North Fork Pipeline Project Design Basis and Criteria

Anchor Point Energy, LLC
Denver, Colorado

Prepared by
Northern Consulting Group
Anchorage, Alaska

March 17, 2009

ANCHOR POINT ENERGY, LLC

March 17, 2010

Mike Thompson
State Pipeline Coordinator's Office
411 West 4th Avenue, Second Floor
Anchorage, Alaska 99501

Re: Design Basis Manual
Natural Gas Pipeline Construction and Operation
Anchor Point Energy, LLC
Kenai Peninsula Borough, Alaska

Dear Mr. Thompson:

Attached is our Design Basis Manual for our proposed North Fork Pipeline Project. The manual has been prepared in accordance with the template provided by your office.

Should you have any questions, you can call either me at 303-623-1821 or Bob Britch at 907-243-7716.

Sincerely,

Ed Teng
Vice President-Engineering

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List of Acronyms

ADEC	Alaska Department of Environmental Conservation
ADNR	Alaska Department of Natural Resources
ADOT/PF	Alaska Department of Transportation and Public Facilities
ANSI	American National Standards Institute
APE	Anchor Point Energy, LLC
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
BTU	British Thermal Unit
CP	Cathodic protection
CFR	Code of Federal Regulations
CFS	Cubic feet per second
CSA	Canadian Standards Association
DGGS	Division of Geological and Geophysical Services
EERI	Earthquake Engineering Research Institute
Enstar	Enstar Natural Gas Company
HDD	Horizontal directional drilling
HEA	Homer Electric Association
JPO	Joint Pipeline Office
KPB	Kenai Peninsula Borough
LLC	Limited Liability Corporation
MAOP	Maximum allowable operating pressure
MMS	Minerals Management Service
MSCF	Thousand standard cubic feet
MSL	Mean sea level
NACE	National Association of Corrosion Engineers
NFU	North Fork Unit
OSHA	Occupational Safety and Health Administration
PHMSA	Pipeline and Hazardous Materials Safety Administration
PSI	Pounds per square inch
PSIG	Pounds per square inch gauge
ROW	Right-of-way
SPCC	Spill Prevention, Control, and Countermeasure
SPCO	State Pipeline Coordinators Office
SMYS	Specified minimum yield strength
USDOT	U. S. Department of Transportation
USGS	U. S. Geological Survey

Section 1.0 Introduction and Project Description

This document presents the design basis and criteria for the Anchor Point Energy, LLC (APE) natural gas pipeline. The APE pipeline is a proposed natural gas pipeline designated as the North Fork Pipeline to be constructed on the Kenai Peninsula near Anchor Point, Alaska.

1.1 Project History

The proposed North Fork Pipeline Project will provide a transportation system to ship natural gas reserves from the Armstrong Cook Inlet, LLC production pad for the North Fork Unit (NFU) to the Enstar Natural Gas Company (Enstar) gas transmission line in Anchor Point, Alaska. The Enstar line transports and distributes natural gas throughout the Kenai Peninsula and other locations, including Anchorage, Alaska. Armstrong Cook Inlet, LLC formed a limited liability corporation to construct the North Fork Pipeline. The corporation, identified as Anchor Point Energy, LLC, has been authorized by Armstrong Cook Inlet, LLC to be their agent for the permitting and engineering phase of the project.

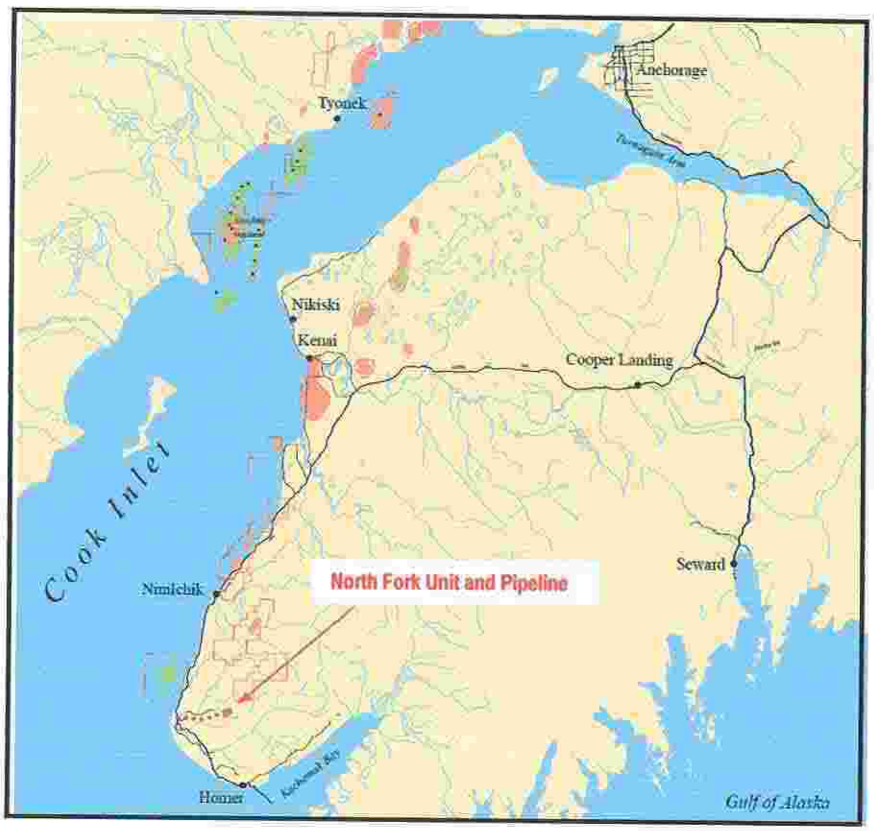


Figure 1-1 Project Vicinity Map

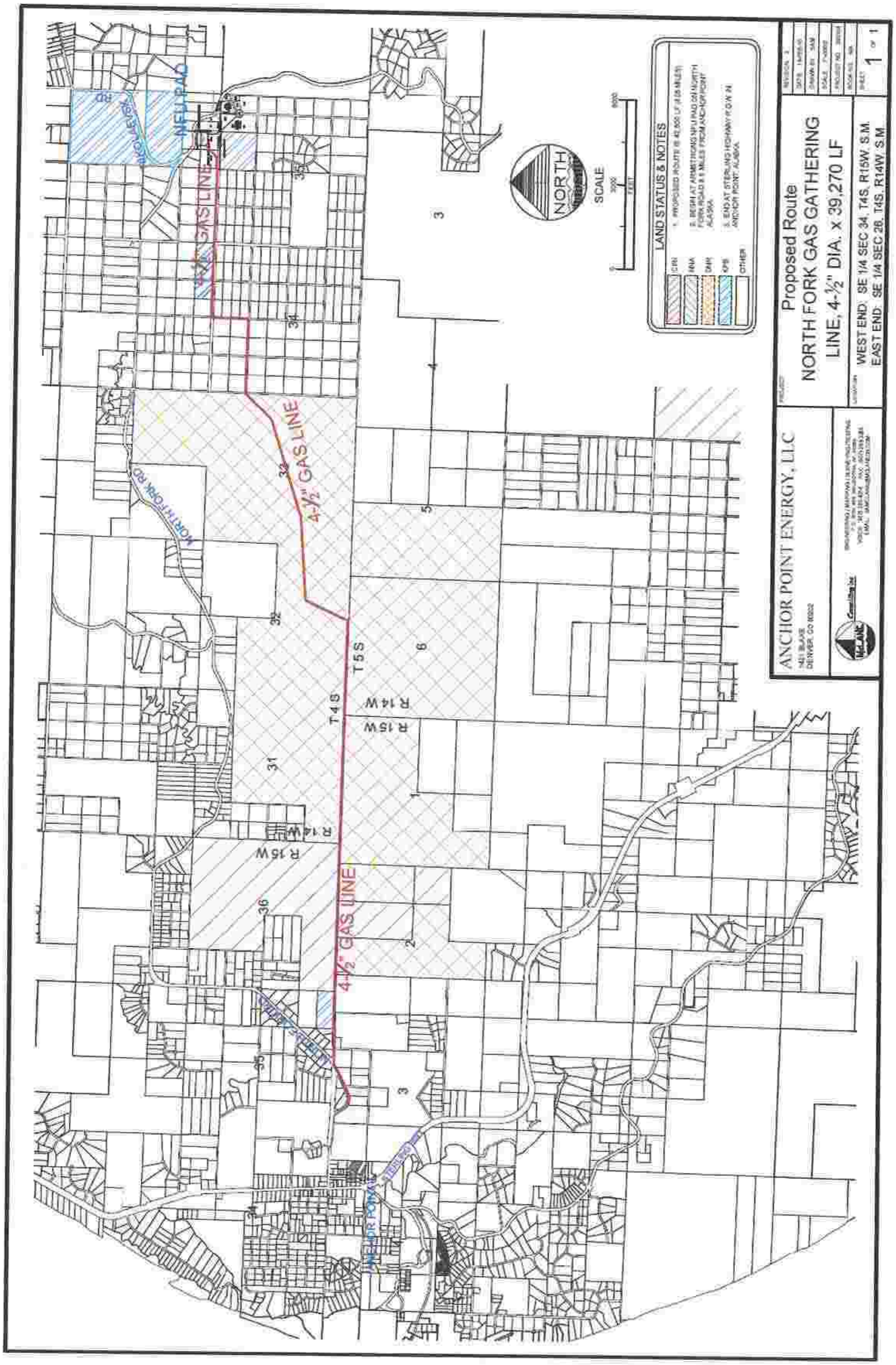


Figure 1-2 Project Location Map

The scope of this project includes the construction and operation of a natural gas transportation system, including metering, with pig launching and receiving facilities at both ends of the pipeline. The natural gas pipeline will consist of approximately 8 miles of buried pipe with a nominal diameter of 4.5 inches.

The exploration, development, and distribution of the natural gas will be separate projects by Armstrong Cook Inlet, LLC and possibly others. The beginning of the natural gas pipeline occurs at the edge of the production pad for the North Fork Unit that is operated by Armstrong Cook Inlet, LLC. The line ends at the flange downstream of a new flow meter building in Anchor Point, Alaska where the natural gas is transferred into the Enstar Natural Gas Company pipeline system. A full and detailed legal description of the pipeline has been presented to the State of Alaska as part of a separate permit application package, and is not repeated herein.

1.2 Location

The North Fork Pipeline is located in the southern portion of the Kenai Peninsula in southcentral Alaska. Natural gas will flow in the proposed pipeline in a generally east-west direction between the NFU Pad and the Enstar pipeline at Anchor Point.

The proposed route generally follows a Kenai Peninsula Borough (KPB) ROW through generally undeveloped subdivisions then crosses a large section of ADNR and CIRI lands. The pipeline then follows an Alaska Department of Transportation and Public Facilities (ADOT/PF) ROW along the North Fork Road into the community of Anchor Point. A 20-foot ROW will be requested for operation of the pipeline. A 50-foot temporary ROW will be requested for construction and as required for operation and maintenance activities. Temporary river crossing ROW permits up to about 100 feet wide will be obtained at select river/stream locations for construction activities.

1.3 Route Selection Process

During conceptual planning, alternative routes were evaluated for construction of the North Fork Pipeline based on environmental, technical, and economic considerations. Two routes were evaluated for detailed consideration:

- Relatively direct cross-country route from the NFU Pad to Anchor Point
- DOT/PF ROW along the North Fork Road

Pipeline route selection was affected by several factors including avoidance of natural and man-made obstacles, land ownership and land interests, river and stream crossings, environmental impacts, and cost. Resources such as aerial photography, satellite imagery, USGS maps, Kenai Peninsula Borough (KPB) maps, and on-the-ground inspections were used to evaluate river crossings and routes. The selected route is the relatively direct cross-country route. This route satisfied all project requirements while minimizing impacts to the environment.

