If you could tour the pipeline route

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Alaska LNG project sponsors often remind people it's really three projects — a gas treatment plant on the North Slope, a long pipeline bisecting the state and a liquefaction plant at coastal Nikiski. Each would cost billions of dollars, and need tons of steel, thousands of workers and years to construct.

But the middle segment of this trinity — the 800-mile natural gas pipeline from Prudhoe Bay to Nikiski — is the symbol of Alaska's 40-year quest for North Slope natural gas development.

The project sponsors are still working out the exact route for the 42-inch-diameter pipeline, testing soils, searching for earthquake faults, scoping the most buildable corridor with the least environmental impact and the fewest construction problems. It's all part of their preliminary front-end engineering and design efforts, expected to last through 2015. The "study corridor" is 2,000 feet wide. The pipeline's ultimate right of way and footprint would be much narrower.

Preliminary maps filed in February 2015 with the Federal Energy Regulatory Commission provide a general path the sponsors and their teams are reviewing.

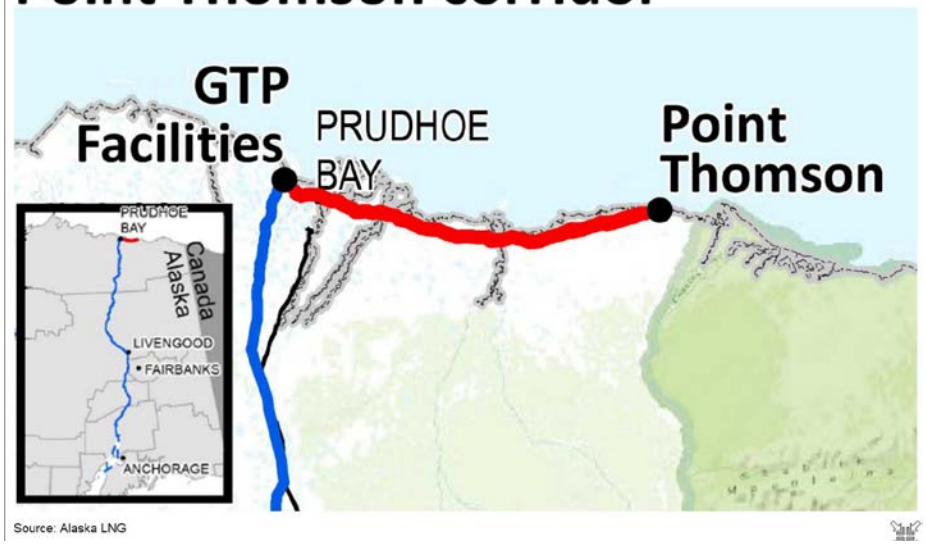
If you could walk, drive or fly over the route, this is what you would see and could learn about the people and places along the way. (We consulted a variety of public filings from current and past projects along the corridor, as well as other publications, in preparing this narrative.)

POINT THOMSON: THE REAL STARTING POINT

More than one-quarter of the proven gas reserves that would feed the Alaska LNG project reside at the Point Thomson Unit, 60 miles east of Prudhoe Bay (home to the project's other start-up gas reserves). Point Thomson is the true launch point for the LNG mega-project.

ExxonMobil is leading the Point Thomson development, which is scheduled to start producing natural gas condensate in early 2016. The partners expect that this $4 billion initial production phase will help them master the tricky reservoir's "plumbing" in anticipation of beginning gas production for the separate Alaska LNG project in the mid-2020s.

Point Thomson lies a few miles west of the Arctic National Wildlife Refuge border and about 60 miles west of the Beaufort Sea coastal community of Kaktovik. Most of Kaktovik's 250 residents are Inupiat, whose North Slope roots go back thousands of years. The name Kaktovik, or "seining place," signifies the region's fishing tradition.



Source: Alaska LNG

Enlargements of all images are at end of document.

The field and pipeline route lie along the Arctic coast, among the northern-most places in the United States. It can snow there any month, and it's reliably covered with snow eight months of the year. It is completely sunless about two months a year. During the warmer months the terrain is largely a squishy mass of peaty tundra and other wetlands, including ponds, lakes, streams and braided rivers.

The project sponsors have not decided whether to bury or elevate the pipeline that would carry Point Thomson gas to Prudhoe Bay. In any event, construction would occur during winter, when the ground is frozen.

The pipeline generally would trace the coastline a mile or so inland.

Sedge and dwarf shrubs dominate the vegetation, both well-suited to thrive in cold, soggy soil. A deep permafrost layer slightly below the surface keeps soils waterlogged as moisture can't filter down.

Numerous freshwater lakes pockmark the flat tundra, providing habitat for ninespine sticklebacks, whitefish, blackfish and others.

Bears — polar and brown — roam the grounds, as do caribou, musk ox, foxes and small mammals such as arctic ground squirrels, collared and brown lemmings, root voles and barren shrews.

The small critters are prey to larger mammals and such birds as raptors and owls. The wetlands support dozens of migratory bird species — including geese, ducks, loons — for nesting and molting in summer. Other areas of Alaska's North Slope see a much greater density of bird migrations each year.

Near Milepost 20. One-third of the way to Prudhoe, just shy of the 20-mile marker, the gas line would pass south of Badami, an oil field BP started in 1998. Badami has been an inconsistent producer — though a new operator, Savant Alaska, is giving it a try.

Until work started at Point Thomson, Badami was the North Slope's easternmost field. The liquids that will flow from Point Thomson starting in 2016 will feed into the existing oil pipeline from Badami to Prudhoe Bay.

Near Milepost 24. The gas line would cross three major drainages along the route, and here it would cross the first of them, the Shaviovik River, for the Native word that means "place where there is iron." The line would encounter many smaller streams along the way, too.

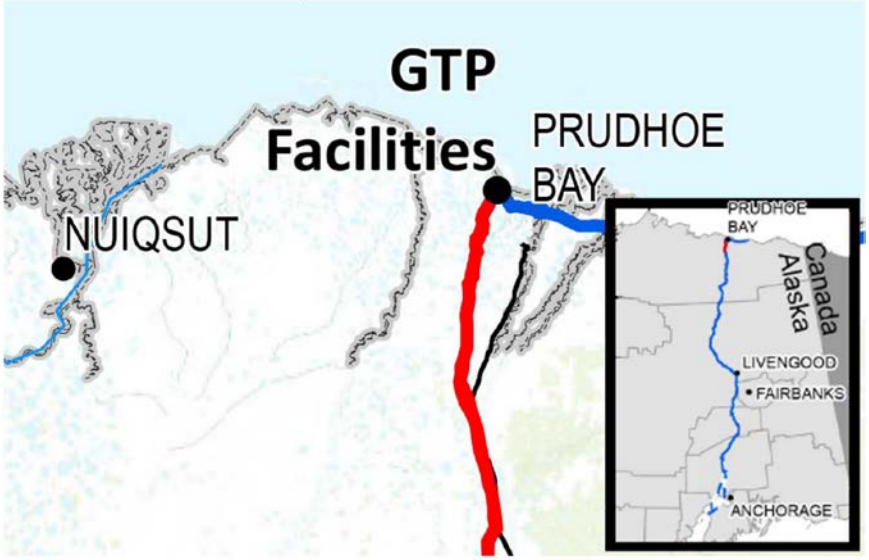
Near Milepost 33. Here lies the second significant river, the Kadleroshilik, a 90-mile-long waterway that empties into the Beaufort Sea. An explorer named the river almost 100 years ago for a 200-foot-tall mound; the name means "possesses something on top."

Near Milepost 50. The mightiest of the rivers along the pipeline route is the Sagavanirktok, the "strong current" coursing along the Dalton Highway, the lifeline for truck traffic to the North Slope. Here you enter the Prudhoe Bay oil and gas complex — roads, rigs and runways; pipelines, people and power poles. It's the nation's largest conventional oil field.

Near Milepost 58. The Point Thomson gas pipeline would reach its endpoint at the new gas treatment plant about eight miles from the Sag River. At this plant, the pipeline's gas would mix with Prudhoe Bay gas and get processed to remove carbon dioxide and other impurities before starting the 800-mile journey to the LNG terminal. The gas treatment plant would be built near Prudhoe's massive central gas plant, which has handled the field's gas production since 1986.

MILES 0-65: PRUDHOE BAY AND THE COASTAL PLAIN

The elephant-sized oil field at Prudhoe Bay is what transformed Alaska into a major oil realm and anchors the state's economy.



Source: Alaska LNG

Prudhoe Bay's oil and gas production facilities are a complex of pads, wells, pipes, roads, machinery, plants and housing that support production and handling of hundreds of thousands of barrels of oil, tens of millions of gallons of water and billions of cubic feet of natural gas every day. Everything there was installed within the past 40 years or so. Thousands of workers keep it humming.

