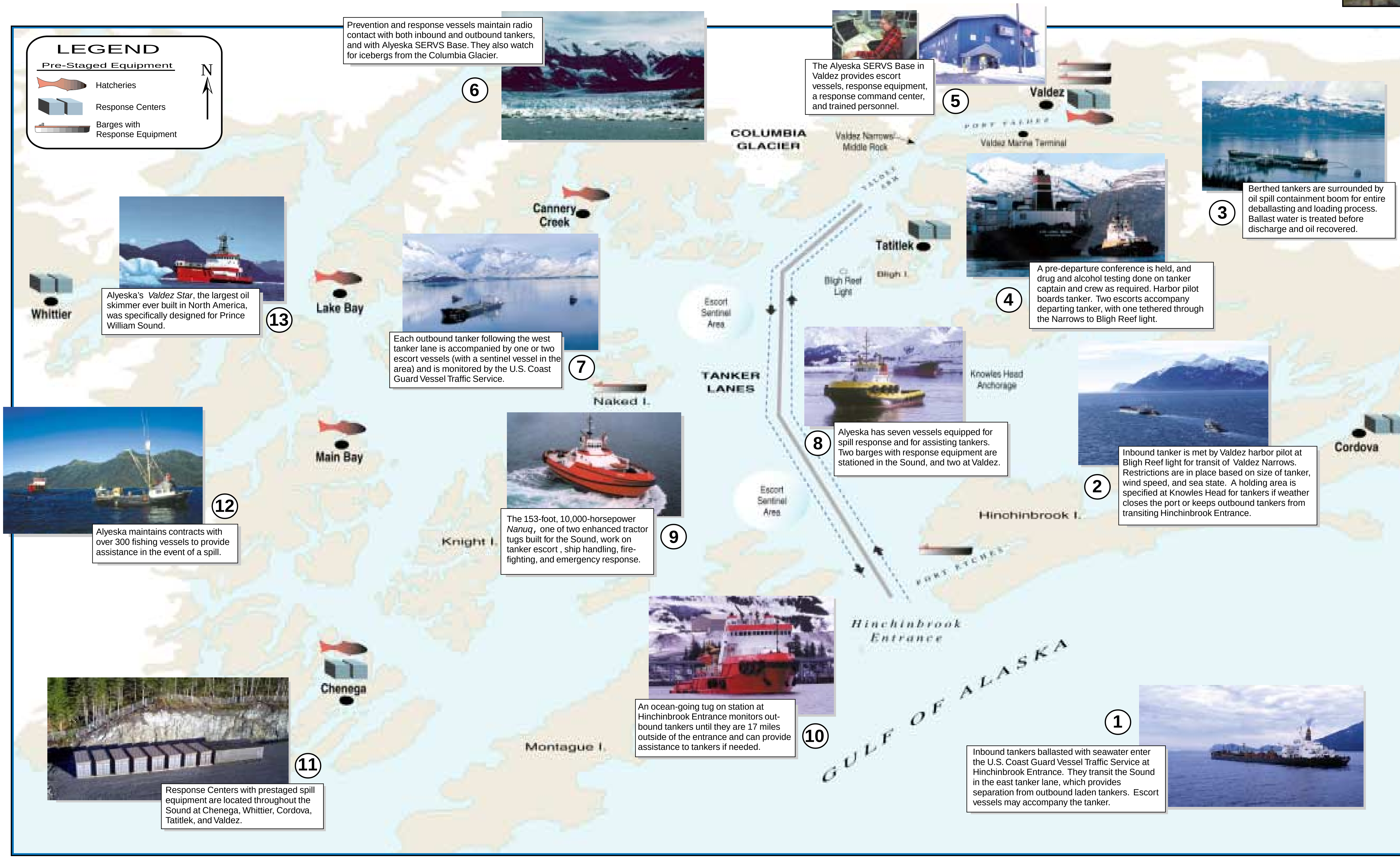
Escorts for Laden Tankers. Nine vessels are assigned to escorting, docking, and response duties, and at least two escort vessels are required for each laden tanker transiting the sound. Tethered escort is required through Valdez Narrows. In the northern sound, the escort vessels will be within one-quarter nautical mile of the tanker, when not tethered. In the central sound, a conventional tug or prevention and response tug (PRT) will maintain close escort, while the second escort vessel goes on sentinel duty to provide response coverage to a larger area. A vessel is on sentinel duty in the Hinchinbrook Entrance area. A third escort vessel may be added, depending on weather conditions.