1.3.1 High Consequence Areas

High consequence areas are part of proposed regulations and are an operational rather than design consideration. The pipeline will comply when the regulations are adopted. The entire pipeline will be designed and built to Class Location 2 requirements in accordance with 49 CFR Part 192.

1.3.2 Class Location

The entire route of the North Fork Pipeline lies in Class 1 or 2 locations, as defined in 49 CFR 192. Figure 1.3 also shows the pipeline class by location.

1.4 Kenai Peninsula Gas Development History

Natural gas has been produced from the Kenai area since the 1960s. Natural gas is still produced from a number of locations between Kenai and Ninilchik, as well as from other sources both onshore and offshore of the Kenai Peninsula.

1.5 Existing and Proposed Natural Gas Production Sites

Marathon, Chevron, and others are currently conducting exploration and production drilling activities on the Lower Kenai Peninsula. The well locations and testing programs may support construction of additional natural gas pipelines in the general area.

1.6 Natural Gas Composition and Qualities

Natural gas produced from existing Kenai Peninsula productions sites is composed almost completely of methane. Results of a typical natural gas composition analysis are listed in Table 1-1. This is the natural gas composition used for design.

Table 1-1 Standard/Wet Analysis of Natural Gas.

Component	Sample 1-Mole Percent	Sample 2-Mole Percent
Methane	96.661	96.470
Ethane	0.274	0.273
Propane	0.092	0.091
i-Butane	0.031	0.028
i-Pentane	0.009	--
(C6+)	0.041	0.028
Moisture	1.750	1.750
Nitrogen	0.991	0.915
CO2	0.460	0.444
TOTAL	100.00	100.00

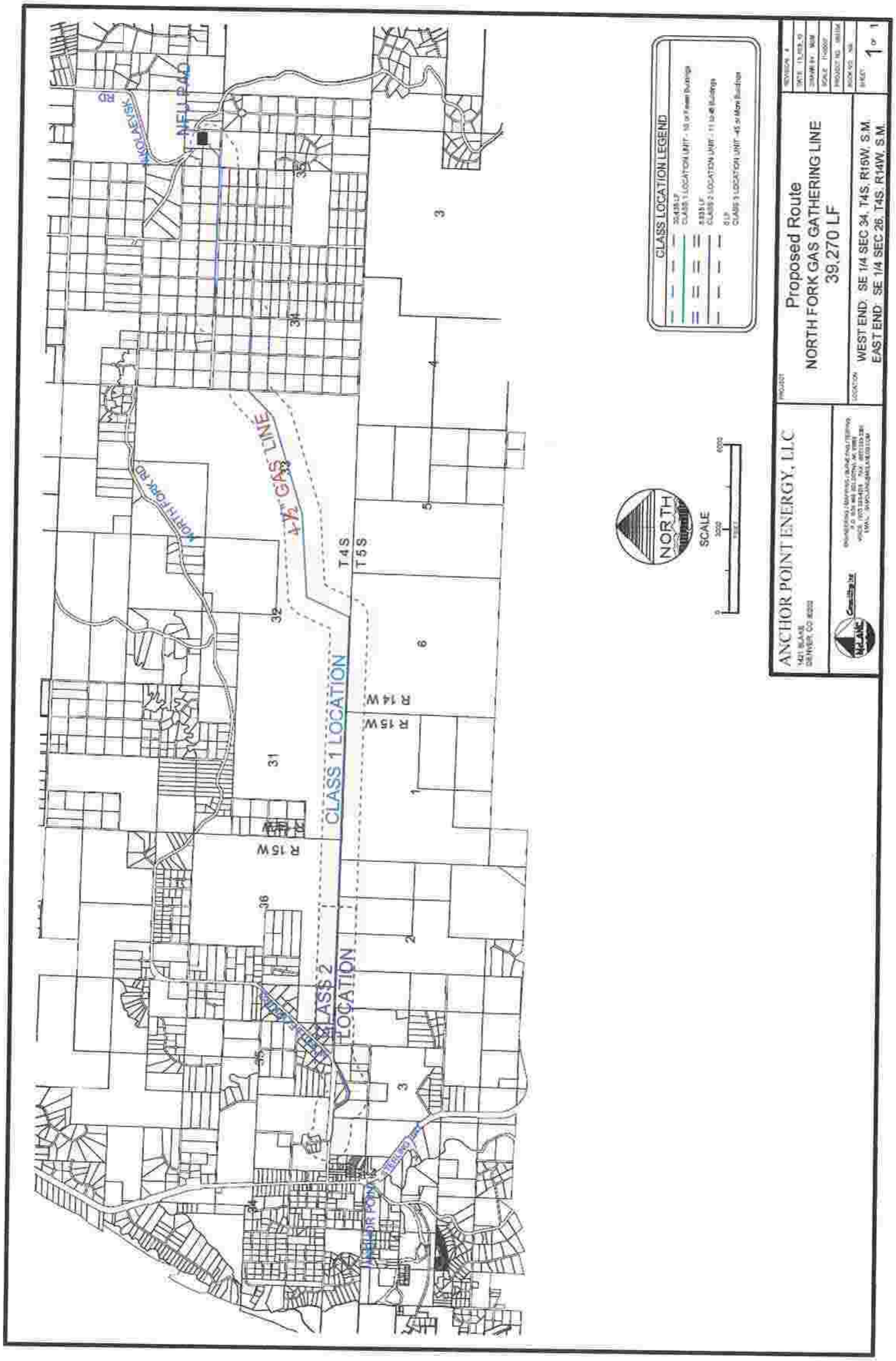


Figure 1.3 Class Designations for the Gas Pipeline.

The test was performed by Industrial Instruments of Kenai on October 9, 2008 on two samples from the Armstrong Cook Inlet, LLC well (NFU 3426), from the Tyonek Formation perforated between 7946 feet and 7970 feet. The heating value of the natural gas was 1000 BTU/standard cubic foot (lower heating value = 981 BTU/standard cubic foot) and had an absolute density of 42.93 and 43.19 lbm/1000 cubic feet. Gas sales contracts allow for up to 1 grain per 100 cubic feet of hydrogen sulfide (H_2S) and 4 lbs/MMSCF of water.

Section 2.0 Physical Environment

2.1 Geology

The North Fork Pipeline Project area on the western side of the Kenai Peninsula in southcentral Alaska. The project area is part of the Kenai Lowland, a broad coastal shelf 20 to 50 miles wide, between Cook Inlet and the Kenai Mountains. This linear basin contains sedimentary rocks and sediments that were laid down during the past 30 million years. The Kenai Lowland is less than 500 feet in elevation, and local relief generally ranges from 50 to 250 feet. The surficial geology of the area consists mostly of terraces and alluvial plains and morainal belts with some areas of muskeg, swamp, and elevated tidal flats. There are numerous undrained depressions containing small lakes, ponds, and marshes. The lakes and marshes make up more than one-third of the total surface. Muskeg covered benches are underlain by finely stratified sand and gravel. The area is covered by quaternary surficial deposits comprised of unlithified fluvial floodplain, colluvial, glacial, alluvial fan, landslide, and swamp deposits. Stratified silt, sand, and gravel predominate the area.

A recent geotechnical program was performed in the project area, focused exclusively on river and road crossings. Typical soil conditions found at the rivers included a few to several feet of peaty soils in the marshy areas, underlain by varying thicknesses of sands and gravels. A silt layer was commonly encountered at depth. Layers and inclusions of coal were encountered in the southern project area, commonly interbedded with fine sand and silt strata. Shallow groundwater was found in most areas near the river crossings.

2.2 Geography

The project is located between the parallels of 59 to 60 north longitude and the meridians of 151 and 152 west latitude, on the lower portion of the Kenai Peninsula. The KPB lies directly south of Anchorage, the largest city in Alaska. The waters of the Gulf of Alaska and Prince William Sound border the Peninsula to the south and east, while the Chigmit Mountains of the Alaska Range border the Borough to the west. The Cook Inlet divides the KPB into two landmasses. The Peninsula itself comprises 99 percent of the borough's population and most of the development. The Kenai Mountains run north and south through the peninsula, contrasting to the lowlands lying to the west.

The Kenai area is populated with moderate to dense forest interspersed with wetlands. The general area is typically either rolling hills or low wetlands. The terrain is gradually sloping to the west with elevations of about 650 feet above mean sea level (MSL) at the NFU Pad to about 130 feet MSL at Anchor Point. The lowest point in the North Fork Pipeline is about 80 feet MSL at the crossing of the North Fork River.

2.3 Climate

The climate of the central Cook Inlet area is characterized as transitional between maritime and continental regimes. Regional topography and water bodies heavily influence area climate. The Kenai Mountains to the south and east act as a barrier to warm, moist air from the Gulf of Alaska. The Cook Inlet precipitation averages less than 20 percent of that measured on the Gulf of Alaska side of the Kenai Mountains. The Alaska Range to the north provides a barrier to the cold winter air masses that dominate the Alaska Interior. Cook Inlet waters tend to moderate temperatures in the area. Occasionally, short periods of extreme cold and/or high winds occur when strong pressure gradients force cold air southward from the Interior. Temperature and precipitation data for various locations adjacent to the project area are summarized on Table 2-1.

Table 2-1 Average Monthly and Annual Precipitation and Temperatures (US National Weather Service, 2009).

Month	Average Precipitation (Inches)			Mean Air Temperature (°F)		
	Homer	Kasilof	Kenai	Homer	Kasilof	Kenai
January	2.08	1.02	1.07	21.3	14.9	13.4
February	1.57	0.86	0.91	22.4	17.9	16.6
March	1.31	0.79	0.81	26.2	23.9	23.5
April	1.26	0.66	0.64	32.9	33.7	34.6
May	1.76	0.76	0.95	40.9	41.9	44.4
June	1.52	0.99	1.09	47.8	49.0	50.8
July	2.26	1.58	1.75	51.9	53.5	55.0
August	3.08	2.63	2.62	51.7	52.4	54.0
September	4.50	3.22	3.31	44.9	45.9	46.9
October	3.63	2.37	2.66	33.8	33.9	34.3
November	2.84	1.74	1.69	26.3	22.9	21.8
December	2.46	1.61	1.45	23.0	17.4	16.3
Annual	28.27	18.23	18.95	35.3	33.9	34.3

Surface winds in the region tend to be strong and persistent. Strong winds are channeled up the inlet and mostly affect the shoreline. Average wind velocities at the Kenai Airport between 1992 and 1999 are shown in Table 2-2 (Alaska State Climate Center). Prevailing wind direction is north from September to April and south from May to August. The wind has the highest probability to blow north, however the wind may blow in any direction on any day of the year. Wind speed is generally less than 28 knots with an annual mean velocity ranging between 5 and 10 knots depending on direction.

Table 2-2 Mean Monthly Wind Speeds and Directions (US National Weather Service, 2009).