Equipment mostly gets delivered via one of two routes: one by land and one by sea. The Dalton Highway is the lone road linking Prudhoe to the rest of Alaska, snaking 415 miles south until it connects to the next road north of Fairbanks. West Dock is a 2.7-mile industrial causeway/dock that knifes into the Beaufort Sea north of the oil field. The industry built both to support developing Prudhoe in the 1970s.

Buildings and plants too giant to move by road get delivered by flotillas called sealifts to West Dock during an ice-free summer window. Alaska LNG plans summer sealifts, too. Likely four of them to sail in enormous modules that would be assembled into the multibillion-dollar gas treatment plant.

The Dalton Highway would be a key artery for moving pipe, machinery and people when building the pipeline from Prudhoe Bay to Nikiski. The road would parallel the northern 400 miles or so of the gas pipeline. The mostly gravel highway was named for James W. Dalton, who came from a pioneering sourdough Alaska family and made a name as a territorial-era engineer involved in early North Slope oil exploration.

Milepost 0. The pipeline south would start at the gas treatment plant.

After performing its main job of removing impurities, this plant would chill the gas below 32 degrees and compress the molecules before the gas enters the pipeline.

Chilling the gas keeps the pipeline cold. The pipe would be buried in permafrost in the Arctic and discontinuous permafrost in some soils farther south. A cold pipe keeps the ground frozen.

Compressing the gas — pumping up its pressure — provides energy that propels it through the pipe: The gas would leave the plant, start expanding and thus stream through the pipe. Along the line, a string of compressor stations would regulate the gas temperature and provide propulsion via compression. Movement gradually slows between compressor stations due to the friction of gas molecules against the steel pipe walls.

Near Milepost 5. The pipeline would pass Pump Station 1, the start of the trans-Alaska oil pipeline, which has been carrying North Slope oil since production began in 1977.

Near Milepost 7. The gas pipeline would have exited the main oil-development area by now and would run roughly parallel to the oil pipeline and Dalton Highway for approximately 400 miles.

Roughly Milepost 7 to Milepost 65. Alaska is considered to have 32 ecoregions across the vast state. Alaska LNG and its pipeline would traverse nine of them.

For the northernmost 60 miles or so — at Prudhoe Bay and immediately south — the pipeline would be in what is called the Beaufort Coastal Plain. This area is generally like the land the Point Thomson line would span: flat, wet and treeless, thus windy. Ice-rich organic silt overlays coarse sands and gravels, which in turn overlay permafrost. Sedges, grasses and mosses tend to dominate the vegetation woven into this soggy soil.

As the elevation slowly rises toward the Brooks Range to the south, the soil drains better. Dwarf shrubs can be found, typically no taller than soda bottles.

The pipeline would weave along the better ground through this terrain to minimize its footprint in wetlands. As with the Point Thomson pipeline and much of the entire pipeline, construction would occur here in winter when the ground is frozen. A special federal Clean Water Act permit is needed to discharge dredged or fill materials into wetlands. The project sponsors as of early 2015 were studying whether to elevate the pipeline above ground for the first 60 miles or so rather than burying it.

Near Milepost 20. The pipeline would come up close to the Dalton Highway for the first time. The Sagavanirktok River, the major drainage in the area, lies just east of the road.

Near Milepost 35. Across the Sag River to the east are the iron-tinged Franklin Bluffs, a visual departure from the Arctic plain's typical flatness and a foreshadower of the Brooks Range ahead.

The bluffs aren't the only contour relief here, however. To the west, a pingo called "Berry" is visible. Pingos are mounds of earth-covered ice. Some are quite large, looming hundreds of feet above the tundra. With their relatively good drainage, they tend to provide botanical contrast to the wet, flat surrounding tundra, especially on their south-facing slopes.

Besides members of construction crews, caribou would be the most likely large mammals encountered in this vicinity. If a grazing caribou bull suddenly darts across the tundra, the likely reason is warble flies. They don't bite or sting, but they can lay eggs that can grow into large grubs under the caribou skin.

A rare brown bear or wolf siting also could occur. Small mammals are present — shrews, voles and arctic ground squirrels.

The wetlands also provide seasonal habitat for migratory birds from around the world. The area is a hotspot for bird-watchers, as migratory birds nest and breed on the arctic coastal plain, including King eiders, spectacled eiders, geese and loons. Rock and willow ptarmigan are widespread here, too.

Near Milepost 65. The pipeline would pass near Pump Station 2. This station was built for the oil pipeline, although it's no longer used. As compressor stations help propel pipeline gas, pump stations keep pipeline oil moving.

The initial gas pipeline corridor veers west of the oil pipeline and Dalton Highway for about 20 miles near Pump Station 2.

Nonetheless, Pump Station 2 is symbolic of what lies ahead: the Brooks Range, the first of two major mountain ranges the gas pipeline would surmount. Owners of the oil pipeline built three pump stations to help the oil get up and over the steep Brooks. Two are still used today.

MILES 65 TO 240: FOOTHILLS AND BROOKS RANGE

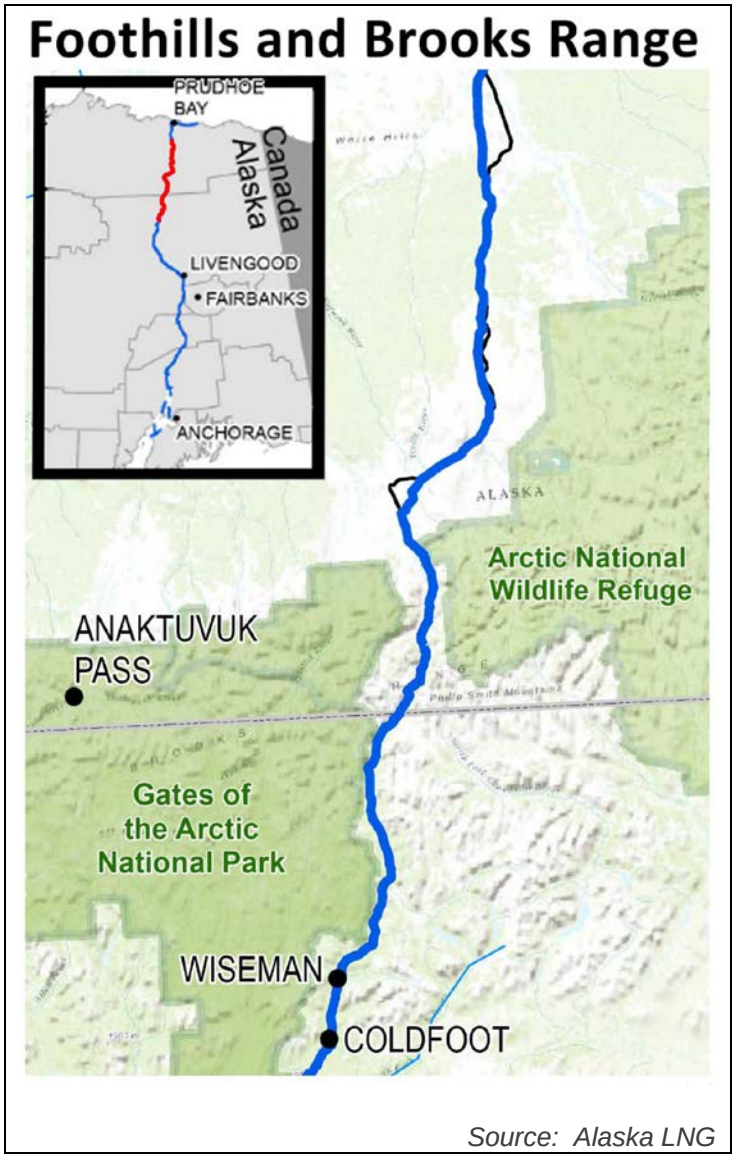
Near Milepost 75. The Sagwon Bluffs lie to the east. The elevation now has noticeably risen. The terrain is getting more texture.

The pipeline here would cross the northernmost advance of the Anaktuvuk Glaciation, which occurred perhaps 100,000 years ago. It was one of the older of several glaciations in recent Brooks Range ice ages that helped sculpt the mountains into their present topographic profiles.

Near Milepost 90. The Happy Valley camp is a former pipeline construction camp and current base for road crews and a leisure and recreation operator offering meals, lodging and flightseeing trips over the Brooks Range and Arctic flats.

The oil pipeline crosses to the west side of the Sag River a few miles back and angles back to the east side a few miles to the north. The gas pipeline would hug the river's east bank, as does the Dalton Highway.