Table 4.2-7. *Prince William Sound spill prevention and response.*

Category	Before March 1989*	Fall 2000*
Tanker, Escort, Tracking, and Operations	• Vessel escort only through Valdez Narrows • USCG radar tracking to pilot station (past Valdez Narrows) • No drug and alcohol testing for tanker crews	• 3 prevention and response tugs (PRTs), 2 enhanced tractor tugs (ETTs), and 4 conventional tugs • USCG Vessel Traffic Service; enhanced radar coverage; automated vessel tracking in Prince William Sound (PWS) • Tanker officer alcohol testing prior to sailing; weather restrictions on tanker operations; ice routing measures; tankers boomed during loading at Valdez Marine Terminal (VMT)
Oil Spill Recovery and Nonmechanical Response Systems	• 13 oil-skimming systems with recovery capability of 27,000 bbl of oil in 72 hours • 1 barge with 12,000 bbl storage for recovered oil • Approximately 5 miles of containment boom; no fire boom/igniter systems • Limited dispersant and application systems in place	• Major SERVS response equipment on 24-hour standby. • Over 70 skimming systems with recovery capability of 300,000 bbl of oil in 72 hours • 7 barges with 818,000 bbl storage for recovered oil • At least 35 miles of containment boom plus over 3,000 ft of fire-resistant boom with 2 helicopter igniter systems • Dispersant stockpile of over 60,000 gallons with fixed-wing, helicopter, and vessel-based application systems
Spill Planning, Management, and Training	• Contingency plan developed for “most likely” spill scenario of 4,000 bbl • Drills conducted every few years outside Port Valdez • Response team in place resembled a command system • Valdez Terminal employees provided response personnel; no SERVS organization	• State-approved comprehensive Oil Discharge Prevention and Contingency Plan developed by shippers and Alyeska for response planning standard of 300,000 bbl • Major tanker drill conducted annually with frequent smaller drills • Weekly drills and training exercises • Unified Incident Command System structure with USCG, Alyeska, shippers, and state for incident response • Alyeska SERVS is the dedicated, trained spill response organization with over 200 personnel and contractors
Community Involvement, Response, and Training	• No organized citizen involvement in plan development and oversight • No community response centers • No community training programs • Approximately 10 fishing vessels at Port Valdez under contract for spill response	• PWS Regional Citizens’ Advisory Council budget for 2000 is $2.5 million • 5 Community Response Centers in PWS • Community training programs in PWS and Kodiak • Program trains and integrates fishing vessels in oil spill response plans; over 300 fishing vessels under contract
Wildlife and Resource Protection	• No specific fish hatchery protection plans • No specific wildlife rescue programs	• Hatchery protection plans with pre-staged equipment for all hatcheries in PWS • Wildlife response plan with hazing, capture, and rehabilitation equipment on site and ready for rapid deployment
Communications	• Radio communications for spill response from scene to command center only	• Fixed radio repeater system with communications capability to cover PWS
Government Oversight	• State oversight at Valdez Terminal and tanker operations by 3 on-site state employees	• Comprehensive oversight of VMT and tanker operations by federal and state agencies, including the Joint Pipeline Office; 7 specially trained on-site state personnel
Spill Prevention and Response Budget	• Approximately $1 million annual for VMT and PWS	• Approximately $60 million annually

*Based on oil spill contingency plans reviewed and approved by the ADEC and USCG for 1999.
Note: ADEC (www.state.ak.us/dec/) offers a similar list (Feb. 1999) titled “Then and Now.”

Source: APSC (1999d) with slight modification.



Photos courtesy of Alyeska Pipeline Service Company

Figure 4.2-14.
Prince William Sound spill prevention and preparedness.