	Mean Wind Speed (mph)		Prevailing Direction	
Month	**Homer**	**Kenai**	**Homer**	**Kenai**
January	6.9	7.9	NE	NNE
February	6.2	8.1	NE	NNE
March	6.9	9.0	ENE	NNE
April	7.5	8.4	WSW	N
May	7.6	8.9	WSW	SSW
June	7.1	8.5	WSW	SSW
July	6.4	8.3	WSW	SSW
August	6.2	7.0	WSW	S
September	6.7	7.7	NE	NNE
October	6.6	7.8	NE	NNE
November	6.3	7.8	NE	NNE
December	7.3	7.4	NE	NNE
Annual	6.8	8.0	NE	NNE

2.4 Seismicity

Cook Inlet and the Kenai Peninsula are seismically active. No earthquakes with a magnitude greater than 8.0 on the Richter scale with an epicenter in the Cook Inlet region have been recorded. However, from 1899-1974 a total of 26 earthquakes with a magnitude of 6.0 on the Richter scale or greater with an epicenter in the Cook Inlet region occurred, including one of magnitude 7.3.

The project area is located in the zone of tectonic interaction between the North American plate and the relatively northwestward-moving Pacific Plate. The average rate of convergence near the southern Kenai Peninsula over the past 3 million years is 2.5 inches per year (Hastie and Savage 1970).

2.4.1 Seismic Zone

The Cook Inlet-Kenai Peninsula region is included in Seismic Design Category D, an area of potential major damage from earthquakes greater than Richter Magnitude 6 (Evans et al. 1972).

2.4.2 Faulting

Known faults in the area trend northeast-southwest. No active faults are known to cross the pipeline route, based on research of United States Geological Survey (USGS), Alaska Division of Geological and Geophysical Surveys (DGGS), and other sources. There are, however, numerous faults both east and west of the project area. The closest large fault, the Border Ranges Fault, lie approximately 10 miles to the east (MMS 1996). Other smaller faults also occur in the area. Subsidence of the region including the Kenai Lowlands from the Great Alaskan Earthquake of 1964 was estimated to range from 2 to 4 feet.

2.4.3 Tsunamis

A large earthquake with an epicenter located in the Cook Inlet area could conceivably generate a tsunami that might damage shoreline structures. Although waves as high as 24 feet were reported within Kachemak Bay as a result of the Great Alaskan Earthquake of 1964, no tsunamis were reported along the coast adjacent to the Kenai Lowlands. The North Fork Pipeline is located at 1 to 9 miles inland from the coast and its lowest elevation is about 80 feet mean sea level at the North Fork River crossing. Because of the large distance from the shoreline and the higher elevations of the project, there are no threats from tsunamis for the project.

2.5 Environment

The North Fork Pipeline area contains some hilly areas, but most of the area is wetlands. The hills are normally covered with paper birch and white spruce with an understory of willow, alder, dwarf birch, blueberry, cranberry, Labrador tea, crowberry, feather mosses, etc. Much of the spruce is affected by the spruce bark beetle and is dead. Wetlands vegetation consists dwarf shrubs over a mat of sedges, mosses, and lichen and interspersed with black spruce.

Common species of terrestrial mammals are known or suspected to inhabit the lowland areas in the general vicinity of the pipeline route include: beaver, black bear, brown bear and moose. Other mammal species that occur in the general area may also include: snowshoe hare, Arctic ground squirrel, masked shrew, dusky shrew, water shrew, pigmy shrew, little brown bat, collared pika, hoary marmot, red squirrel, northern red-backed vole, tundra vole, singing vole, muskrat, brown lemming, northern bog lemming, meadow jumping mouse, porcupine, coyote, wolf, red fox, marten, ermine, mink, wolverine, river otter, and lynx (SAIC 2002).

Most terrestrial birds species found in the Cook Inlet region are migratory and only occur during the summer months (April to September) when temperatures and food availability are conducive for breeding. Major species groups found in the area include owls (7 species), raptors (20 species), grouse (6 species), woodpeckers (5 species), and passerines (58+ species). Most species are widely distributed in the area and are relatively abundant. Only two species, the Bald Eagles and Peregrine Falcon, have been identified as species of concern due to their sensitivity to human disturbance during nesting or because of limited populations.

About 30 to 35 species of waterfowl regularly occur in the Cook Inlet area, including two species of swans (Trumpeter and Tundra swans), six species of geese, about 25 duck species, and 6 species of loons/grebes. Although there are numerous wetlands along the pipeline route, there are few lakes in the general area that would attract large number of waterfowl.

Cook Inlet is an extremely important migratory corridor for various anadromous fish that migrate to numerous streams throughout the area. There are five stream crossings including one unnamed tributary to an unnamed tributary of the Anchor River, three unnamed tributaries to the North Fork River, and the North Fork River.

The unnamed tributaries to the Anchor River and North Fork River may contain rearing dolly varden and coho salmon. North Fork River has spawning silver salmon, king salmon, and pink salmon and dolly varden and steelhead trout present at the crossing location.

2.6 Hydrology

The North Fork Pipeline route is located entirely within the drainage basin for the Anchor River and mostly within the basin of its major tributary, the North Fork River.

Runoff in the project area is characterized by minimal stream flows in February through April, with occasional low flow during dry summer months. Large glacier-fed streams continue to have high flows throughout the summer months. The Kasilof River is partially fed by glacial meltwater. The other streams are non-glacial and exhibit only moderate flows in late summer and fall. Flood flows typically occur in spring and are associated with snowmelt and midsummer rains can also cause high water levels. Maximum flood runoff on record range are about 60 to 70 cubic feet per second (cfs) per square mile.

Surface water quality is generally good. High concentrations of naturally occurring calcium and bicarbonate ions are typical. The water is low in dissolved solids, chloride, and hardness. Most surface waters meet drinking water standards except for iron content and color.

Section 3.0 Technical

3.1 Criteria, Codes and Standards

This design basis and criteria was prepared based on applicable U.S. codes and standards, latest editions. All work will be performed in accordance with codes, standards, specifications, recommended practices, figures, and/or exhibits, which are part of the project design documents.

ANSI – American National Standards Institute

- ASC GPTC Z380.1, American Gas Association Guide for Natural Gas Transmission and Distribution Piping Systems, 2002

API – American Petroleum Institute

- 5L, Specification for Line Pipe, 2000 Edition
- 6D, Specifications for Pipeline Valves, 2002 Edition
- 6FA Fire Test for Valves
- 15HR – 01 High Pressure Fiberglass Line Pipe
- 15S, Qualification of Spoolable Reinforced Plastic Line, 2006 Edition
- RP1102, Steel Pipelines Crossing Railroads and Highways, 1993 Edition
- 1104, Standard for Welding Pipelines and Related Facilities, 1999 Edition

ASCE – American Society of Civil Engineers

- 7-98, Minimum Design Loads for Buildings and Other Structures

ASME – American Society of Mechanical Engineers

- B16.5, Pipe Flanges and Flanged Fittings, 1998 Edition
- B31.8, Gas Transmission and Distribution Piping Systems, 1999 Edition
- B16.34a Valves-Flanged, Threaded, and Welding End, 1998 Edition

ASTM – American Society for Testing and Materials (ASTM International)

- D 2513 – 09a, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings
- D 2517 – 06, Standard Specification for Reinforced Epoxy Resin Gas Pressure Pipe and Fittings
- D 2837 – 08 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- D 2992 – 06 Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings
- B16.34a Valves-Flanged, Threaded, and Welding End, 1998 Edition

CFR – Code of Federal Regulations

- Title 49, Part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, January 26, 2010

CSA – Canadian Standards Association (Reference)

- Z662 - 03, Oil and Gas Pipeline Systems

DOT – Department of Transportation

- Fiberspar DOT Petition – PHMSA-2010-0003, Fiberspar Petition to Amend Title 49 Code of Federal Regulations Section 192.121

EERI –Earthquake Engineering Research Institute (EERI)

- Earthquake Design Criteria, Housner and Jennings, 1982
- Ground Motion and Soil Liquefaction During Earthquakes, Seed and Idriss, 1982
- Seismic Design Codes and Procedures, Berg, 1982

NACE - National Association of Corrosion Engineers

- SP0169-2007, Control of External Corrosion on Underground or Submerged Metallic Piping Systems

3.2 Class Location

The proposed natural gas pipeline as identified is either located in Class 1 or 2 locations as defined in 49 CFR 192.5. Figure 2-3 shows the class locations.

3.3 Overpressure Protection

Overpressure conditions caused by production facilities will not be evaluated under this design basis. The pipeline operator will coordinate with the designers of the production facilities that will provide gas to the North Fork Pipeline to ensure that the pipeline overpressure protection requirements of applicable codes and regulations are met.

3.4 Pipe Load Conditions

The design development for a pipeline system requires the identification of expected forces, imposed movements, and other external effects. The design loading conditions are based upon the loads anticipated during the useful lifetime of the system. Two general categories of design loading are the design operating condition and the design contingency condition.

The design operating condition is defined to include all normal operating conditions and environmental loadings. These loadings are established in ASME B31.8. The loadings for the design operating condition on the belowground pipeline are:

- Internal design pressure
- Hydrostatic test pressure
- Temperature differential
- Dead and live loads
- Differential pipe movement
- Overburden loads
- Traffic loads

Surge analysis is not applicable for natural gas due to the physical properties of the product.

3.4.1 Internal Design Pressure

The internal design pressure for the pipeline system is 1,347 psig. This is based on the maximum allowable pressure for Fiberspar FS LPJ 4-1/2" 2,250 (E) Plastic LinePipe in accordance with the proposed changes to 49 CFR 192.121, Design of Plastic Pipe, and 192.123, Design Limitations for Plastic Pipe, per Fiberspar DOT Petition – PHMSA-2010-0003.

The minimum wall thickness for the Plastic Line Pipe will be calculated in accordance with a petition to amend 49 CFR 192.121 (see §3.4.1 Internal Design Pressure, above). Wall thickness for steel pipe will be in accordance with 49 CFR 192.105, Design Formula for Steel Pipe, using a Design Factor F = 0.60, to accommodate a Class 2 location.

The minimum wall thickness will be calculated in accordance with 49 CFR 192.105. The design wall thickness may be greater if determined necessary by stress analysis described in Section 3.4 to ensure resultant stresses remain within the allowable limits.

3.4.2 Hydrostatic Test Pressure

All pipe and components will be hydrostatically tested to a pressure not less than 1.5 times the MAOP per 49 CFR 192.503, 49 CFR 192.513, and 49 CFR 192.619 (2)(i).

3.4.3 Temperature Differential

The maximum and minimum design operating temperatures for the buried pipeline (including HDD and bored road crossings) is 120°F and 20°F, respectively. For aboveground pipe, the maximum and minimum design operating temperatures are 120°F and -20°F, respectively.

3.4.4 Dead and Live Load

The dead loads include the pipe weight, external coatings, piping components, and buoyancy control devices. The live load is the weight of the pipe contents.

3.4.5 Differential Pipe Movement

Differential pipe movement may be caused by frost heave, settlement, flotation, and thermal expansion and contraction. The potential for thaw settlement is low, as permafrost is not generally found on the Kenai Peninsula. Applying appropriate buoyancy control measures will control flotation. Frost heave will not be a significant concern due to the burial depth of the pipe and the fact that the natural gas will not be chilled. Differential movement caused by thermal expansion will be minimal due to restraint by the trench backfill. Axial friction and passive soil restraints will limit the pipe movement at the sidebends. The pipe will be designed to accommodate a 2-foot differential movement. Greater differential movement may be tolerable in some cases, and shall be allowed if validated by site-specific analysis. Differential pipe movement will be considered a secondary load.