The gas pipeline's route is generally plotted but not finalized. Alaska LNG says the gas pipeline would cross the oil line multiple times. But the specific locations and exactly how the crossings would be constructed are details to be worked out. Pipeline safety regulators would have to sanction the crossings. Alaska LNG's engineers are working on the plans. Typically, the gas line would go under the oil line, but it could rise over its older cousin. Note, however, that Alaska LNG plans to bury the gas line along most of its route, while the oil line is above ground for a good portion of the 400 miles that the lines run parallel.



Source: Alaska LNG

Plans are similarly unspecific for road crossings. The gas pipeline would parallel the Dalton Highway for about 400 miles and the Parks Highway farther south for about 200 miles, according to Alaska LNG filings with the Federal Energy Regulatory Commission. Besides the Dalton and Parks, the pipeline would parallel or intersect 44 other roads. Typically, a pipe is buried well below the roadbed, and stronger steel gets used for the pipeline because of the extra weight it will bear.

Near Milepost 110. The oil pipeline's Pump Station 3 is still operating. Only four of the 11 started up by 1980 still pump the oil today.

Because of glaciation, the Brooks Range hills often feature glacial moraines covered with loess. Whatever the soil type, ice commonly is found in it and permafrost under it. Because the surface layer — called the active layer — can thaw seasonally, and the ground can be sloped, movement called solifluction (saturated surface layer slowly slides downhill) can occur and must be avoided or engineered around when a pipeline is buried. Gelifluction is even possible, in which relatively flat saturated soils atop frozen ground start to creep.

Near Milepost 115. The pipeline would have been on state-managed land to this point. Now it would be crossing onto federally managed land. Soon it would be running a gauntlet between the Gates of the Arctic National Park and Preserve to the west and the Arctic National Wildlife Refuge to the east. The preliminary route would have the pipeline avoid both areas, although it would pass within 0.2 miles of ANWR at its nearest point, roughly 35 miles south of here.

To the west lies Slope Mountain, elevation 4,010 feet, composed of sedimentary rocks deposited about 100 million years ago. Across the Sag River to the southeast is one of the older archaeological sites in northern Alaska, with human evidence — charcoal within loess — from as long as 10,000 years ago.

Near Milepost 130. Another 20 miles down the Dalton is the Toolik Field Station. The University of Alaska Fairbanks' Institute of Arctic Biology runs the station, and scientists there study arctic ecosystems and global climate change. The station provides meals, lodging, laboratories, mapping services, equipment and environmental data to visiting researchers from around the world. But it's closed to the public.

The preliminary gas pipeline route would have it zig to the east a few miles before Toolik then zag back in sync with the Dalton Highway and oil pipeline several miles south of the science station.

Near Milepost 145. Here lies Galbraith Lake, which once occupied the entire Atigun Valley. The lake is named for Bush pilot Bart Galbraith, who died in a 1950 plane crash while flying from Barter Island off Alaska's northeast coast to Barrow. The Native name is Natravak, which means "big lake," a name shared by many water bodies in a state with perhaps 3 million lakes.

The lake is a notable landmark along the route because of the nearby campground with picnic tables and bear-proof containers for tent campers. The Dalton is a corridor for hunters — bow hunters. No firearm hunting along the oil pipeline, please. Moose, caribou and Dall sheep are among their targets.

Today's hunters follow a long tradition of pitching camp here. Archaeological evidence found near the lake during oil pipeline construction in the 1970s indicates humans had used the area for thousands of years.

The Alyeska Pipeline Service Co., which runs the oil pipeline on behalf of the oil company owners, also has buildings nearby Galbraith Lake and there is an airstrip.

Near Milepost 150. Alyeska's Pump Station 4 is here. It is the last pump station tasked with pulsing North Slope oil over the Brooks Range. It also sits at the highest elevation among the oil pipeline's pump stations, at 2,760 feet. This wouldn't be the gas pipeline's highest elevation, however. That spot lies roughly 25 miles ahead at Atigun Pass.

The pipeline would have said farewell to the Sag River by now. The Atigun River would lie just west and escort the line for a while, up a broad valley pocked with wet sedge meadows.

The Brooks Range would be all around. The mountains span northern Alaska and part of Canada's Yukon Territory. The tallest peaks along the pipeline route top 8,000 feet. The pipeline would be in the range or its southern foothills for another 100 miles or so.

The terrain is generally rugged, with land shaped by alpine glaciers and eroded over time into cirques and U-shaped valleys, talus slopes and alluvial fans. Past glaciation shoveled coarse-grained sands and gravels, now typically frozen, beneath sometimes-peaty soils. Permafrost still is the norm, although on the Brooks Range southern slopes some discontinuous permafrost can be found.

Near Milepost 175. Atigun Pass at 4,739 feet would be the pipeline's apex.

This is a tricky channel. The gas pipeline would need thread through without disrupting the road or oil pipeline, which is buried in places because of avalanches and falling rocks.

The pass approach is steep — the highway gains/loses about 1,000 feet both north and south in just a few miles. The pass proved problematic for the oil pipeline in its early years, with damage from buckling and settlement on either side before Alyeska figured out Atigun. In places Alyeska has buried the oil line in insulated concrete cribbing, or added steel supports, or slid a concrete slurry beneath the line for support.

Atigun Pass is the Brooks Range's continental divide. Rivers north of it, such as the Sag and Atigun, drain to the Arctic Ocean. Rivers south drain to the Bering Sea.

Source: Alaska Department of Transportation and Public Facilities

Atigun Pass in northern Alaska's Brooks Range would be the gas pipeline's highest elevation, at an altitude of 4,739 feet. The pipeline would share space with the trans-Alaska oil pipeline and the Dalton Highway through the pass.

The southern flanks offer the classic collection of Alaska critters: caribou, Dall sheep, brown bear, beaver, marten, mink — each in its own preferred habitat, of course. Moose density increases the farther south one goes as the foraging grounds improve. Arctic ground squirrels live in colonies on well-drained mountainous tundra, and they are meals for bear, wolves, wolverines and weasels.

Near Milepost 181. The pipeline would cross the Chandalar Shelf, a mile-long plain that offers impressive views looking east toward the Chandalar River headwaters. The vista is unobstructed by trees. On descending the shelf, the route would cross the tree line's northern extreme. Some very old white spruce might be found around here.

The name "Chandalar" is a slur from the name Hudson's Bay Co. French employees, based in Fort Yukon, gave Gwich'in Indians along the river. They called them "Gens de Large," or "nomadic people." When later transcribed into English, voila: Chandalar.

Near Milepost 183. The pipeline would exit the North Slope Borough for the first time. At 95,000 square miles, the borough is an Alaska-sized local government. If a state, its area would rank it 12th largest, just behind Michigan and ahead of Minnesota. The gas pipeline would not again penetrate a local-government boundary until around Milepost 420.

The Dietrich and Koyukuk rivers systems start here. These have steeper gradients and are extensively braided.

The Alaska LNG project sponsors have told regulators that on this portion of the route they prefer to follow river valleys, where thin soils cover bedrock, or thin surface peat might cover rock fragments at the foot of cliffs or sand, silt and rocks deposited by the moving water. "For example, thin peats and wet mineral soils with shallow permafrost are present where the Mainline corridor traverses valley bottoms along the Dietrich and Koyukuk rivers," they told the Federal Energy Regulatory Commission in February 2015. Up higher in the Brooks Range, soils are thin to nonexistent.

Near Milepost 205. This is around the northern limit of the paper birch. Black spruce trees —some leaning — are common enough by now. Tree cover still is thin, though.

The Dietrich River will join the Koyukuk's middle fork just ahead. The preliminary route would place the pipeline on the Koyukuk's west bank for the first two or three miles before it crossed over to the east bank for the next 20 miles or so to the town of Wiseman, the first community it would encounter.

Near Milepost 225. Wiseman lies just west of the oil pipeline and Dalton Highway. It also would be just west of the gas line.

Wiseman would signal the gas pipeline's passage onto ground linked to Alaska's gold-mining history. The region from here south on the line's route was where some of Alaska's first economic boom played out roughly 100 years ago.

Gold mania that brought thousands to Alaska in the early 1900s led to Wiseman's founding in 1908, with supplies hauled up river by horse-drawn barges and poling boats. Equipment included boilers and gear that could thaw the frozen gravel on nearby Nolan Creek to free entrapped gold and to allow sinking of mine shafts to bedrock. An estimated 100 men worked the creek in 1908, and they produced 52,414 ounces of gold. By 1910, their output had plunged to 1,309 ounces. Wiseman's heyday was over, although gold continued to trickle out of the area into the 2000s.

Fourteen people lived in Wiseman as of the 2010 census — seven males, seven females, seven people under age 20. The state's 2014 population estimate for Wiseman was 16.

Subsistence hunting, fishing and trapping sustain the residents, the state says. The town has a smattering of tourist-related businesses, too.