Table 4.2-8. *Summary of Alyeska SERVS spill response equipment.*

CATEGORY	TYPE	QUANTITY	SPECIFICATIONS
Vessels	Enhanced Tractor Tugs	2	153 ft long; 10,000 horsepower; 70,000-gallon storage for recovered oil.
	Prevention and Response Tugs	3	Enhance maneuverability, response equipment and towing equipment
	Other Tugs	4	Equipped with towing winches, and fire-fighting equipment
	Work Boats	10	
	Fishing Vessels on Contract:	50 (core group), 280 (support group)	
Storage (total capacity exceeds 835,000 bbl)	Response Barges	7	Including one dedicated nearshore barge and one lightering barge
	Mini Barges	48	Storage capacity of 249 bbl each
	Pollutank/Unitor Bags	6	Storage capacity of 629 bbl each
Skimmers (total maximum skimming capacity: 50,000 bbl per hour)	V*aldez Star* Oil Spill Recovery Vessel:	1	2,000 bbl per hour skimming capacity, 123 ft long
Self-Propelled	*Chenega Bay Star*	1	Recovery rate up to 571 bbl per hour
	Tatitlek Star	1	Recovery rate up to 571 bbl per hour
	Marco Class V	1	Recovery rate up to 571 bbl per hour
	Marco Class VII	1	Recovery rate up to 1,281 bbl per hour
Weir Skimmers	Boom/Weir System	2	Recovery rate up to 600 bbl per hour each
	High-Capacity Skimmers	12	Combined recovery rate up to 32,400 bbl per hour
	Moderate-Capacity Skimmers	13	Combined recovery rate up to 5,280 bbl per hour
	Skimmers	10	Recovery rate up to 171 bbl per hour each
Disc Skimmers	High-Sapacity Skimmers	12	Total recovery rate up to 4,620 bbl per hour
Miscellaneous	Skimmers	20	Various capacities and types
Containment Boom (at least 35 miles)	Open Water Boom:	Over 68,000 ft	
	Protected Water Boom:	Over 44,000 ft	
	Calm Water Boom:	Over 72,000 ft	
Non-Mechanical Equipment	Fire-Resistant Containment Boom:	Over 3,000 ft	
	Heli-Torch Ignition System	2	Plus contract helicopter
	Dispersant Application Systems: 3 vessel-based, 2 helicopter-based, and 2 C-130 based;		Over 60,000 gallons of dispersant in stock
Response Centers	Valdez, Cordova, Whittier, Chenega, Tatitlek		
Prestaged Hatchery Equipment	Lake Bay, Cannery Creek, Solomon Gulch, Main Bay, Sawmill Bay		
Other Prestaged Equipment	Naked Island, Port Etches		

Additional vessels are available if needed for a response or to fill in for scheduled and unscheduled maintenance.

- Currently, the three PRTs and two enhanced tractor tugs (ETTs) are designated to fill escort and response duties. These vessels carry response equipment such as boom and skimmers. The escort vessels accompanying each laden tanker monitor the vessel's actions, and will radio the escorted tanker to question or alert the tanker of atypical behavior. The tanker notifies the escort vessels upon recognition of a loss of steering and/or propulsion or suspected equipment malfunction.
- All laden tankers must have one tethered escort in the northern sound from Port Valdez to Bligh Reef light.
- One of the vessels is stationed in the Hinchinbrook area (including Port Etches) to provide sentinel assistance to tankers in Hinchinbrook Entrance. This vessel, which is also used as a close escort vessel for laden tankers, has open-ocean rescue capabilities.
- The two ETTs were built specifically for service in the sound and were both deployed in 1999.
- The three 140-foot, 10,000-horsepower PRTs were deployed in 2000. They have twice the horsepower and are more maneuverable than the escort/response vessels they replaced.

Vessel Traffic Management. The USCG Vessel Traffic Service (VTS) includes radar coverage in the upper sound and Automated Identification System (AIS) throughout the sound offshore to about 60 miles off Hinchinbrook Entrance. Tankers are required to notify the VTS before entering lanes and to maintain communication while transiting.

Vessel traffic is separated in to lanes. Traffic lane depths range from 600 to 1,000 feet, with a minimum of 350 feet in the Valdez Narrows. Traffic lane width is typically a mile.

- Vessel traffic is limited to one-way traffic in Valdez Narrows, with speed restrictions for laden tankers. The USCG grants permission for vessels to begin transiting the Narrows. Maneuvering zones have been established at each end of Valdez Narrows.
- The maximum speed for a laden tanker can not exceed 10 knots through Valdez Arm and 5 knots through the Narrows. Through the central sound, the maximum speed is 12 knots (pending state approval). The maximum speed for a tanker under ice-escort is 6 knots.
- Federal regulations require each tanker to have two licensed deck officers on watch on the bridge and one pilot between 60º 49' north latitude (south of Bligh Reef) and Port Valdez.

Inbound and outbound laden tankers maintain direct telecommunication with the SERVS Duty Officer, the USCG, and each other. The tanker escorts coordinate their position and course with the tanker's position and course. The tanker and the escort(s) also report their position to the SERVS Duty Officer as they reach designated way points.

Ice Navigation Procedures. Columbia Glacier is about 10 miles from the tanker lanes, and ice is sighted in the tanker lanes on average 10 to 15 times a month. When the USCG Captain of the Port determines hazardous ice conditions exist in Valdez Arm, the Valdez Narrows ice-routing measures will be placed into effect.