A buried pipeline is essentially continuously supported by the ditch bottom. It is recognized, however, that certain geotechnical conditions could cause movement of the supporting soil. For short sections, the pipe will be able to span an unsupported section without exceeding the design criteria. The vertical displacement of the pipe will be resisted by the stiffness of the pipe, by the strength of the supporting soil on each side of the span of settlement, and by the longitudinal restraint provided by the soil.

Frost heave is a potential source of differential pipeline movement. However, it is not expected to be a significant design consideration for the North Fork Pipeline. In order for frost heave to occur:

1. There must be a freezing front.
2. There must be a water source capable of supplying ice growth at the freezing front.
3. The soil must be capable of supporting capillary transfer of water (a function of the abundance of soil particles 0.02 mm in diameter and finer).

Conditions 2 and 3 almost certainly occur at many points along the pipeline route, and it is impractical to attempt to mitigate either of these factors. Condition 1 is the reason frost heave is unlikely to cause significant differential pipe movement.

Since gas entering the North Fork Pipeline will not be chilled and hydraulic operating conditions will not induce Joule-Thompson cooling (except upstream of the pipeline system, on pad, at a control valve or the wellhead choke), the only potential mechanism for providing a freezing front will be seasonal freezing. Since the pipeline will be buried with a minimum 4.5 feet of cover and the pipeline diameter will be 4.79 inches, the bottom of pipe will be nearly 5 feet below the ground surface, close to or below the seasonal frost line in this portion of the Kenai Peninsula, which typically will not reach, in this area, deeper than 5 feet in most years; and particularly not when there is significant snow cover. In order for deeper frost penetration, there generally needs to be a combination of very cold temperatures, little or no snow cover, and/or coarse soils with low moisture content. Coarse soils with low moisture content do not present a frost heaving risk.

If frost were to penetrate deeper than the bottom of pipe, it would not penetrate significantly deeper. The thermal resistance resulting from more than five feet of frozen soil overlying the freezing front is very high, and it is unlikely that the heat transfer necessary to allow freezing of a significant thickness of segregated ice at this depth would be sufficient to result in frost heaving beneath the pipe. Also, the heaving forces would need to be extremely high to push the pipeline upward, since the upward movement is resisted by 4 feet of frozen soil over the top of pipe.

3.4.6 Overburden Loads

Overburden is the backfill soil that is placed around and over the pipe in an excavated ditch. The pipe will be designed to withstand the maximum overburden load experienced. The weight of the soil above the pipe will be considered a primary load.

3.4.7 Traffic Loads

The North Fork Road is classified as a major road crossings. All other public roads are classified as minor road crossings. Minor roads will be crossed using open cut and major roads will be bored. If calculations show that a greater pipeline wall thickness is require under roadways to ensure pipeline integrity, a larger bore carrier pipe may be installed or other safeguarding methods employed to protect the normal walled pipeline in those areas.

Pipeline burial depths for road crossings will be determined based on load calculations in accordance with API 1102 and DOT/PF requirements. The pipeline will be sized to safely withstand internal and external loads at road crossings.

3.4.8 Loss of Soil Support

Erosion, scour, and liquefaction are phenomena that could lead to loss of soil support. Erosion is the most likely circumstance that could lead to loss of soil support and forms the basis for setting loss of support criteria. The project approach to stream and drainage crossings where there is significant risk of erosion is to install the pipeline by HDD, and placing it well below the depth to which scour or erosion could occur. Thus, the crossings where risk of loss of support due to scour or erosion is highest are smaller streams that are installed using conventional methods.

The streams and drainages that fall into this category are typically less than 10 feet wide. Potential scour or erosion would almost certainly be confined within banks. To address uncertainty in predicting the loss of support under these conditions, a generous safety factor is warranted. Therefore, the design loss of support for the project will be 50 feet.

3.4.9 Earthquake Loads

The North Fork Pipeline project area is located in an active seismic region and it will be designed for the anticipated seismic forces. The available engineering survey data has not indicated zones of potential soil liquefaction or surface fault locations along the route. The significance of any seismic hazard will be assessed on completion of the engineering surveys. Potential seismic hazards that will be considered for the pipeline include:

- Liquefaction
- Fault Displacement
- Ground Motion

Liquefaction

Liquefaction risk is greatest where soils are medium to fine grained clean sand in relatively loose state, and saturated. Liquefaction ground failure risk is greatest where liquefaction-susceptible soils occur on or beneath a slope. The principle risk to the pipeline from liquefaction is from large ground movements that may result from slope failure. Primary mitigation of this risk is in pipeline routing. The pipeline has not been routed across major cut or fill slopes or other slopes that are known to be unstable.

An air photo review was conducted to identify any areas of potential historic liquefaction or mass slumping. No area were identified in this analysis. If any areas are found during the pipeline construction where liquefaction is judged to be a potentially significant risk, additional investigation may be performed. This investigation could include analysis of existing soils data, calculations, analysis with commercially available computer models, or additional field investigation. The appropriate form of additional investigation may be determined based on the conditions found. Results of this work will be transmitted to the SPCO.

Fault Displacement

Previously published geological studies indicate that the pipeline ROW does not cross any active fault zones (see Section 2.4.2). Therefore, consideration of fault displacement for pipeline design is not required.

Seismic Design Data

Based on the sites location and information obtained during our soils exploration McLane has referenced the seismic design criteria from the International Building Code, 2006.

- Site Class, per Section 1613.5.2 and Table 1613.5.2 = Site Class C
- Mapped Spectral Acceleration for short periods, Ss = 138% g
- Mapped Spectral Acceleration for a 1-second Period, S1 = 50% g
- Site Coefficient as defined in Table 1613.5.3(1), Fa = 1.0
- Site Coefficient as defined in Table 1613.5.3(2), Fv = 1.5

Loading can be increased one third when transient earthquake and wind conditions are considered.

3.5 Pipe Stress Criteria

The North Fork Pipeline project is subject to the requirements of 49 CFR 192. This federal regulation places limitations on the allowable internal pressure but does not specify other loads, loading combinations, or limitations on combined states of stress. Detailed industry requirements are addressed by the ASME Code for Pressure Piping B31.8.

Based on the nature and duration of the imposed loads, pipeline stresses are categorized as primary, secondary, combined, or effective stresses. The general stress criteria are summarized as follows:

- **Primary Stresses** – Primary stresses are stresses developed by imposed loads with sustained magnitudes that are independent of the deformation of the structure. The basic characteristic of a primary stress is that is it not self-limiting. The stresses caused by the following loads are considered as primary stresses: internal pressure, external pressure including overburden, and dead and live loads.
- **Secondary Stresses** – Secondary stresses are stresses developed by the self-constraint of the structure. Generally, they satisfy an imposed strain pattern rather than being in equilibrium with an external load. The basic characteristic of a secondary stress is that it is self-limiting. The stresses caused by the following loads are considered as secondary stresses: temperature differential, differential settlement, and earthquake motion.
- **Combined Stresses** – Stress criteria limitations were imposed for combinations of primary and secondary stresses. The stress state in any element of the pipeline is defined by the three principal stresses acting respectively in the circumferential, longitudinal, and radial directions. Limitations are placed on the magnitude of primary and secondary principal stresses and on combinations of these stresses in accordance with acceptable strength theories that predict yielding.

3.5.1 Load Combinations

Pipe load conditions will be analyzed in the combinations shown in Table 3-1. When calculating equivalent stresses, the most unfavorable combination of loads that can be predicted to occur will be considered. For the purpose of calculating equivalent stresses, hoop stress will include all relevant circumferential stresses and be based on nominal values of diameter and wall thickness.

Table 3-1 Cross Country Pipeline Load Combinations

	Pipeline Load Combinations										
	Testing		Operating						Contingency		
Description	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Internal Pressure			x		x	x		x	x	x	x
Hydrotest Pressure	x	x									
Dead Load		x			x	x	x	x	x	x	x
Live Load		x[1]			x	x	x	x	x	x	x
Soil Overburden		x			x	x	x	x	x	x	x
Traffic Loads					x	x	x	x	x	x	x
Buoyancy					x	x	x	x	x	x	x
Earthquake Ground Motion					x	x					x
Temperature Differential		x[2]		x		x		x	x	x	x
Differential Pipe Movement									x		
Loss of Soil Support										x	

[1] Live load for hydrotest is the loading from the hydrotest fluid.
[2] Temperature differential for hydrotest is based on the difference between tie-in temperature and hydrotest temperature.

3.5.2 Allowable Stresses

Circumferential, longitudinal, shear and equivalent stresses will be calculated considering stresses from relevant load combinations (see Table 3-2). Calculations will consider flexibility and stress concentration factors of components other than straight pipe.

Table 3-2 Pipeline Allowable Stresses

Criterion	Value	Basis	Load Combination
Hydrotest Stresses			
Hoop Stress (hydrotest pressure)	1.5 x design pressure	49 CFR 192.513 B31.8, 841.322	1
Longitudinal Stress		Project Design	2
Primary Stresses			
Hoop Stress (design pressure)		49 CFR 192.111, 49 CFR 192.121, B31.8, 841.11	3
Secondary Stresses			
Longitudinal Stress Range (temperature differential, tie-in to operating)		B31.8, 833.4	4
Combined Stresses			
Longitudinal Stress (design pressure, live and dead load and other operating loads)		B31.8, 833.4	5 & 7
Longitudinal Stress (design pressure, live and dead load, temperature differential, and other operating loads)		B31.8, 833.4	6 & 8
Longitudinal Stress (design pressure, live and dead loads, temperature differential and contingency loads)		Project Design	9, 10 & 11

3.6 Hydraulics

The pipeline(s) will be sized to handle a maximum flow rate of 17 MMSCFD (each) with a maximum pressure drop of 900 psi. For hydraulic purposes, with a maximum inlet pressure of the pipeline system at 1,350 psig, a design gas temperature of 20°F (a value based on a corresponding typical ground temperature at the burial depth), the outlet pressure of the pipeline is nominally 1,000 psig. Based on gas composition, pipeline hydraulic profile, and local experience, neither water condensation nor the formation of distillates are expected. Pipe design parameters for hydraulic analysis are summarized in Table 3-3.

Table 3-3 Pipe Design Parameters for Hydraulic Analysis

Nom. Outside Diameter (in)	Inside Diameter (in)	Assumed Gas Temperature (°F)	Minimum Outlet Pressure (psig)	Maximum Inlet Pressure (psig)
4-1/2	3.57"	20	50	1,350

3.7 Pipe Properties

The pipeline will be constructed of a thermoset composite pipe that is manufactured by Fiberspar LinePipe LLC. The Fiberspar LinePipe has a 3.57 inch inside diameter and a 4.79 inch outside diameter. It consists of the following three layers:

Table 3.4. Description of Fiberspar LinePipe.

Layer	Thickness	Composition
Inside	0.230 inches	HDPE Pressure Barrier
Middle	0.284 inches	Glass Fiber Reinforced Laminate
Outside	0.100 inches	HDPE Wear Resistant Layer

Technical specifications for Fiberspar Line Pipe are provided in Figure 3-1.

The design life of the project is 30 years. Fiberspar's published pressure rating is calculated at 20 year design life a maximum temperature and a MAOP of 2,250 psi. Changing the design life from 20 to 30 years changes the MAOP from 2,250 psi to 2,203 psi; the MAOP would be greater if the pipeline operated at less than maximum temperatures and pressures.

Over 25 million feet of Fiberspar LinePipe has been installed including a DOT regulated application requiring a special permit and shallow water offshore applications with specific project approval from the MMS. The Fiberspar LinePipe meets American Petroleum Institute RP 15S, Canadian regulation CSA Z662, Mexican Specification NRF 185, along with other industry accepted standards.