Near Milepost 235. The Marion Creek Campground, run by the U.S. Bureau of Land Management, would lie just east of the pipeline. It is pretty fancy for campgrounds thereabouts, with potable water, firewood, a hiking trail that leads to a waterfall, raised tent pads, pull-through RV sites, handicap accessibility and a host during summer -billed as "the farthest north public campground host in America." Plenty of mosquitoes, too.

Near Milepost 240. Coldfoot, like Wiseman up the road, also got its start as a mining camp during the gold stampede.

The town reportedly got its name in 1900 when one or more cheechako prospectors got "cold feet" and left before winter. But Coldfoot rebounded. The promise of gold nearby proving a powerful draw. By 1902, the town "boasted one gambling hole, two road houses, two stores, seven saloons, and ten prostitutes," author Robert Marshall wrote in his famous 1933 book "Arctic Village." Coldfoot cooled off, though, with gold discoveries a couple years later near what would become Wiseman, the village at the center of Marshall's book.

Ten people lived in Coldfoot during the 2010 census, two of them children.

The town provides services to travelers on the Dalton Highway. In particular, it's the first place to gas up or get a tire fixed if southbound from Prudhoe Bay, or the last place if northbound.

The Brooks Range is more rolling hills than mountains by this point. The Coldfoot vicinity is the northern limit of aspen trees. But this is still far north. The Arctic Circle lies another 1 degree latitude south, or about 60 miles away.

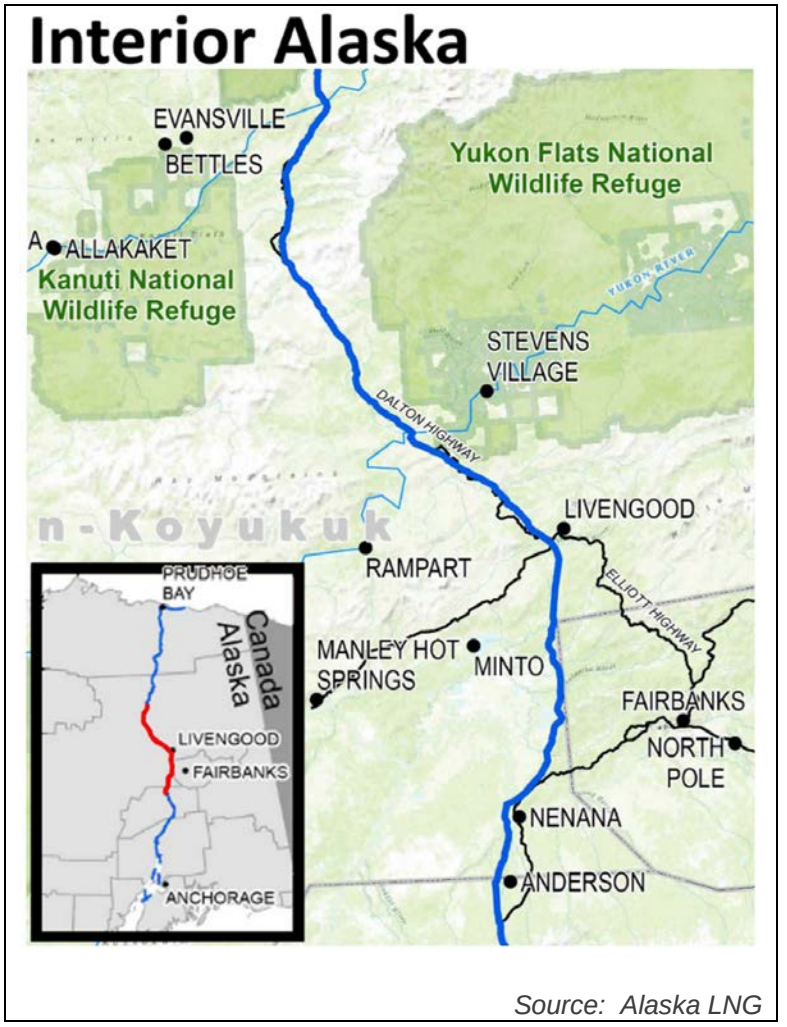
MILES 240 TO 505: INTERIOR ALASKA

Near Milepost 250. The gas pipeline would veer away from the Koyukuk River's middle fork, which it has paralleled for more than 40 miles. The river heads southwest toward the Yukon River; the pipeline would continue south, bound for Cook Inlet.

Near Milepost 260. The pipeline would cross the Koyukuk River's south fork, which also runs southwest. When the Dalton Highway was built, the final connection was made here in September 1974, on the eve of winter.

There's fishing in the rivers, streams and lakes along the route. Grayling, whitefish, pike and burbot. Chum and king salmon in the Koyukuk River south fork. A lake around Milepost 265 is called Grayling Lake. Moose, ducks and loons can be spotted there and elsewhere in the vicinity.

This isn't Alaska's only Grayling Lake, of course. The "Dictionary of Alaska Place Names" lists four others, plus at least eight Grayling creeks and a Grayling hill, peak, island and slough, as well as the village of Grayling in the state's West.



Source: Alaska LNG

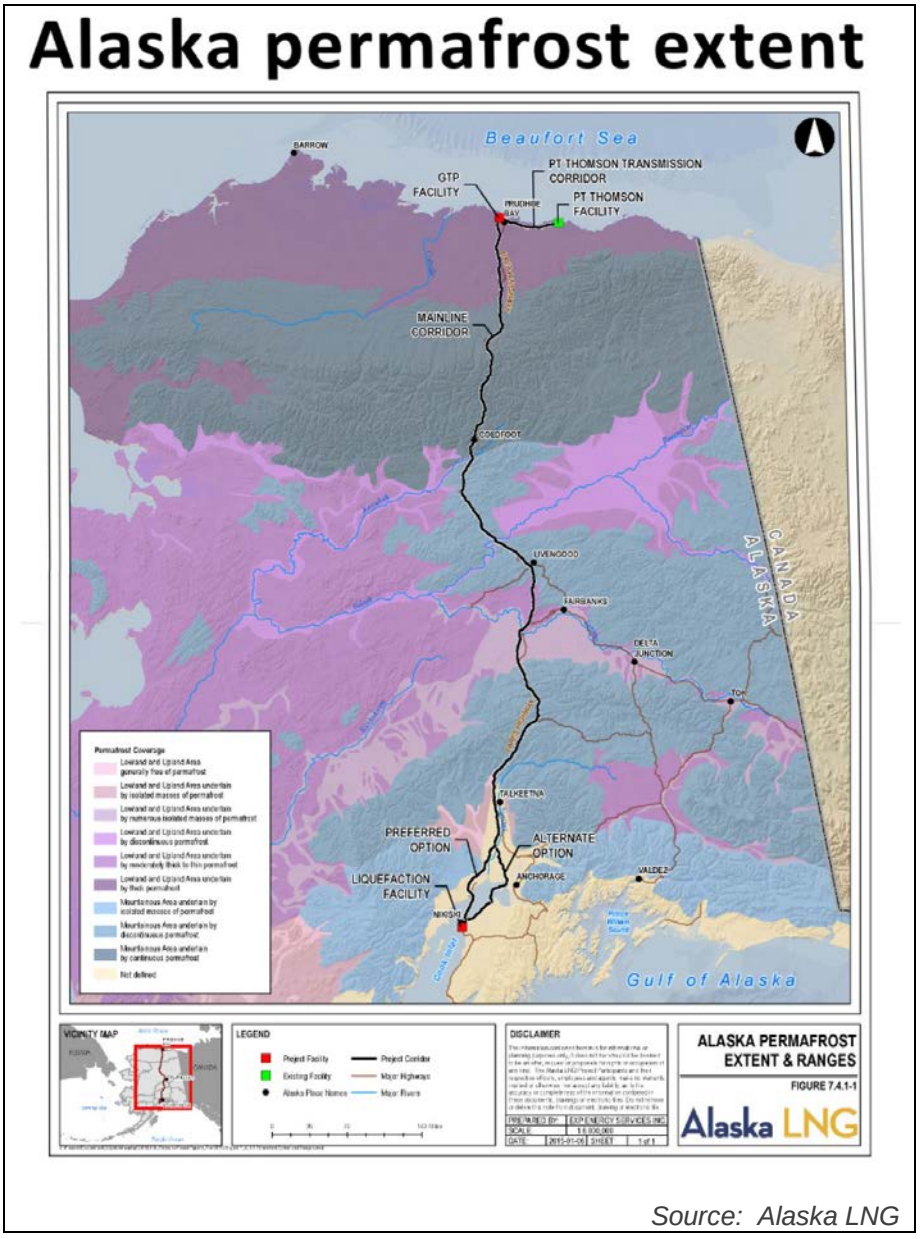
Near Milepost 280. The gas pipeline would pass east of the oil pipeline's Pump Station 5. Unlike the other pump stations, which were designed to pump the oil forward, this one's role is to brake it, or "relieve the pressure that builds" as the oil surges down from Atigun Pass, as Alyeska puts it.