- Outbound tankers are required to use an ice-scout vessel if ice is within 1 mile of the traffic lanes.
- The USCG will route traffic around ice, as appropriate. These measures may include one-way zones. An ice-scout vessel may also be used and tanker speeds reduced.
- During low visibility, when ice is spotted or if no ice report has been received in 6 hours, SERVS dispatches an escort vessel to act as an ice scout for empty inbound tankers.
- Using searchlights, lookouts, and radar, the scout vessel keeps about one-half mile ahead of the tanker to assess ice hazards.
- The ice scout maintains a position between the tanker and Columbia Glacier on the trip to the VMT. When a laden tanker leaves, an escort vessel acts as a scout through the sound.
- The maximum speed for tankers under ice escort is 6 knots.
- If no safe routing exists, Port Valdez will be closed to tank vessel traffic.

Weather Restrictions. The primary weather concern in Prince William Sound is wind.

- If winds are below 30 knots, tankers may loiter in Port Valdez for up to 3 hours. If winds are above 30 knots, the USCG determines whether a tanker may loiter.
- Port Valdez and Valdez Narrows will be closed when the steady wind is above 40 knots.
- Outbound tanker transits through Hinchinbrook Entrance are restricted when the steady wind exceeds 45 knots or sea states exceed 15 feet.
- For tankers smaller than 150,000 deadweight tons, a third escort vessel participates in outbound transits when the steady wind exceeds 30 knots — the speed at which transits for larger tankers are prohibited.

Substance Abuse Prevention Program. Alyeska and the tanker owners and operators have programs for sub-

stance abuse prevention, as mandated by the USCG and the U.S. Department of Transportation:

- Each employee undergoes a pre-employment physical that includes substance abuse testing.
- Masters of tank vessels and any other officer who will be placed in command of the bridge during the transit of the sound are given a chemical breath test within 1 hour of scheduled departure.
- Employees performing designated work functions are subject to both annual and random substance-abuse testing.
- Personnel in operations or maintenance, emergency response workers, and any tanker, Alyeska, or contractor personnel seeking access to vessels via the VMT are subject to probable-cause testing.
- Anyone on a vessel (except stewage personnel), as well as anyone at the berth involved in an incident, is subject to post-incident substance testing.

Response Preparedness in Prince William Sound

The tanker owners and operators maintain the *Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan*, which serves as the basis for plans for each individual tanker. Alyeska acts as the implementing contractor for the tanker plan, which describes the equipment, methods, and procedures for preventing tanker spills and for responding to a variety of potential spills. According to State of Alaska rules, the plan must describe how it meets the state's "response planning standard" of 300,000 barrels within 72 hours. The plan also addresses the response to a catastrophic or worst-case discharge of 1.8 million barrels of oil over 8 days.

Each tanker operating in Prince William Sound maintains its own state- and USCG-approved discharge prevention and contingency plan, with Alyeska acting as the contractor for prevention and initial response.

The tanker owners and operators have contracted with Alyeska to provide initial response for a minimum of 72 hours, after which the response may transition to the responsible party. Transfer of the response occurs from Alyeska when the Federal and State On-Scene Coordinators allow the responsible party to assume management and control of response efforts. The approval process ensures that the responsible party's oil spill response personnel understand their responsibilities so that the transition from Alyeska to the responsible party may occur as effectively as possible. Guidelines are in place for the transfer of the response from Alyeska to the tanker owner/operator. Following transfer of response management, SERVS may continue to make response equipment and personnel available for the tanker owner/operator in its oil spill response.

Dispersants and In-Situ Burning. To supplement mechanical response equipment, Alyeska maintains three types of dispersant application systems. One such system mounts on tugs, while a second is used by a helicopter. In addition, Alyeska owns two Airborne Dispersant Delivery System Packages (ADDS Packs) stationed near Anchorage International Airport. ADDS Packs are available for large-volume aerial spraying from chartered or USCG aircraft. Helicopter dispersant systems are also available in Valdez.

Alyeska maintains a special fire-resistant oil spill containment boom that can be used to hold burning oil. Helicopter-based ignition systems are also part of Alyeska's inventory.

Approval would be obtained from the Unified Command for use of dispersants or burning, and Alaska Regional Response Team guidelines would be followed.