Additional details for the Fiberspar LinePipe can also be obtained from:

Christopher E. Makselon, P.E.
VP of Engineering
Fiberspar LinePipe LLC
12239 FM 529
Houston, TX 77041 USA

Office: 713.849.2609
Direct: 281.854.2613
Cell: 713.417.1298
Email: cmakselon@fiberspar.com

FIBERSPAR

FS LPJ 4 1/2" 2,250 (E)

4 1/2 Inch Nominal, 2,250 Series Fiberspar LinePipe-J w/HDPE Pressure Barrier & HDPE External Wear Layer

Product Data Sheet (Imperial Units)

ASTM 2996 Designation: RTRP-11HZ1-4112

Fiberspar s/n: JEFN045026

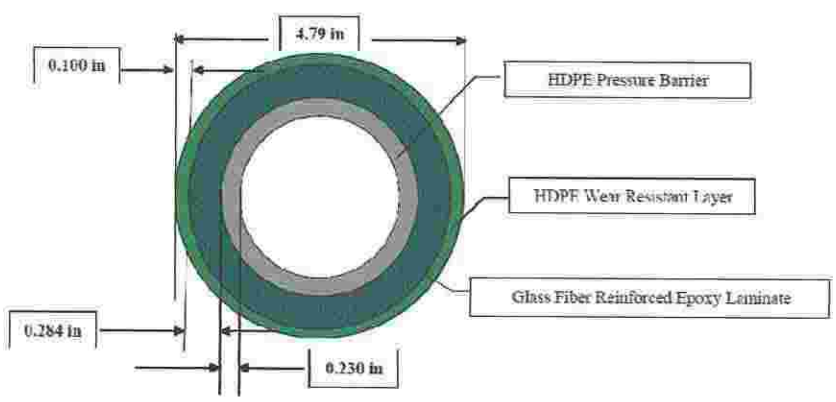
Physical Properties:

Geometry		**Tensile Modulus**	
Outside Diameter (in)	4.79	Axial (psi)	9.65E+05
Inside Diameter (in)	3.57	Hoop (psi)	1.25E+06
Inside Flow Area (in^2)	9.98	**Poisson's Ratio**	
Total Wall Thickness (in)	0.61	Major	0.49
C/S Area (in^2)	8.06	Minor	0.63
Linear Weight		**Thermal Exp. Coeff.**	
Linear Weight - Air (lb/ft)	5.06	Axial (in/in -°F)	1.17E-05
Linear Weight - Water (lb/ft)	1.57	Hoop (in/in -°F)	6.75E-06
Net Density (lb/in^3)	0.052	**Thermal Conductivity**	
Flow Coefficients		(BTU/hour/ft^2- in/°F)	1.92
Hazen - William's	150	**Resin T_g**	
Darcy-Wiesbach	0.0004	(°C)	125°
Manning	0.009	(°F)	257°

Mechanical Performance:

Maximum Operating Temperature	140 °F	
Minimum Operating Temperature	-20 °F	

	78 °F	140 °F
Max. Recommended Operating Pressure (psi)	2,250	2,250
Nominal Ultimate Burst Pressure (psi)	9,000	7,700
Maximum Recommended Tensile Load (lbs)	23,800	20,400
Nominal Ultimate Tensile Load (lbs)	59,500	51,100
Nominal Ultimate Compressive Load (lbs)	-67,800	-55,600
Nominal Ultimate Collapse Pressure (psi)	1,950	1,950
Minimum Operating Bend Radius (in)	77	77
Minimum Spooling Diameter (in)	132	132



Fiberspar LinePipe LLC
(713) 849-2609
www.fiberspar.com
Rev: 1.0
December 11, 2007

Figure 3-1. Technical Specifications for the Fiberspar LinePipe.

3.8 Geotechnical

Near-surface soils along the proposed pipeline route are variable. However, the only design parameter that changes as the soils change is the need for buoyancy control. As the pipeline passes from silt to sand to gravel, the basic design and construction mode remains the same. When the pipeline passes through high groundwater areas containing peaty soils that provide little vertical upward restraint, buoyancy control will be applied. Other special conditions (such as occurrence of boulders or sharp, angular rock in the backfill that require coating protection) will be handled during construction in accordance with project specifications.

Geotechnical investigations for the proposed pipeline have been limited to subsurface borings at selected river/creek crossing.

3.8.1 Thermal Design Data

The Kenai Peninsula including the limits of this project is generally free of permafrost. The route is mostly wetlands with some forested areas; the region is physically referred to as lowlands ranging in elevation from approximately 50 to 250 feet above sea level. Environmental factors, as published in the Alaska (Hartman and Johnson 1978), which effect depth of freeze are outlined Table 3-5 below:

Table 3-5 Thermal Design Parameters

Parameter	Value
Freezing Index	900 to 1500 degree-days
Design Freezing Index	2200 to 2400 degree-days
Thawing Index	3000 degree-days
Design Thawing Index	3900 degree-days

3.8.2 Buoyancy Control

Pipeline segments below the water table (or submerged) will have an associated buoyancy force acting upward on the pipeline. Buoyancy control methods will be developed to counteract the effects of buoyancy.

Possible buoyancy control measures include:

- Geotextile swamp weights
- Concrete coatings
- Additional wall thickness
- Bolt-on weights
- Concrete weights

The buoyancy control measure selected for the project is the geotextile swamp weights. The weights will be placed so that the pipeline will be designed to achieve a minimum 5% negative buoyancy.

3.8.3 Soil Properties

The geotechnical investigation for this project is being constructed this winter and will be limited to borings at the HDD locations at the North Fork River. Four soils borings were obtained to depths of 22 to 27 feet in early 2010. Table 3-6 presents provides a general summary of the soils encountered from these borings.

Table 3-6 Soil Present at North Fork River Crossing

Soil Type	USCS Designations	Depths
Silty sandy gravel or silty gravelly sand fill	GM or SM	3 to 5 feet
Gravels, sands or silts	GP, SP, GW, SM or ML	3 to 16 feet
Firm to hard silt	ML	11 to 27 feet

3.9 Corrosion Protection

The proposed pipeline will be constructed almost entirely of Fiberspar LinePipe which is thermoset plastic pipe that is considered to be non-corrosive. Pipe connectors for the Fiberspar LinePipe will be stainless steel and will have a low potential for corrosion. Discussions related to corrosion in this section are primarily directed towards non-stainless steel piping that may be used either at the start or end of the pipeline.

3.9.1 External Coating

The Fiberspar LinePipe has an 0.1-inch HDPE coating that is used primarily as a wear surface rather than for corrosion protection.

External coating for steel piping will be in accordance with 49 CFR 192.461 and 49 CFR 192.479 shall be applied to all buried and aboveground steel pipe segments, and at steel pipe couplings. External coatings shall be applied on all metallic pipeline components.

Appropriate quality assurance and quality control measures will be employed to verify the integrity of all coated pipe.

3.9.2 Cathodic Protection

The materials identified by the final pipeline design and the soil properties along the pipeline route will determine the type of cathodic protection (CP) system that is required for this pipeline. The CP system will be designed in accordance with 49 CFR 192.463 and 192.469, and the guidelines in NACE SP0169-2007.

The design will likely be composed of magnesium anodes placed at metallic pipe connections, transition points, and other buried metallic structures as appropriate.

Test Stations

Test stations will be installed in accordance with 49 CFR 192.469 and NACE SPO169-2007.

Test stations will include leads from the steel pipe and the anode.

Monitoring

The CP system shall be commissioned and monitored by a NACE Certified Cathodic Protection Specialist. The criteria used to demonstrate adequate levels of cathodic protection shall be in accordance with NACE SPO169-2007. A commissioning report, complete with test data, discussions, the criteria for demonstrating adequate levels of protection, and recommendations shall be completed.

An annual cathodic protection survey shall be conducted in accordance with 49 CFR 192.465. The criteria used to demonstrate that adequate levels of protection were achieved shall be in accordance with NACE SPO169-2007. Test results shall be tabulated and discussed, and recommendations based on the survey results shall be included in the yearly cathodic protection report.

3.10 Welding

Welding is not required for either the Fiberspar LinePipe or the prefabricated steel connectors.

Welding may be required at the beginning and end of the pipeline where steel piping may be present. Welding in these areas will be compatible with the base material in order to avoid local corrosion of weldment and heat-affected zone. Welding and nondestructive examination (NDE) on the pipeline will be performed using procedures and operators qualified in accordance with 49 CFR 192 Subpart E and API 1104.

Section 4.0 Pipeline System Components

4.1 Pipeline

The mainline pipeline will be designed using a thermoset composite plastic pipeline material designed to comply to 49 CFR 192.121 as modified by Fiberspar's Petition to Amend Title 49 Code of Federal Regulations Section 192.121 (dated May 1, 2008). Belowground/aboveground transitions and aboveground piping, valves and fittings will be designed as a steel ANSI 600 Class system with wall thickness to comply with 49 CFR 192.105 and ASME B31.8. All pipeline connectors,, aboveground/belowground transition sections, and aboveground piping, valves, and fittings will be carbon steel.

4.2 Bends

There are no fabricated bends required in segments using the Fiberspar LinePipe. Elastic bends will be used as necessary to conform to the trench geometry.

The bend radius for bends in segments of steel piping will be a minimum of three times the nominal diameter of the pipe. Field bending of steel pipe past yield is not allowed; wrought elbows or ovality controlled induction bends will be provided. All bends will be accomplished in a manner to ensure the pipeline is capable of being maintenance pigged and to accommodate internal inspection tools such as caliper pigs.

4.3 Flanges and Fittings

All steel flanges and fittings will be designed for normal operational requirements (design pressures, temperatures including expected variations, pressure test, and load effects) in accordance with applicable codes, standards and specifications, including:

- ASME B16.5a, Pipe Flanges and Flanged Fittings. NPS 1/2 through NPS 24

Forged tee fittings or, for small diameter branches, standard weld-o-lets will be installed at all pipeline branch locations. Both field welding and shop welding are acceptable provided the weld design is sufficiently analyzed to ensure adequate strength. All branches larger than 2 inches on piggable sections of the line will be barred.

Also see Section 6.5 of this document for additional details.

4.4 Valves

Valves will be provided in accordance with applicable codes, standards, and specifications including:

- ASME B16.34a, Valves – Flanged, Threaded and Welding End

- API 6D, Specification for Pipeline Valves (Gate, Ball and Check Valves)
- API 6FA, Fire Test for Valves

Mainline block valves outside of mainline pipeline metering stations and smart pig launching/receiving stations (facilities) will be full port ball valves, with manual operators. Automated operators may be provided for some remotely operated shutdown valves. Pressure safety valves will be provided to protect the pipeline and provide blowdown capability in accordance with applicable codes, standards, and regulations.

All mainline valve installations will be above ground and will have fences and security measures installed as appropriate.