During the oil pipeline construction, Alyeska based a big work camp here, called the Prospect Creek Camp. On Jan. 23, 1971, a weather observer there logged the coldest temperature ever recorded in the United States: minus 79.8 Fahrenheit. The high that day was minus 64.

Near Milepost 300. The route would cross the Arctic Circle. Plans are to route the gas pipeline, like the oil pipeline, well east of the popular Dalton Highway rest stop/photo op at this point. A no-frills campground is here, too.

Near Milepost 305. The pipeline would bisect the path of the Hickel Highway, an infamous 550-mile "road" state bulldozers carved during the 1968-1969 winter to jump-start equipment deliveries to the newly announced Prudhoe Bay oil discovery. The road was hastily conceived, poorly designed and barely used. It didn't even go all the way to Prudhoe Bay, but ended at an airstrip called Sagwon, about 75 miles short of the oil field. The Dalton Highway soon supplanted it. But traces of the Hickel Highway, named after Alaska's governor when it was approved, can be seen today.

Near Milepost 310. The pipeline would have entered a long stretch of discontinuous permafrost now. And this would be a challenge. Generally, when the pipe is buried in permafrost, the trick is to keep the gas temperature below freezing so that the ground doesn't thaw. Gas will flow just fine at cold temperatures.



Source: Alaska LNG

But it becomes tricky when some ground is frozen and some isn't, especially in the transition zones between the two. Or during seasonal changes when the ground in which the pipe would be buried sometimes is frozen and sometimes isn't. This is one reason the gas pipeline likely would need a special permit from the federal Pipeline and Hazardous Materials Safety Administration. PHMSA regulates the safe construction and operation of gas transmission lines. And nowhere else in the United States would there be one facing the pileup of potential longitudinal stresses and strains as this one: traversing hundreds of miles of permafrost and discontinuous permafrost, dodging solifluction and gelifluction, avoiding avalanches and rock slides, spanning earthquake faults.

Here's the basic deal with discontinuous permafrost: Gas that's too cold in warm soil could draw moisture to the pipe, freeze it into an ice bulb that would press the pipe toward the surface, possibly causing it to split. Gas that's too warm could cause frozen ground to thaw, causing the pipe to sag and possibly crack.

The trick is to be careful and make sure the pipe — and how it would be handled — meet safety standards.

Near Milepost 315. Finger Mountain to the east. It features a tall tor — an isolated pinnacle of granite — that resembles a finger. Early aviators used Finger Rock for navigation. The landscape is dotted with other tors and granite boulders for the next several miles, the result of deep weathering over many millennia.

Near Milepost 325. The route would be amid the Kanuti Flats and Ray Mountains region all the way to south of the Yukon River.

Soils are rocky and thickening as the route moves toward the river, especially in valley bottoms as compared to hilltops. Rubble, gravel, sand, silt and loess are common.

Vegetation varies depending on whether the slope faces north or south. White spruce, birch and aspen on south slopes. White spruce, balsam poplar, alders and willows in floodplains. Shrub birch at high elevations. Black spruce everywhere, growing on thin surface peats.

Near Milepost 355. The pipeline would need to cross hundreds of streams, rivers, ponds and lakes along its route. The first big one would be here — the Yukon River, North America's third longest river.

Typically the pipe would cross under a river, using a variety of techniques.

The oil pipeline bridges the Yukon, and the gas pipeline could, too. Bridging is the "lead case," as of February 2015, subject to change. If so, the Coast Guard would need to issue a permit. The Coast Guard is charged by law with ensuring that building on the nation's waterways doesn't unreasonably impair navigability. If the project sponsors apply for a bridge permit, Coast Guard experts would analyze potential navigation impacts as well as environmental, historical and/or socio-economic impacts covered under the National Environmental Policy Act and related laws and regulations.

Likely somewhere around 80 percent or more of the gas line crossings would involve minor — less than 10-foot-wide — water bodies, and most of the rest would be intermediate — less than 100 feet wide — as opposed to biggies like the Yukon.

Few likely would be bridged. Most often the water body would be trenched or sometimes a tunnel would be bored beneath, with the pipe threaded through. Factors determining which method to use, where to cross and when to do the work would include stream width, water depth, presence of fish spawning habitat, depth of ice scouring and local topography. Fisheries regulators would sign off.

Source: Alyeska Pipeline Service Co.

The Yukon River bridge, looking north, carries both Dalton Highway traffic and the trans-Alaska oil pipeline. Alaska LNG project sponsors have not decided yet how their pipeline would cross the river, which lies almost halfway between the Prudhoe Bay field and the Nikiski liquefaction plant site.

Near Milepost 357. The gas line would pass just east of the oil pipeline's Pump Station 6. The station no longer pumps oil. Rather, it serves as Alyeska's staging base for oil spill response crews in northern Alaska.

Near Milepost 365. The Yukon Flats National Wildlife Refuge spans the vast Yukon River lowlands to the northeast and beyond. The refuge's 8.6 million acres — larger than nine states — serve as a haven for migratory birds, Dall sheep, bears, moose, wolves and so on, which gives an idea of the wildlife around here. The pipeline would be running well west of the refuge for many miles now. Here it would brush by within a mile or so, its closest point, without entering the refuge.

Near Milepost 380. The Hess River marks a transition in the Ray Mountains to rolling hills north of Fairbanks. The hills top 1,500 to 3,000 feet here, and they reach 500 to 1,500 feet above the narrow valleys. The Dalton Highway has been meandering in the hills relative to the more straight line the oil pipeline follows and the gas pipeline intends to follow, according to preliminary route information

Discontinuous permafrost remains common under the topsoil. The soil itself largely was deposited by rivers over time or washed from hilltops. The thickness depends on distance from the Yukon and Tanana rivers and, again, from hilltops. In valley bottoms, soils can be more than 40 feet thick. Ice can lace the soil.

Near Milepost 395. The first private property would be encountered, land subdivided along the Dalton. But the pipeline's preliminary route does not encroach on this land.

The project sponsors estimate 4 percent of the land the main pipeline would cross is classified residential. More than 85 percent would be federal, state or borough land.

Near Milepost 400. The gas pipeline would cross under the Elliott Highway. The Dalton ends/starts where it links to the Elliott. The oil and gas pipelines would part company here. The oil pipeline then generally shadows the Elliott's western flank toward Fairbanks, and then to Valdez, while the gas line would bear due south.

Several miles away, off the Elliott, is Livengood, another old mining boom town that still has active claims. It was named after Jay Livengood, who discovered gold nearby in 1914. The heyday ran until the early 1920s. One report said a person could have walked four miles underground through connected drift mines. The population peaked at over 1,500 people around 1918. The 2010 census placed 13 residents there, down from 29 a decade earlier.

Near Milepost 420. The route would enter the Fairbanks North Star Borough and exit about two miles later, the only time the route would touch this local government's boundaries. The Fairbanks area likely would get some of the pipeline's gas, however, with the state to take the lead on a spur line to the community.

The preliminary route would channel the pipeline through rolling hills northwest of Fairbanks. Then it would drop toward lower, flatter ground that several rivers drain. Discontinuous permafrost under the surface would be common.

In general, for the next 30 to 50 miles the route would track a sliver of higher ground between Tanana Valley State Forest on the east and Minto Flats State Game Refuge on the west. The route would encounter some wetlands and some boreal forests on this stretch.

The Tanana is the largest state-managed forest. Paper birch, quaking aspen, white and black spruces, balsam poplar and tamarack dominate the tree species. Because a major road — the Parks Highway — bisects it and the Tanana River straddles it, hunting, fishing and other recreation can be found there, too.

Minto Flats is a huge wetlands complex — covering a half-million acres. Geese and swans in particular stage their spring and fall migrations there. It sustains one of the nation's largest trumpeter swan breeding grounds. The ponds, oxbows and stream channels provide habitat for big game and fur-bearer mammals as well.

Near Milepost 455. The route would approach the Alaska Railroad near an old whistle-stop called Dunbar. The line would be roughly 30 miles west of downtown Fairbanks.

The route would continue to track the state forest for another 15 to 20 miles until reaching the Tanana River near the town of Nenana.

Near Milepost 470. The pipeline would meet up with the Parks Highway just north of Nenana. It would generally follow this main road that links the Anchorage and Fairbanks areas, and skirts Denali National Park & Preserve, for the next roughly 200 miles. The highway is not named for Denali and other parks along it, though. It honors George Parks, a territorial governor in the 1920s and 1930s.