Wildlife Protection and Response. The *Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan* contains a wildlife response program based on requirements, guidance, pre-approval, oversight, wildlife protection efforts, and on-scene coordination of the wildlife trustee agencies (U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the Alaska Department of Fish and Game). The Alyeska SERVS oiled-wildlife treatment facility in Valdez is designed to stabilize, treat, and rehabilitate oiled sea otters. Oiled birds would be stabilized in the field and treated at the industry-sponsored Alaska Wildlife Response Center in Anchorage.

Lightering Operations. Alyeska maintains lightering equipment to assist a tanker with salvage operations as needed. Cargo may be moved internally on the vessel or removed to a barge or other vessel. Although it may be impossible to prevent an initial escape from a leaking tank, use of the lightering vessel in combination with internal transfer may significantly reduce the likelihood of further spillage. Lightering operations will be directed by the responsible party and the USCG.

Spill Response Scenarios. The tanker plan contains three oil spill response scenarios to show how the strategies and tactics in the plan would be applied in a spill. The three tanker spill scenarios evolve from a similar hypothetical grounding of a single-hull vessel of 265,000 deadweight tons with a loaded cargo capacity of 1,800,000 barrels of crude oil. All three scenarios focus on strategies and tactics for direct response to spilled oil as required in State of Alaska regulations.

Best Available Technology Analysis. Systems and procedures presented in the current *Prince William Sound Tanker Oil Discharge Prevention and Contingency Plan* were determined by the State of Alaska to be best available technology. The 1998 revision of the plan contains analyses of the following topics in accordance with recent revisions to ADEC regulations:

- Prompt detection of an oil spill.
- Escort vessel system.
- The Hinchinbrook tug.
- Towlines.
- Field communications system.
- Positive means of stopping a transfer in the shortest amount of time.
- Procedures to stop a discharge at its source and prevent spreading.
- Procedures for real-time surveillance and tracking of discharged oil.
- Wildlife hazing, capture, treatment and release.

Incident Management. Management of a spill under the Prince William Sound tanker plans follows the Incident Command System, which provides for a consistent approach by the various parties involved, including Alyeska, the tanker owner or operator, and state and federal agencies. The Incident Command System has been adopted and implemented by state and federal emergency response organizations and regulatory agencies in Alaska.

Communications System. Radio control stations, base radio stations, mobile radios, and fixed and portable repeaters are in place to provide for coverage of the entire sound.

- The radio telecommunications network comprises the following major components: radio control facilities, radio base stations, and mobile units aboard the vessels, vehicles, and aircraft employed in operations.
- All tankers loading at the VMT are outfitted, at a minimum, with two VHF marine radios, one single-sideband radio, and a satellite terminal with voice and telex. These stations enable the vessels to communicate not only with Alyeska facilities but with other vessels and coast stations operated by common carriers or governmental agencies. Each escort vessel is equipped with at least two VHF marine radios and one single-sideband radio.
- Alyeska uses radio sites at Reef Island and at Johnstone Point in Prince William Sound to provide VHF marine coverage supporting day-to-day escort of vessels into and out of the Port of Valdez and to provide dedicated, in-place, spill response channels available for immediate use.

Overall Training Program. The Alyeska SERVS training program includes courses in the Incident Command System, oil spill prevention and response, safety, simulation exercises, and both announced and unannounced drills. The program follows the guidelines outlined in the National Preparedness for Response Exercise Program.

- Qualified Individual Notification, Spill Management Team and Equipment Deployment Exercises are conducted annually.
- One internal unannounced exercise is conducted annually. Several government-initiated unannounced exercises may be conducted each year with Alyeska.
- The contingency plan is categorized into 15 elements. Each element of the plan is exercised on a rotating basis, at least once every 3 years.
- Each type of boom and skimming system must be exercised once per year in each operating environment (fully protected areas such as rivers, sheltered areas such as harbors, and open water).
- Tethered-tug exercises are conducted to familiarize vessel personnel with rescue techniques.

Fishing Vessel Fleet. Alyeska maintains over 300 contracts with fishing vessel owners from four regions (Seward, Kodiak, Cook Inlet and Prince William Sound). The contracted vessels are grouped in two tiers as the Initial Responders (50-vessel core fleet) and Secondary Responders, and a database is maintained of other vessels in the area that could assist if needed.

Equipment Staging at Communities and Hatcheries. Response equipment is staged at five Prince William Sound communities: Valdez, Cordova, Whittier, Chenega, and Tatitlek. Hatchery protection equipment is staged at the five operating hatcheries in Prince William Sound: Armin F. Koernig Hatchery (Chenega), Cannery Creek Hatchery (Unakwik Inlet), Wally Noerenberg Hatchery (Lake Bay), Main Bay Hatchery, and Solomon Gulch Hatchery (Port Valdez). In addition, response equipment is prestaged near the sensitive Valdez duck flats aquatic habitat.