4.5 Launchers and Receivers

Pipelines will be designed to accommodate maintenance and internal inspection tools (caliper pigs). All pig launchers and receivers (traps) will be located on private property and will be designed in accordance with appropriate codes and standards, including:

- ASME B16.5a, Pipe Flanges and Flanged Fittings. NPS 1/2 through NPS 24
- ASME Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels - Division 1, 2001

Design and location of pig launchers and receivers will consider the following:

- Provision and location of permanent pig traps or connections for temporary pig traps
- Safety of access routes and adjacent facilities
- Lifting facilities
- Isolation requirements for pig launching and receiving
- Requirements for venting and draining
- Minimum permissible bend radius
- Distance between bends and fittings
- Maximum permissible change in diameter
- Tapering requirements at internal diameter changes
- Design of branch connections and compatibility of line pipe material
- Internal fittings
- Pig location signals
- Spill prevention, protection and containment

A launcher will be located at the eastern terminus of the pipeline on the NFU Pad. A receiver will be located at the pipeline western terminus near Anchor Point. Each trap will be equipped with valves capable of safely relieving pressure in the barrel before insertion or removal of pigs, as well as pressure indicators to ensure that pressure has been relieved. The pig traps will be equipped with the necessary appurtenances for efficient and safe operation of the pipeline system during the pigging process. Pig location signals ("pig sigs") will also be installed near each launcher and receiver.

All design, fabrication, and inspection of closures and details such as trap doors and other items not classed as standard pipeline sections, will comply with ASME Section VIII, Division 1.

4.6 Future Natural Gas Supply and Discharge Points

The possibility of future distribution lines being connected to the North Fork Pipeline exists. The size and distribution of future supply lines will be installed dependent on the population density of the specific areas and the economics of potential natural gas sales. All future designs will comply with the criteria set forth in this document and will be submitted to SPCO for review prior to construction. Metering facilities will be provided where natural gas is added or removed from the mainline. These facilities may or may not be located adjacent to the pipeline ROW depending on project specific criteria.

4.7 Supports and Anchors

Detailed analyses will be performed on any aboveground facilities as well as any transition areas between aboveground and belowground facilities to determine the requirements for supports, anchors, and expansion bends. These analyses will consider pipeline axial forces (installation temperature, operating temperature, ambient temperature, and operating pressure), equipment cycles, soil strength, soil-to-pipe friction, and pipe/assembly size, weight, and orientation.

The pipeline and equipment will be adequately supported to prevent or dampen excessive vibration or expansion, and to prevent undue loads on connected equipment.

Section 5.0 Crossings

The proposed pipeline crosses streams, rivers, wetlands, roads, and utilities. Each crossing will be designed to maintain pipeline integrity throughout the design life and to minimize environmental impacts. If unanticipated conditions force a crossing to be cased, the State Pipeline Coordinators Office (SPCO) will be consulted while making the decision.

5.1 River Crossings

River and stream crossings will be designed to maintain pipeline integrity under design scour and bank migration conditions. Construction of river and stream crossings will be scheduled with appropriate permitting agencies to minimize environmental impacts.

5.1.1 Hydrology and Hydraulics

Stream channel designs are based on the specific stream conditions. The proposed route will cross four minor streams and one medium sized pond as summarized below in Table 5-1.

Table 5-1. Stream Crossings for the Proposed Pipeline Route.

Stream	Location	Channel Width	Channel Depth	Comments
Unnamed Tributary to North Fork River	Sec. 34, T4S, R14W, SM	3 feet	< 1 foot	Sands and silts, 3.5% slope
Unnamed Tributary to Two Moose Creek	Sec. 32, T4S, R14W, SM	8 feet	2.4 foot	Sands, silts and cobbles; 0.7% slope
Branson Creek-Upstream	Sec. 36, T4S, R15W, SM	160 feet (pond)	1 foot	Organic soils; 0.2 % slope
Branson Creek-Downstream	Sec. 35, T4S, R15W, SM	9 feet	2 foot	Sands and silts, 0.6 % slope
North Fork River	Sec. 36, T4S, R14W, SM	40 feet	3-5 foot	Sands and gravels; 0.5 % slope

River and stream crossings were designed using existing data, information collected during site surveys, hydraulic calculations, and air photo/map interpretation. Based on topographic maps, drainage basins for the first four crossings are all about 1 mi^2 or less. The North Fork River has a total drainage basin of 76 mi2 based on a draft study by the Kenai Peninsula Borough (KPB 2009).

The first four streams listed are all considered as very minor stream crossings. The channels are all shallow and flow with low gradients through wetland areas. The channels are very stable and are not subject to shifting. The channels will typically have relative low currents during flood events and are not subject to significant scour (estimate <1 ft). The crossing design includes burial to a depth of at least 4 feet below the lowest elevation in the channel.

The North Fork River, with a drainage area of 76 mi^2 is considered to be a medium size river and it has a past history of damage to road structures during flood events. KPB (2009) information indicated the following flood discharges for the North Fork River at its mouth (the flood flow for the river at the pipeline crossing would be approximately 95 percent of the reported flow below based on drainage area).

Table 5-2. Flood Flows for the North Fork River.

Flood Return Period	Location
10 years	1,150 cfs
50 years	2,850 cfs
100 years	3,925 cfs
500 years	7,725 cfs

The river channel is about 40 ft wide (bank to bank) and the 100 year floodplain is about 250 ft wide based on flood analysis immediately downstream (KPB 2009) and air photo interpretation. The floodplain is constrained about 200 ft upstream by the gravel embankment for the North Fork Road, and this area could be subject to possible erosion on the stream channel. The area downstream where the pipeline crossing is located at an old roadway crossing of the North Fork River. While the floodplain is still constricted, it is less constrained than the upstream road crossing. Based on the channel and floodplain geometry the maximum scour depth is estimated at 5 to 7 ft at the proposed pipeline crossing. . The design depth for the pipeline crossing at this location is a minimum of 10 feet.

5.1.2 River and Stream Crossing Methods

River and stream crossings will be constructed using one of two methods. Small streams with manageable flow rates will be crossed using the open cut method. Streams where significant flow exists will be constructed using the dam and pump method. The North Fork River will be crossed using horizontal directional drilling (HDD).

Open Cut and Dam and Pump Crossings

Open cut crossings of small streams will be done during winter when flow is very low. In all likelihood, streams will be frozen to the bottom and stream damming and pumping will not be necessary.

Care will be taken to ensure that damage to the surrounding vegetation is reduced, and bank lines will be restored as close as possible to original condition during winter. The success of the winter restoration will be examined during the subsequent summer.

Figure 5-1 shows the typical trench cross-section at a stream. Figure 5-2 shows the open cut and dam-and-pump crossing.

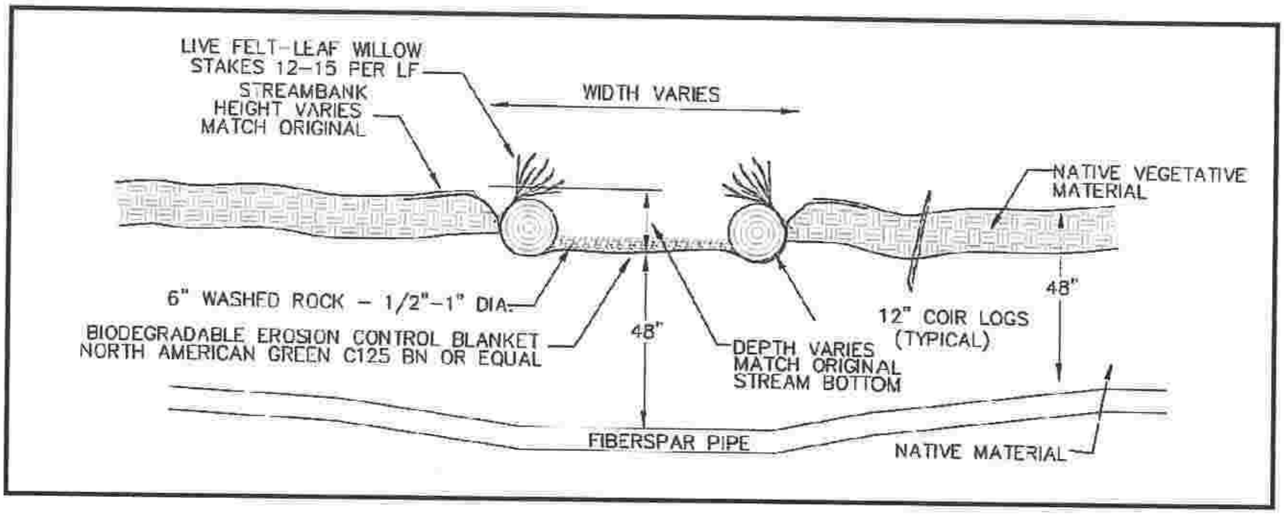


Figure 5-1 Open Cut Stream Crossing Section

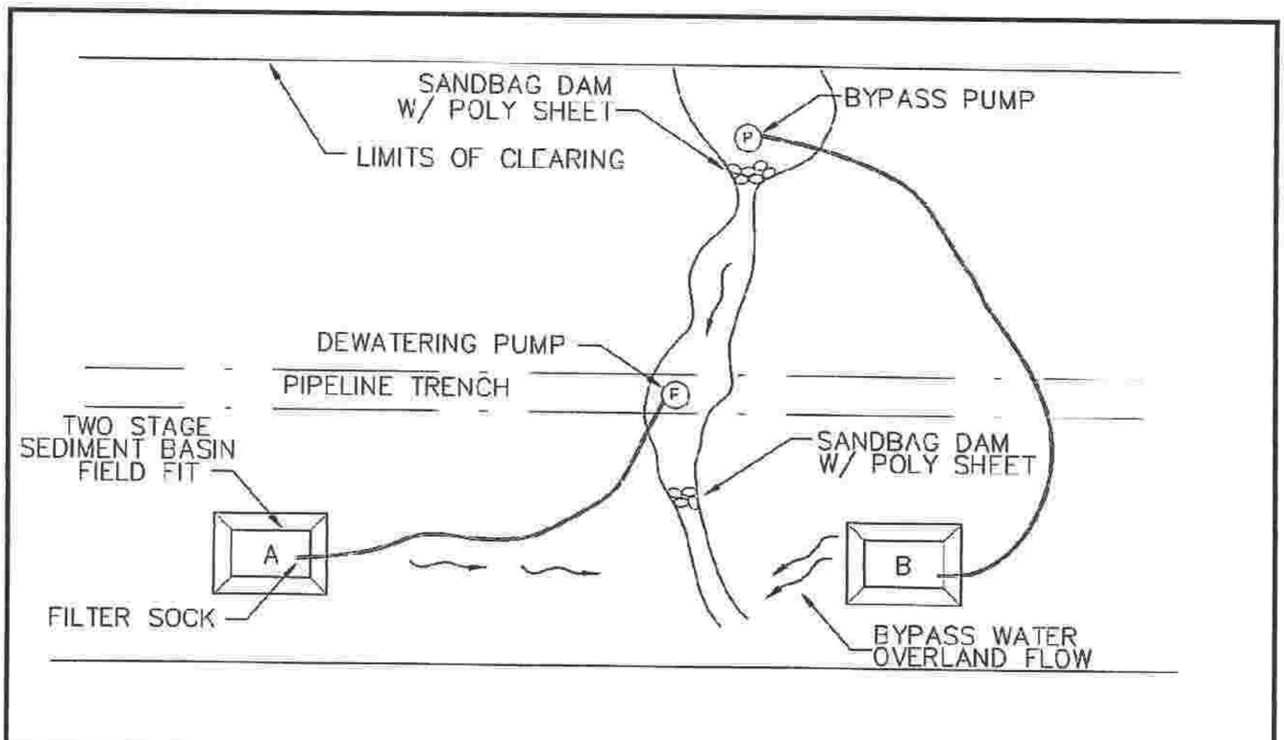


Figure 5-2 Dam & Pump Stream Crossing Plan

Horizontal Directionally Drilled Crossings

The pipeline crossing for the North Fork River will be installed using horizontal directional drilling (HDD). This option is used in order to avoid any disruptions to the North Fork River which is an important anadromous fish stream.