Near Milepost 475. The pipeline would cross the Tanana River just northwest of Nenana. U.S. President Warren Harding drove the golden spike ceremonially completing the Alaska Railroad near here in 1923.

The 440-mile Tanana is one of Interior Alaska's major drainages. Minto Flats drain into it downstream. Later, the Tanana empties into the Yukon River. Tanana is an Indian term for "mountain river." French fur traders called it "Gens des Buttes," meaning "mountain people" after Indians living upstream.

South of the Tanana, discontinuous permafrost should be less of a problem, except in parts of the Alaska Range, which looms ahead.

Near Milepost 490. The pipeline would have been running the gauntlet between the Nenana River to the west and Seventeenmile Slough to the east, a lowland streaked with smaller drainages. The Parks Highway and railroad lie across the slough. Near Milepost 490 it would enter the Denali Borough, where it would remain for the next approximately 87 miles, well into the Alaska Range.

Almost immediately, it would cross to the Nenana River's west bank.

Near Milepost 500. The line would skirt west of the small town of Anderson and Clear Air Force Station, which lie across the river. Staying away from military land avoids extra permitting. Clear is on the front line of the nation's early-detection installations that spot ballistic missile launches and attacks.

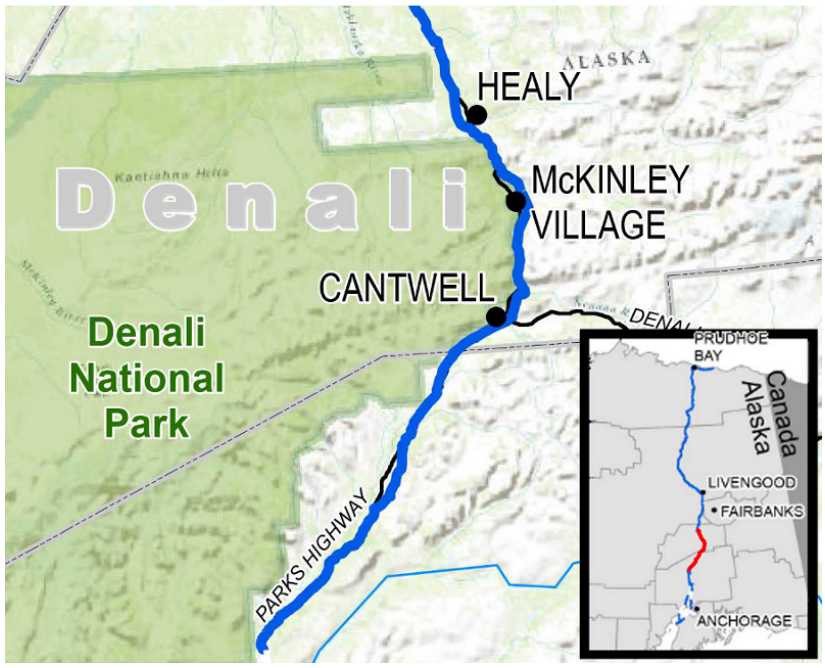
Near Milepost 505. The Parks Highway crosses the Nenana River and would join the pipeline running along low rolling hills parallel to the west bank. The railroad is on the east bank.

MILES 505 TO 640: THE ALASKA RANGE

Near Milepost 525. The pipeline would cross Paguingue Creek, notable because it's named after a Philippine card game, in the rummy family. Like much else in the region, the name can trace a history to the gold rush era, as the card game was popular with some stampeders.

The terrain is changing along here. The hills are taller, transitioning into the Alaska Range foothills. They can reach 1,500 feet altitude near the Nenana River and top 3,000 feet not far away. The hills and muntains ahead drain through old moraines and outwash plains into the Nenana, giving froth to the river's flow during its 140-mile run north to the Tanana.

Coniferous forests and woodlands can be found on lower slopes and valleys — white and black spruces are common. As elevation rises, soils thin out and become rocky, and discontinuous permafrost increasingly can be found underlying them.



Source: Alaska LNG

Near Milepost 530. The town of Healy lies to the east. The elevation there is 1,300 feet, reflecting the rise into the Alaska Range.

A coal mine has anchored Healy's economy since the 1940s. Tourism businesses tied to the proximity of Denali National Park & Preserve just ahead add spark during the summer. Roughly 1,000 people live there, making it the largest town the pipeline would have passed close by so far.

Near Milepost 535. The pipeline would cross to the Nenana River's east side. The route needs to do this or it would run smack into Denali National Park and Preserve and the extra permitting that would entail.

The Parks Highway crosses the river here, too. A bit of the highway goes through a slice of Denali up ahead. But the pipeline would stay in the mountains just east of the park boundary, main park entrance, highway and tourist businesses strung along the road.

The pipeline's preliminary corridor actually does touch inside Denali, but as it is refined it will avoid the park, the project sponsors told the Federal Energy Regulatory Commission in February 2015.

Near Milepost 550. The highway and pipeline would have come back together after the highway exited the Denali boundary. The park would parallel the pipeline on the west for another 30 miles or so.

Near Milepost 570. The pipeline would pass just west of Cantwell, a small town that started as a flag stop on the Alaska Railroad in the 1920s.

It would also cross the Denali fault, one of the biggest seismic hazards in its path. The fault runs east-west across the Alaska Range. A 7.9-magnitude earthquake in 2002 shredded some state highways and tested the oil pipeline, which crosses the fault about 130 miles to the east. The oil line survived the quake thanks to engineering that anticipated such an event.

Near Milepost 577. The boundary between the Denali and the Matanuska-Susitna boroughs. The pipeline would be in Mat-Su for the next 180 miles, or until just before it reaches Cook Inlet.

Mat-Su is Alaska's second largest in population, with almost 100,000 residents, according to the state's 2014 estimate. But the line would avoid any large pockets of homes or businesses.

Near Milepost 580. The route would cross through Broad Pass, an aptly named wide valley that scrub spruce punctuate. The Parks Highway would lie just west of the pipeline, with Summit Lake beyond the highway. An airstrip dates to World War II, its location considered too far inland to be imperiled by planes launched from enemy carriers.

The pass would be the pipeline's high point in its Alaska Range transit, 2,409 feet. That's just over half the altitude of the Brooks Range's Atigun Pass. The approaches aren't anywhere near as steep as Atigun's.

Beyond here, rivers drain south toward Cook Inlet.

Near Milepost 605. The gas pipeline would cross Hurricane Gulch. The highway bridge gets travelers' attention because it spans the gulch 260 feet above the water. The railroad bridge downstream is even higher.

The preliminary gas line crossing would be about a mile and a half uphill — at a higher elevation where the gulch is more of a ditch. The pipeline route would edge east, away from the highway, about five miles before the crossing then return to the road's vicinity a few miles after.

Near Milepost 610. Denali State Park starts here. The pipeline would follow the Parks Highway corridor though the park for about 30 miles, mostly on a bluff roughly 1,000 feet above the braided Chulitna River. Travelers along the road get sharp views of the Alaska Range and Mount McKinley in spots, when they're not clouded.

The park encompasses the range's southern peaks and foothills. A mosaic of plant life is present, depending on where you're standing, east or west of the river, high or low elevation. Birch, alder and willow thickets can confound hikers. Black spruce sprout from muskeg. Edible berries include blueberries, cranberries, currants, watermelon berries, crowberries and cloud berries.

Moose, brown and black bears, wolves, wolverines and mink inhabit the park, as do more than 130 bird species during peak season.

Near Milepost 630. The route would pass west of the Alaska Veterans Memorial and Byers Lake, site of a popular campground.

Near Milepost 640. The gas line would separate from the highway by crossing the Chulitna River just before Denali State Park's southern boundary. The highway will cross the river in about four miles.

MILES 640 TO 805 - COOK INLET BASIN

Near Milepost 660. The land would have been lower and wetter for the past 20 miles or so, on the Chulitna's east bank.