Technical Response Tools. Alyeska maintains a computer model to predict the surface movement and weathering of oil spilled in the sound. The model also contains geographical information on resources at risk from a spill.

Regional Citizens' Advisory Council. OPA 90 established two "Oil Terminal and Oil Tanker Environmental Oversight and Monitoring Demonstration Programs" with Regional Citizens' Advisory Councils — one in Prince William Sound and one in Cook Inlet. The councils have the following duties:

- Advise on policies, permits, and site-specific regulations relating to the operation and maintenance of terminal facilities and crude oil tankers.
- Monitor environmental impacts of the terminals and tankers.
- Monitor operation and maintenance activities that

may affect the environment.

- Review the adequacy of oil spill prevention and contingency plans for tankers and terminals.
- Provide advice and recommendations on port operations, policies, and practices.
- Recommend standards and stipulations for permits and site-specific regulations intended to minimize the impact of terminal and tanker operations, modifications to tanker and terminal operation and maintenance, and modification to oil spill prevention and contingency plans.

4.2.3.4 North Slope Oil Fields

Spill mitigation measures associated with operation of the North Slope oil fields are presented here for consideration in the cumulative effects analysis in Section 4.5. Following are examples of the many spill prevention measures the operators have incorporated into their day-to-day operations:

- Preparation of spill prevention, control, and countermeasures (SPCC) plans and oil discharge prevention and contingency plans.
- Preparation of marine transfer operations manuals for facilities that receive fuel transfer from barges or other vessels.
- North Slope Fluid Transfer Guidelines: These guidelines provide a step-by-step procedure for transferring fluids, including checks before transfers, use of secondary containment, and checks after the transfer is complete. In addition, the guidelines call for the avoidance of transfers near water bodies, tundra, and wildlife habitat.
- North Slope Unified Operating Procedure for Surface Liner/Drip Pan Use: This procedure requires the use of portable under-equipment liners wherever there is a chance of spills from equipment during maintenance work or fluid transfers. The purpose is to provide secondary containment, maintain contaminant-free work sites, and to encourage proper spill prevention techniques during normal field operations.
- Tanks, vessels, and piping are subject to both visual inspection and non-destructive integrity testing to detect corrosion so that remediation measures can be taken before system integrity is compromised.

North Slope operators maintain oil spill contingency plans for all their operations on the North Slope, in accordance with state and federal laws and regulations. The State of Alaska law requiring such plans is contained in AS 46.04.030, while the federal Oil Pollution Act of 1990 dictates plans for facilities that handle oil. The following agencies require plans:

- Alaska Department of Environmental Conservation
- U.S. Coast Guard
- U.S. Environmental Protection Agency
- U.S. Minerals Management Service
- U.S Department of Transportation

The plans provide detailed descriptions of the facilities, spill prevention programs, and response plans to handle spills of varying sizes.

Central to industry's spill response plans on the North Slope is the use of the Incident Command System (ICS), a crisis management system adopted by state and federal agencies, as well as the oil industry in Alaska. This system uses standardized organization charts and position descriptions, as well as forms for completing essential work. Use of ICS by all parties involved in an oil spill helps to ensure efficient management of the incident.

North Slope spill response plans are based on the operators' membership in Alaska Clean Seas (ACS), the oil spill response cooperative for the North Slope. ACS was founded in 1980 as the Alaskan Beaufort Sea Oilspill Response Body (ABSORB) and has the capability to respond to major onshore and offshore spills.

4.2.4 Social Mitigation Measures

By L.D. Maxim

Because social direct, indirect, and cumulative effects are closely intertwined, mitigation measures for all such effects are considered here. At the outset, it is appropriate to note that physical, biological, and social impacts are closely linked. Indeed, nearly all of the mitigating measures identified in Sections 4.2.1 through 4.2.3 above also help to reduce potential social impacts. Thus, for example, measures designed to reduce the likelihood or consequences of oil spills also reduce the likelihood and/or severity of impacts on subsistence harvests, one of the social impacts considered in this analysis. Adverse effects on subsistence resources have significant sociocultural implications because of the central importance of subsistence to Alaska Native culture. Therefore, measures that reduce subsistence impacts also lessen social impacts.