The HDD process starts with a pilot hole being drilled under the river channel, starting well back from one side and exiting at a predetermined point on the other side. Locating devices are used during drilling to assist in steering the drill bit and determining the actual depth and location of the advancing drill bit. The depth of the bore below the river thalweg (lowest point in the river) is set by determining an anticipated scour depth (10 ft for the North Fork River) of the river and keeping a specified clearance below this point (in our case we will add an additional 5 ft of depth). After drilling the pilot hole to the desired configuration, successive reaming passes are made to enlarge the drill hole to the desired diameter, usually 6-inches to 10-inches larger than pipe diameter. The minimum radius of curvature for an HDD profile will be not less than 100 times the pipeline diameter, where the diameter is in inches and the radius is in feet. An oversize HDPE or steel conductor pipe will be installed, then the Fiberspar LinePipe will be pushed through the conductor pipes and connected to the pipeline at both ends.

Figure 5-3 provides a topographic map of the proposed crossing. The crossing is located on top of the gravel approaches to the old North Fork Road crossing which was replaced many years ago. Figure 5-4 shows the profile view of the crossing. The crossing will be about 335 feet long and will be at a minimum elevation of 15 ft below the thalweg of the North Fork River.

5.2 Road Crossings

The pipeline will be sized to safely withstand internal and external loads at road crossings. The depth of cover will be determined as a result of load calculations and in accordance with ROW agreement with the DOT/PF. However, the depth of cover will not be less than 48 inches. If required to lower external stresses on the pipeline, a conduction pipe may be installed at road crossings to protect the Fiberspar LinePipe. Road crossings will be separated into two categories.

- Major Road Crossings – North Fork Road
- Minor Road Crossings – Other roads and driveways

The minor road crossings will be constructed by open trenching across the road. The amount of time any road or driveway is impassable will be minimized through construction sequencing or arranging alternative traffic patterns as approved by local authorities. The major road crossing of the North Fork Road will be constructed by HDD in order to avoid traffic interruptions.

5.3 Other Pipeline Crossings

There are no know pipeline crossings required for the project.

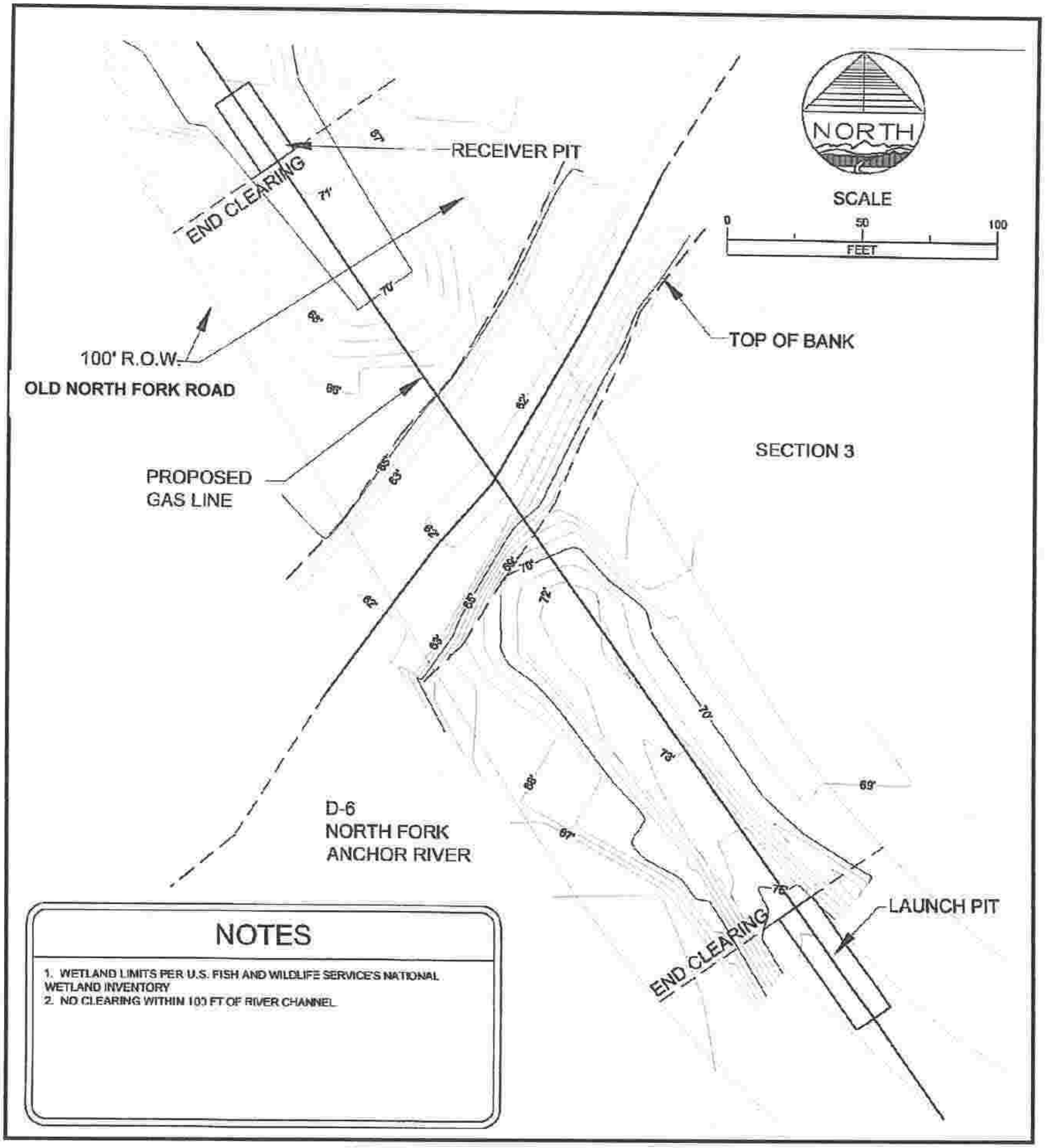


Figure 5-3. Topographic View of the North Fork River Crossing.

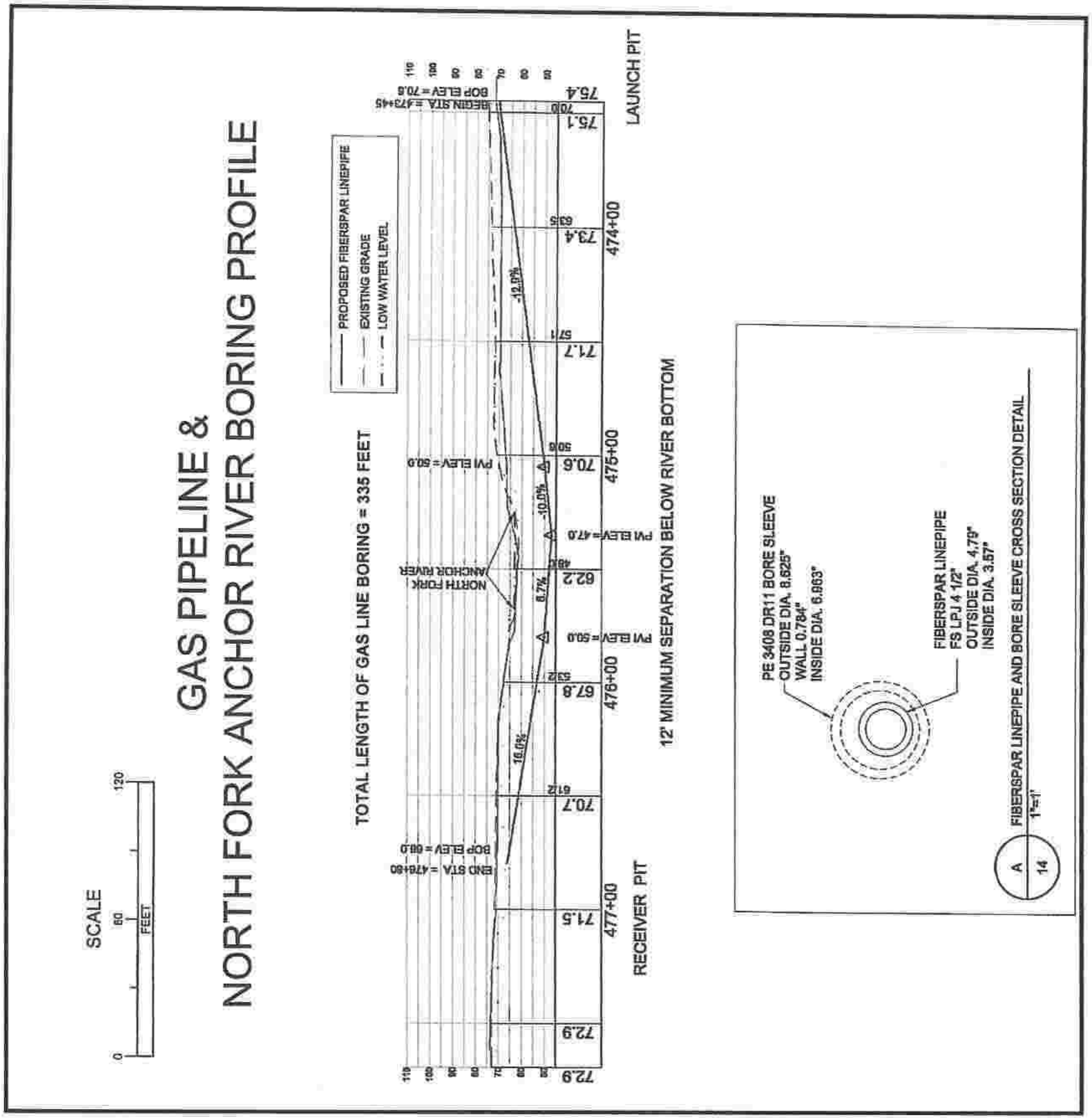


Figure 5-4 Profile View of the North Fork River Crossing.

5.4 Other Utility Crossings

Utility crossings will be limited because of the route of the proposed pipeline. Other utility crossings will likely be of the following type:

- Electrical (buried and aerial)
- Telephone (buried and aerial)
- Fiber optic cable
- Water
- Sewer

The pipeline will be installed beneath other buried utilities, and a separation distance of 12 inches minimum will be maintained. Stray currents induced at electrical line crossings will be mitigated with an appropriate grounding system. Additionally, pipeline insulators will be installed between electrical lines and the pipeline.

5.5 Wetland Crossings

Buoyancy control may be necessary for wetlands crossings. If the weight of the pipeline is less than 1.05 times the calculated buoyant force, buoyancy control will be added. Buoyancy control will be provided via geotextile swamp weights. The weights will consist of non-degrading geotextiles formed into sandbags. The sandbags will be filled with sands and gravels so that they are permeable for groundwater flow.

Winter construction is the preferred method for pipeline installation in wetland to minimize the impact to wildlife and habitat, see Figure 5-5. The wetlands will be restored as near as practically possible to original conditions following construction.