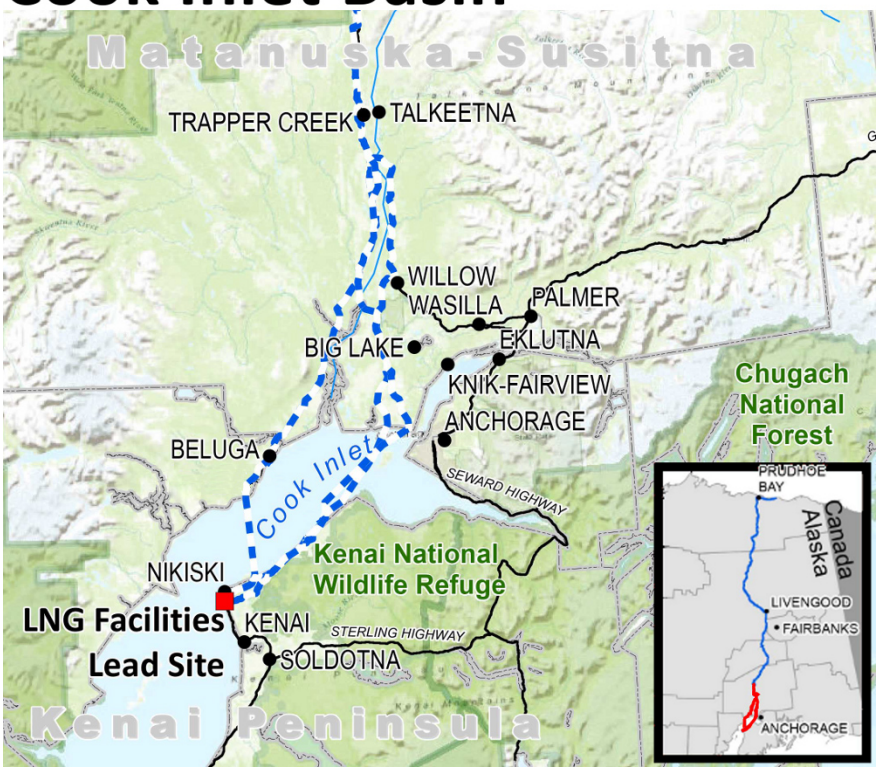
The Chulitna flows into the Susitna River a couple miles west of here. The project sponsors preliminarily intend to keep the line west of the Susitna to avoid crossing the salmon-spawning river that boasts a variety of popular sport-fishing tributaries. The Parks Highway, however, does cross the Susitna in about 10 miles.

Milepost 660 is near Trapper Creek, a small community and tourist stop along the highway. The Petersville Road extends into the wetlands and hills to the west. It's an old mining road, of course, now popular for four-wheel and snowmobile recreation.

Near Milepost 670. The Parks Highway veers southeast to cross the Susitna River while the gas pipeline route would continue due south across the hills, ponds and black-spruce-forest bogs west of the river.

Near Milepost 685. The elevation rises a little south of Trapper Lake, providing better-drained ground for pipeline burial.

Near Milepost 700. The line's preferred route — the one that stays west of the Susitna River — would cross the Deshka River just before it flows into the Susitna River. It then would veer slightly southwest toward Cook Inlet.



Source: Alaska LNG

The Alaska LNG project sponsors are considering two route options for crossing Cook Inlet to the liquefaction plant site at Nikiski. Their preferred option as of early 2015 was the more western route that would enter the inlet near Beluga on the north shore.

An alternative route the project sponsors were considering during pre-front-end-engineering in 2015 would cross the Susitna River here. This corridor would head south on higher ground just west of the state's Nancy Lake Recreation Area. It would then cross the Little Susitna River and track just east of the Susitna Flats State Game Refuge, a popular destination for ducks, geese and other waterfowl, as well as hunters with access to floatplanes. The corridor would reach Cook Inlet's north shore near Point MacKenzie, across from Anchorage.

In filings with FERC in February 2015, the project sponsors said the alternative Cook Inlet crossing posed problems that their preferred route to the west would avoid. These include:

- A longer inlet crossing.
- Crossing the long, shallow shore near Point MacKenzie.
- Crossing buried power cables in shallow waters.
- Dealing with the dredged shipping channel, whose depth contrasts with the shallower shoals.

Near Milepost 715. The preferred route would cross the Yentna River after passing through miles of swampy terrain. The ground is higher on the Yentna's west side. Ahead, the route would run between Mount Susitna, the "Sleeping Lady" landmark visible from Anchorage across the inlet, and Susitna Flats State Game Refuge, low wetlands in the big river's broad delta.

Near Milepost 730. The pipeline would nestle across the lower southern slopes of Mount Susitna.

Near Milepost 757. The pipeline would enter the Kenai Peninsula Borough and remain there for its last 50 miles or so, from Cook Inlet's west shore, across the inlet to landfall just north of the liquefaction plant site in Nikiski.

Near Milepost 765. The pipeline would reach the Cook Inlet waters at a spot between Beluga village, less than a mile north, and Viapan Lake a mile southwest.

CROSSING COOK INLET TO NIKISKI

Near Milepost 765. The gas pipeline would wade offshore south of the gas-fired power plant at Beluga that has helped keep the lights on in Southcentral Alaska for almost 50 years.

The line's builders would sink the pipe to the inlet's bottom, weighting it and protecting it for the roughly 30-mile run to the other shore. Upper Cook Inlet waters generally are shallow between Beluga and landfall northeast of Nikiski, ranging from muddy tidal flats to not much more than 150-feet deep.

The project sponsors would need to ensure they protect beluga whales in these waters. Belugas are listed as an endangered species, and the project would need to go through a public process to receive authorization from the National Marine Fisheries Service.

It would be a similar process for ensuring the protection of critical habitat and the polar bear population near the North Slope gas treatment plant and pipelines, although the U.S. Fish and Wildlife Service would manage that authorization.

For its Cook Inlet crossing, Alaska LNG addressed one "potentially viable" alternative in its Draft Resource Report No. 10 filing with FERC in February 2015. Starting the inlet crossing farther north, near Point MacKenzie, would be longer than the preferred option and would cross several buried power cables in shallow water. After crossing the inlet, this option would cut through Captain Cook State Recreation Area and wetlands next to the Kenai National Moose Range. The preferred option would avoid both.

In preparation for the crossing, Alaska LNG would survey the seabed for depth, terrain, obstacles, currents and other data to determine the best path. The line may be buried near shore and then laid on the sea floor in deeper water.

The line would pass east of the offshore Granite Point, Trading Bay, Grayling, Dolly Varden oil and gas platforms on the inlet's west side. These have anchored the region's production for decades.

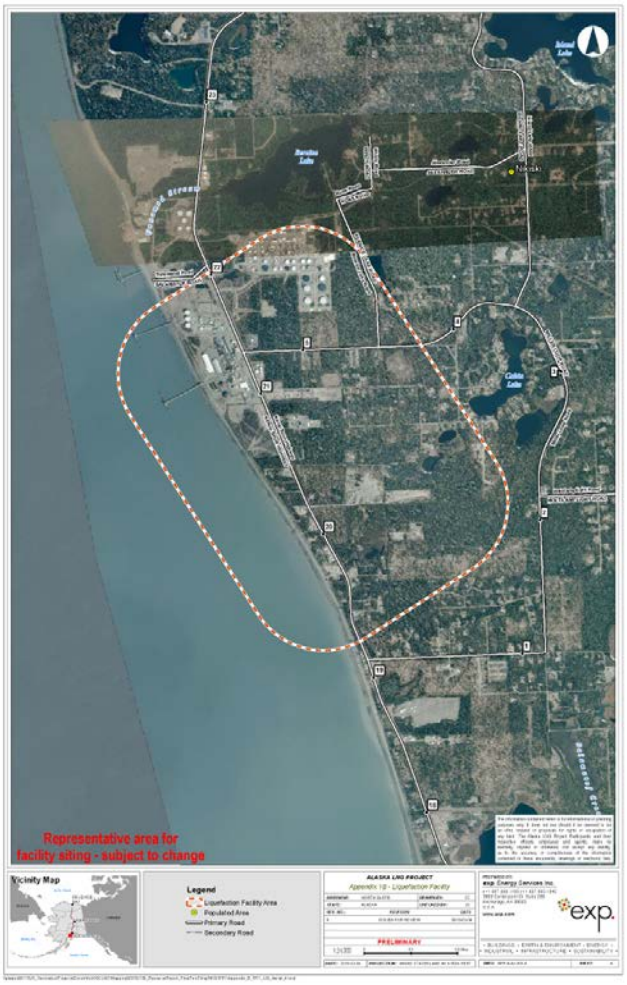
Near Milepost 795. When the pipeline reaches the Kenai Peninsula about at Boulder Point — a promontory listed as 216 feet above sea level — it would be about six air miles north of the LNG plant site. But the pipeline, with route bends and curves, would cover a longer distance.

It would stay west of the Kenai Spur Highway for the first few miles along flat terrain, crossing a lot of private land and, near Mile 802, it would cross Nikishka Beach Road. From there, across Wik Road before it turns into the Nikiski industrial area, all the time staying west of the Kenai Spur Highway.

In draft reports to federal regulators, Alaska LNG said "the planned liquefaction facility would require that the existing Kenai Spur Highway be relocated to allow for site safety and security buffer zones." That decision, the sponsors said, would be made in consultation with state and local officials.

Maybe two miles from the liquefaction plant site, the pipeline would jag east, cross the highway, and enter the plant's grounds in Nikiski, population about 4,500.

Near Milepost 805. The sponsors have identified a general area for the plant south of Bernice Lake, a small water body less than 1 mile long, and west of Cabin Lake, which is even smaller.