As a second example, the pipeline has been designed with features (e.g., height constraints on elevated sections, buried animal crossings, and designated big-game crossings) to mitigate possible constraints on the free passage of terrestrial mammals. Though designed to minimize impacts on animal populations, these measures also limit adverse

impacts on subsistence harvests.

Because of such linkages among physical, biological and social impacts, the focus of this section is on mitigating measures that are either targeted specifically on social issues and those (regardless of motivation) that are likely to have significant applicability to social impacts.

Mitigating measures are identified in, reflected by, or pursuant to one or more of the following:

- Stipulations in the 1974 Federal Grant and State Lease for TAPS;
- Stipulations in lease agreements for onshore and offshore ANS development (see, e.g., BLM and MMS, 1998);
- Specific commitments made by the TAPS Owners or Alyeska (e.g., as a component of oil spill contingency plans, in consent agreements);
- Economic/demographic factors; and
- Applicable federal and state laws and implementing regulations.

Examples from each of these general categories are presented below.

4.2.4.1 Original ROW Stipulations

Both the Federal Grant and State Lease contain numerous provisions that identify mitigating measures and duties to abate/rehabilitate damages relevant to possible social impacts. For example, several sections of the Federal Grant require measures that limit, mitigate, or require rehabilitation of potentially adverse TAPS impacts. These include:

- Section 9, Construction Plans and Quality Assurance Program.
- Section 10, Compliance With Notices To Proceed.
- Section 13, Damage to United States Property; Repair, Replacement or Claim for Damages (including requirements to rehabilitate any natural resource that shall be seriously damaged or destroyed).
- Section 16, Laws and Regulations.
- Section 23, Port Valdez Terminal Facility (including provisions to minimize environmental impacts).
- Section 24, Duty of Permittees To Abate.
- Section 29, Training of Alaska Natives.
- Section 30, Native and Other Subsistence.

As another example, most stipulations are designed to prevent, mitigate, or rehabilitate potential impacts. Three categories of stipulations are included in the Federal Grant: *general*, *environmental*, and *technical.* Stipulations in each category are applicable to social impacts. In the general category, for example, Stipulation 1.9 (Antiquities and Historical Sites) requires that an archaeologist provide surveillance and inspection of TAPS and its archaeological values, including an assessment of the protection measures to be undertaken by the Permittees. In the environmental category nearly all stipulations serve to mitigate social impacts. For example, Stipulation 2.10 (Aesthetics) instructs the permittees to consider aesthetic values in planning, construction, and operation of TAPS. This stipulation includes specific provisions (e.g., limitations on the straight length of pipeline segments visible from highways) to limit aesthetic impacts. As another example, Stipulation 2.5 (Fish and Wildlife Protection), referred to above, identifies measures that protect wildlife. Lastly, in the technical category, many stipulations mitigate possible social impacts. For example, Stipulation 3.6 (Stream and Flood Plain Crossings and Erosion) contains provisions to minimize the effects of scour, channel migration, undercutting, ice forces and degradation of permafrost.

4.2.4.2 Stipulations Contained in Other Lease Agreements

A routine feature contained in EISs regarding federal and state leasing activities for ANS fields is the identification and analysis of mitigation measures, which minimize cumulative impacts. Mitigation measures are ultimately reflected in lease stipulations. For example:

- The EIS for the Beaufort Sea Planning Area Oil and Gas Lease Sale 170 (MMS, 1998) contains numerous measures for protection of biological resources, conflict avoidance mechanisms to protect subsistence whaling and other subsistence activities, limitations on facility siting in the vicinity of Cross Island (to minimize subsistence conflicts), use of pipelines for transport of crude, and measures to minimize adverse effects on polar bears.
- The EIS for the National Petroleum Reserve-Alaska (NPR-A) (BLM and MMS, 1998) incorporates mitigation measures both implicitly and explicitly. For example, numerous explicit constraints on exploration and production and facility siting are identified for the entire planning area and for certain parts of this area, termed *land use emphasis areas*, because of their surface resource values. For each of the alternatives, there are both generic and specific stipulations that mitigate social impacts. Proposed stipulations for this planning area are detailed and include subsistence-related stipulations such as developing a monitoring plan for effects of exploration, development, and production on subsistence, and consulting with the North Slope Borough and the Subsistence Advi-

sory Panel about siting, timing, methods of operation, and mitigation that could be implemented to assure that exploration, development, and production activities do not conflict with subsistence practices.