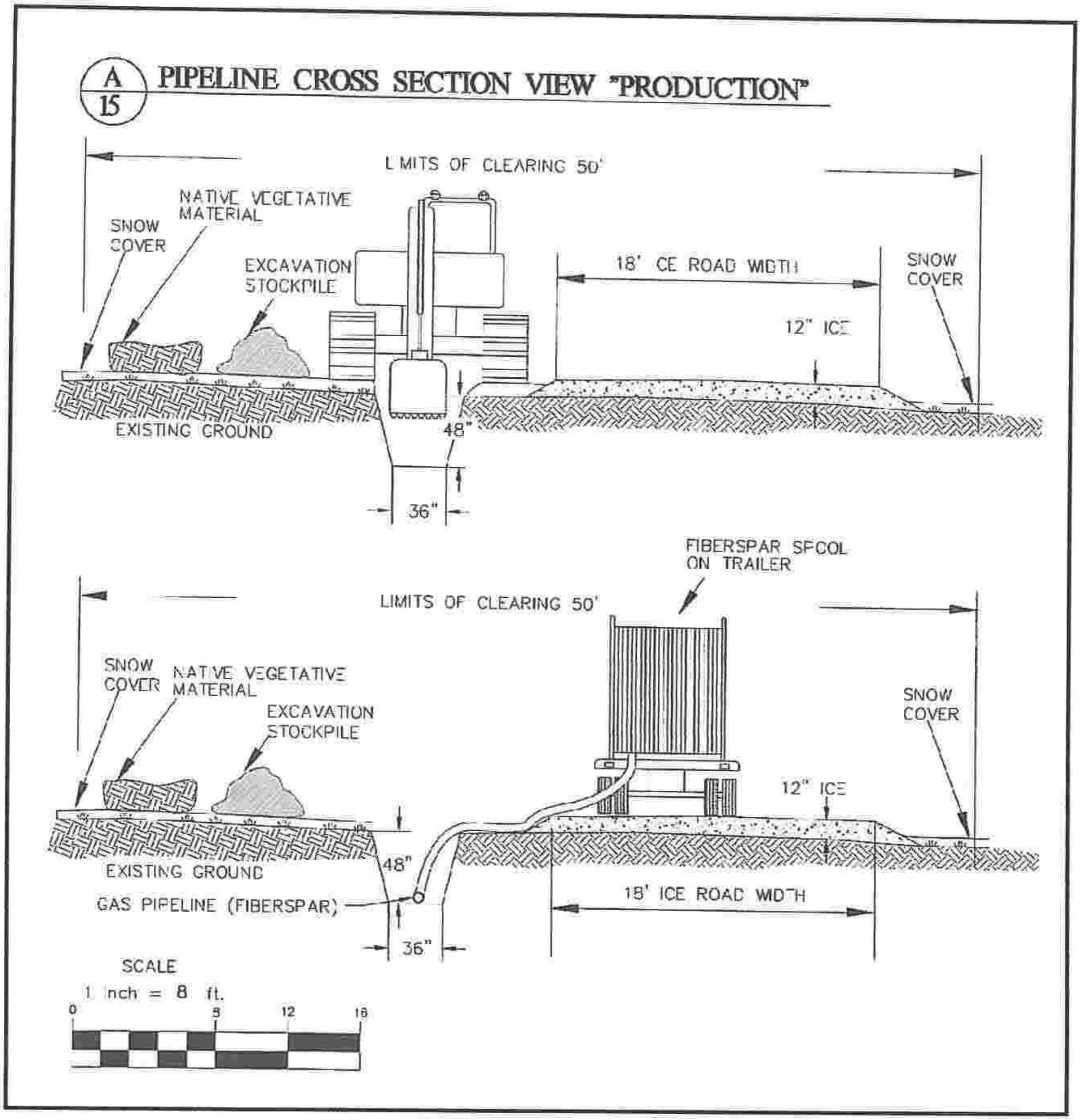


Figure 5-5 Typical Wetland Trench Details

Section 6.0 Construction

6.1 Clearing

The construction will include clearing a 50 ft wide ROW. ROW leveling and grading is not planned to occur, especially in wetland areas.

6.2 Excavation

Once the ROW is leveled, excavation of the trench will be accomplished by the use of backhoes and bucket type trenchers. The ditch will be excavated to the specified depth and the bottom graded as necessary. Spoils from the excavation will be placed within the ROW limits.

6.3 Pipe Handling

The Fiberspar LinePipe will arrive on site in 3,000 ft long rolls of continuous pipe. The pipe will be spooled directly from the roll and placed into the trench. A flatbed truck will be required to haul the rolls of pipe to the site, but side booms or other pipe handling equipment will not be required.

6.4 Bending and Set-up

No field pipe bending or setup is required for the proposed operations.

6.5 Line-up and Pipe Connections

Traditional construction operations will be employed for the steel portions of the pipeline (belowground/aboveground transitions and aboveground piping). For the buried portions, it is estimated that approximately 14 spools of Fiberspar LinePipe of about 3,000 feet each will be required for the project. The shipping size of each spool is about 16 ft in diameter and 8.5 ft wide. Spools of the pipeline material are connected using mechanical joints designed for plastic pipeline use – traditional welding is not required to connect the spools. With a connection at each end and joints between spool lengths the minimum number of connections would be 15; additional connectors may be required along the line for construction purposes. The connectors supplied will be Fiberspar LinePipe compression slip connector fittings specially constructed for the pipe. The connectors will be constructed of stainless steel and will have a high resistance to corrosion. The use of impermeable surface wraps is also being considered to further protect the connectors.

Transitions between above and belowground will be accomplished by using steel connectors with one buttweld end. The plastic piping will be elastically bent toward the surface grade, a piece of steel pipe will be welded to the connector, and this portion of piping will come above grade, terminating in an aboveground stainless steel flange. Steel aboveground components may then be bolted to the steel flange, and electrically isolated with electrical isolation flange kits.

The connectors will be installed in the field by specially trained Fiberspar personnel and appropriately qualified welders.

6.6 Lowering-In and Backfilling

The pipe will be fed from the spool and into the trench by hand. Care will be taken not to over stress the pipe or cause any damage to the pipe coating. Once the pipe is installed into the trench, the spoils pile will be used to carefully backfill around the pipe. Specially selected bedding material may be required in certain portions of the alignment to ensure proper support of the pipe. Backfill will be mounded to allow for settlement.

A marker wire or tape will be installed in the trench to expedite locating the pipe in the future..

6.7 Ditch Plugs

Ditch plugs will be placed at appropriate intervals to reduce or eliminate the movement of surface water and groundwater in or along the trench during construction. It is expected that these will be required only for the potential summer construction operations which may occur in upland areas. Ditch plugs will consist of either silty material or sandbags placed in the trench. If in situ material containing high amounts of silt is utilized as backfill, the need for ditch plugs is lessened due to the fact that groundwater will be less likely to migrate through silty backfill. The bags may either be left in place or removed as appropriate at the time of trench filling.

As the topography is generally of low relief and the construction timing will be relatively short, it is not anticipated that ditch plugs will be extensively used.

6.8 Drainage and Erosion Control

Drainage and erosion control during construction will be employed in accordance with the approved project specific Storm Water Pollution Prevention Plan. Drainage and erosion control will include:

- Diverting overland flow around disturbed areas to minimize the amount of erosion-generating runoff from the disturbed area.
- Diffusing or diverting flows to stabilized outlets to reduce problems associated with concentrated flows and velocities resulting from clearing of vegetation.
- Constructing dikes across the slope of a disturbed area to redirect sheet flow or concentrated flow runoff around disturbed areas.
- Sequencing construction activities to minimize the amount of area disturbed at one time. Final grading, clean-up and restoration and reclamation will be completed as soon as possible after construction is completed.
- Implementing temporary stabilization of soil prior to and during construction, and permanent stabilization of soil during and after construction. Stabilization practices include

seeding, mulching, geotextiles, sodding, riprap, re-vegetation and other approved techniques.

6.9 Revegetation

Revegetation will primarily include reseeding and fertilization in the ROW in order to reestablish the native species in areas of disturbance. Temporary construction erosion measures may remain in place in areas of concern until the vegetative growth is well established. Revegetation plans and measures will be employed along with a sound erosion control plan.

6.10 Signage and Pipeline Marking

Pipeline alignment signage and marking will be provided in accordance with applicable codes and regulations.

Section 7.0 Technical Issues to Monitor During Operations

No commitments were made during the right-of-way process to monitor technical issues during operations that do not fall under the realm of the federal pipeline safety codes presented in 49 CFR Part 192.

Section 8.0 Pipeline Segments and Permits

8.1 Pipeline Segments

There are two segments of pipeline that are included in the project. The main line is a 7.40 mile long sales quality natural gas pipeline (i.e. the North Fork Pipeline). The second segment is a 0.34 mile long in-field natural gas gathering line; this segment is not regulated by the SPCO. Both segments are located within the Kenai Peninsula Borough within the State of Alaska. Each is discussed in the following paragraphs.

The main pipeline starts at the North Fork Unit (NFU) Pad operated by Armstrong Cook Inlet, LLC, and the end point will be at an Enstar Natural Gas Company pipeline to be located at the unincorporated community of Anchor Point. This segment will consist of a single or dual 4.5 inch Fiberspar pipeline that is approximately 39,063 feet (7.40 miles) in length.

The gathering line will be an in-field line within the NFU. It begins at an existing well site and ends at the NFU Pad. This segment will consist of a single 4.5 inch Fiberspar LinePipe that is approximately 1,800 feet (0.34 miles) in length

8.2 PHMSA Special Permit

The use of a composite piping system discussed in the preceding sections requires a special permit from the U.S. Department of Transportation (USDOT), Pipeline and Hazardous Materials Safety Administration (PHMSA). The contents and requirements for an application for a special permit are defined in 49 CFR 190.341. Accordingly, Anchor Point Energy, LLC has requested that 49 CFR 192.121 be revised to allow the use of the Fiberspar LinePipe up to the hydrostatic design basis as listed by ASTM D 2517. The application was submitted to PHMSA on February 25, 2010; a copy of that application including attachments will be provided to the SPCO.

8.3 Other Permits

Various aspects of the pipeline construction operations will require permits. Table 8-1 provides a listing of these permits and approvals. Copies of applications for these permits have been submitted to the SPCO.

Table 8-1. Summary of Permits Required for the Project.

Alaska Dept. of Natural Resources
Division of Coastal and Ocean Management
Coastal Zone Management Review
Division of Mining Land and Water
ROW Lease
Temporary Land Use Permit (Geotechnical Investigations)
Temp Water Use (possible)
State Historic Preservation Office
Cultural Resource Clearance
Alaska Dept. of Transportation & Public Facilities
Right of Way Easement
Alaska Dept. of Fish & Game
Habitat Permit
Kenai Peninsula Borough
Permit Review
Right of Way Easement
Temporary Land Use Permit (Geotechnical Investigations)
U.S. Army Corps of Engineers
Wetlands Permit
Section 401 Certification (ADEC)

Section 9.0 References

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American National Standards Institute (ANSI)

ASC GPTC Z380.1, American Gas Association Guide for Natural Gas Transmission and Distribution Piping Systems. 1998

American Petroleum Institute (API)

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- 6D, Specifications for Pipeline Valves. 2002.
- 6FA, Fire Test for Valves
- 1102, Steel Pipelines Crossing Railroads and Highways. 1993.

1104, Standard for Welding Pipelines and Related Facilities. 1999.

American Society of Civil Engineers (ASCE)

- 7-98, Minimum Design Loads for Buildings and Other Structures

American Society of Mechanical Engineers (ASME)

- B16.5, Pipe Flanges and Flanged Fittings. 1998.
- B16.34a, Valves-Flanged, Threaded, and Welding End. 1998.
- B31.8, Gas Transmission and Distribution Piping Systems. 1999.
- ASME Boiler and Pressure Vessel Code, Section VIII: Pressure Vessels -

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