- The EIS for the Northstar Project (USACE, 1999) identifies numerous mitigation measures designed to reduce impacts on subsistence species. Examples include requiring the use of acoustic scaring devices to disperse sea ducks and other migratory birds from an oil spill area, establishing flight corridors for helicopter traffic to minimize noise impacts on various bird and mammal populations, establishing vessel corridors and seasonal operating restrictions to maximize separation between vessels and migrating whales, prohibition of certain drilling operations during periods of broken ice to reduce the chance of an oil spill occurring when oil spill cleanup efficiencies are likely to be low, and the imposition of various constraints on construction activities to minimize environmental impacts.

These measures mitigate indirect and cumulative impacts of the proposed action.

4.2.4.3 Specific Commitments by TAPS Owners or Alyeska

Mitigation measures are also identified in specific commitments made by TAPS Owners and/or Alyeska. These measures are contained in numerous documents, such as various oil spill contingency plans and consent agreements. For example, Section 29 of the Federal Grant requires permittees to enter into an agreement for recruitment, testing, training, placement, employment, and job counseling of Alaska Natives. The purpose of this section was to ensure that Alaska Natives received certain economic benefits from TAPS operations and to help alleviate chronic unemployment on the North Slope. The consent agreement ultimately developed employment goals (expressed as the percentage of positions to be filled by Alaska Natives) by labor category by year.

From time to time, companies institute or modify internal policies that mitigate possible social impacts. For example, access to oil field lands is one of the subsistence issues on the North Slope. Traditionally, all access for subsistence hunting has been restricted in the oil fields for security and safety reasons. Recently, ARCO agreed to permit access at its Alpine and Tarn developments for subsistence hunting and fishing purposes with certain security/safety-related exceptions. This policy change serves as a mitigation measure for subsistence-related cumulative impacts.

4.2.4.4 Economic/Demographic Factors

Economic and demographic factors sometimes act in concert to align economically efficient choices with those that mitigate social impacts associated with oil field development. For example, the remote location of the ANS fields relative to population centers, the lack of infrastructure, and the difficult climatic conditions make it necessary to provide accommodations and meals for ANS workers and those who work at several pump stations along TAPS. This economically efficient solution also limits contact between Alaska Natives and non-Natives.

Concerns for the potential adverse consequences of increased interaction between oil-industry workers and local residents of North Slope villages are often addressed in EIS analyses of ANS developments (e.g., BLM and MMS, 1998). Specific impacts noted include the growth of racial tension between oil workers and residents, introduction of new values and ideas, and an increased availability of drugs and alcohol (BLM and MMS, 1998). Analysts (e.g., BLM and MMS, 1998) claim that these effects could cause "some disruption to sociocultural systems," but concede that these impacts "would not displace existing institutions." Presumably, such contact could also have benefits (cultural exchange, new ideas), although these are not typically addressed in project analyses.

The alignment of economic and other factors — which provides an impetus for enclave development — also creates a de facto mitigation measure. Potential social benefits of enclave development are acknowledged implicitly in the NPR-A EIS (BLM and MMS, 1998).

4.2.4.5 Federal and State Laws and Implementing Regulations

TAPS operations are governed by numerous laws and implementing regulations. For example, environmental laws and regulations limit environmental impacts, which generally also serve to limit social impacts (e.g., subsistence, sociocultural). One broad subset of environmental laws with particular relevance to social impacts is that collection of laws and regulations dealing with oil pollution. Measures taken to ensure compliance with these laws (see Sections 4.1 and 4.2) reduce the likelihood and consequences of oil spills and, therefore, social impacts.

Another group of laws with specific applicability to impacts on cultural resources is that concerned with preservation of cultural resources, including portions (Section 106) of the National Historic Preservation Act of 1966 (as amended), NHPA, and the companion Alaska Historic Preservation Act. NHPA and implementing regulations (e.g., those in 36 CFR 800) provide for the identification of cultural resources (sites, districts, structures, buildings, and objects) in the TAPS project area and consultation with various groups to ensure that cultural values are considered. Section 106 of NHPA requires federal agencies to "take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation ('Council') a reasonable opportunity to comment on such undertakings." Key objectives of the Section 106 process are the identification of historic properties potentially affected by an undertaking, assessment of potential effects, and search for ways to avoid, minimize, or mitigate any adverse effects on historic properties (36 CFR 800.1). This and similar laws have spurred considerable archaeological research in the TAPS project area prior to, during, and subsequent to construction to identify and characterize historic sites in the area.

In practical terms, Alyeska refers to the State Historic Preservation Office to obtain site clearance prior to engaging in activities that have the potential to cause adverse impacts on cultural sites.