Source: Alaska LNG

An aerial view of the Nikiski industrial area showing the general site Alaska LNG is considering for its proposed liquefaction plant and marine terminal.

Some of the acreage is tree covered, but a lot has been developed. Like the start of the project more than 800 miles north, the land is flat. But unlike the North Slope acreage, it's generally dry. Alaska LNG has been acquiring parcels in the area, looking to piece together as much as 800 acres for the liquefaction plant, LNG storage tanks, marine terminal and safety and security buffer.

The site is mostly south and east of the Tesoro refinery, the shuttered Agrium fertilizer plant and the ConocoPhillips LNG plant, a fixture in Nikiski since it started operations in 1969.

Larry Persily and Jeannette Lee contributed to this report.

The Office of the Federal Coordinator for Alaska Natural Gas Transportation Projects closed in March 2015. This was the agency's final report.

More White Papers

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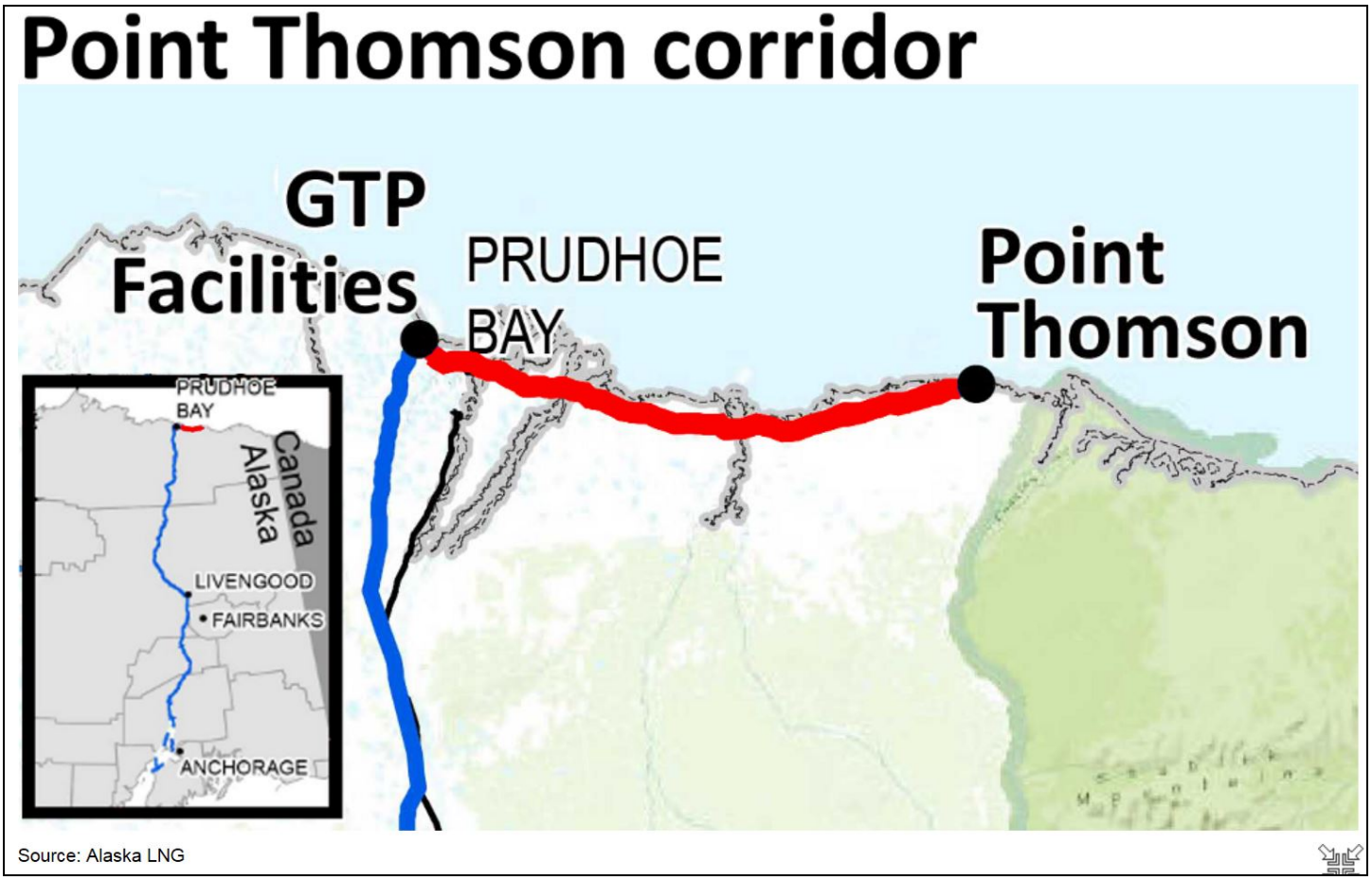
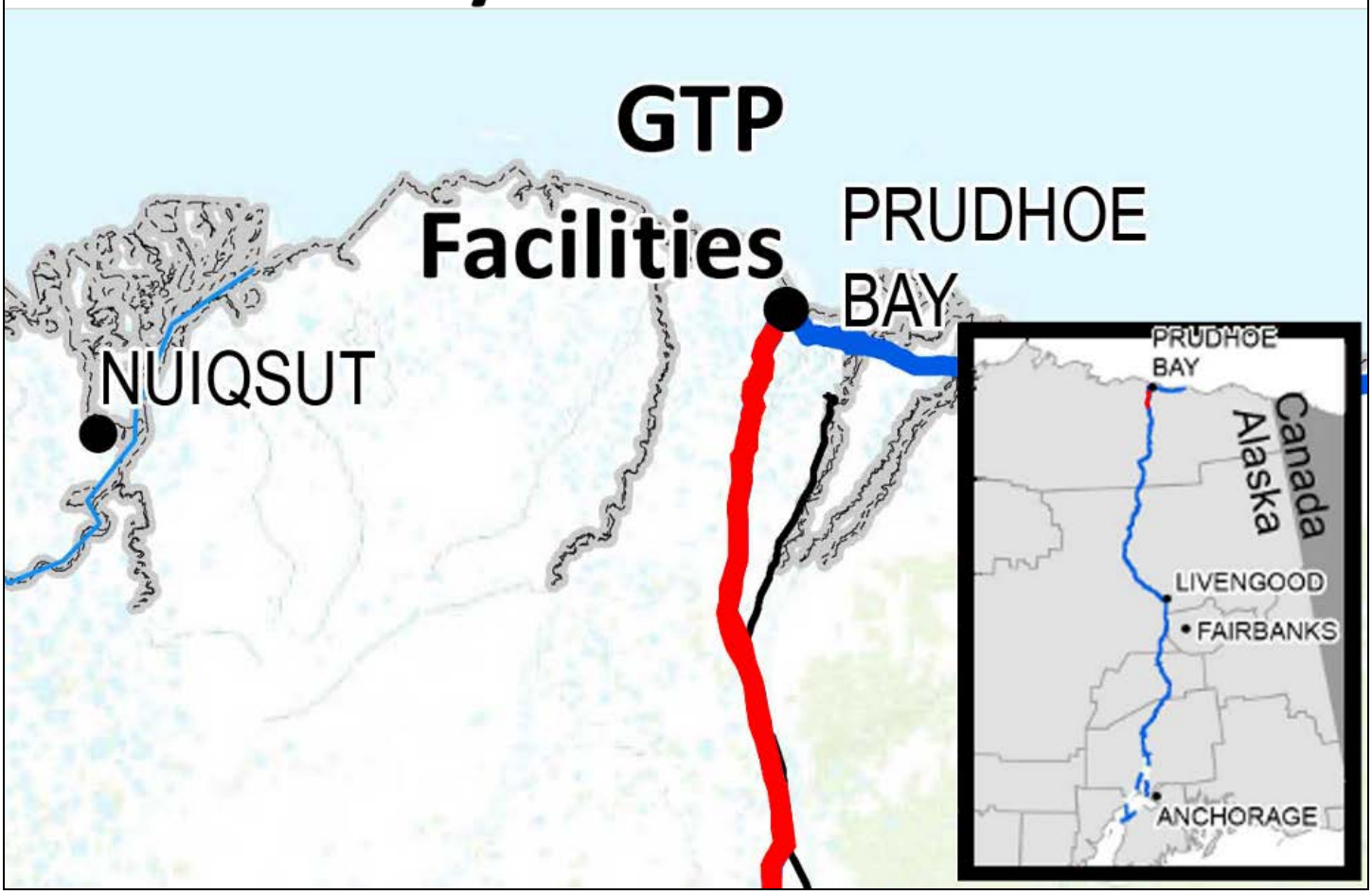
Enlargements of Photographs and Maps

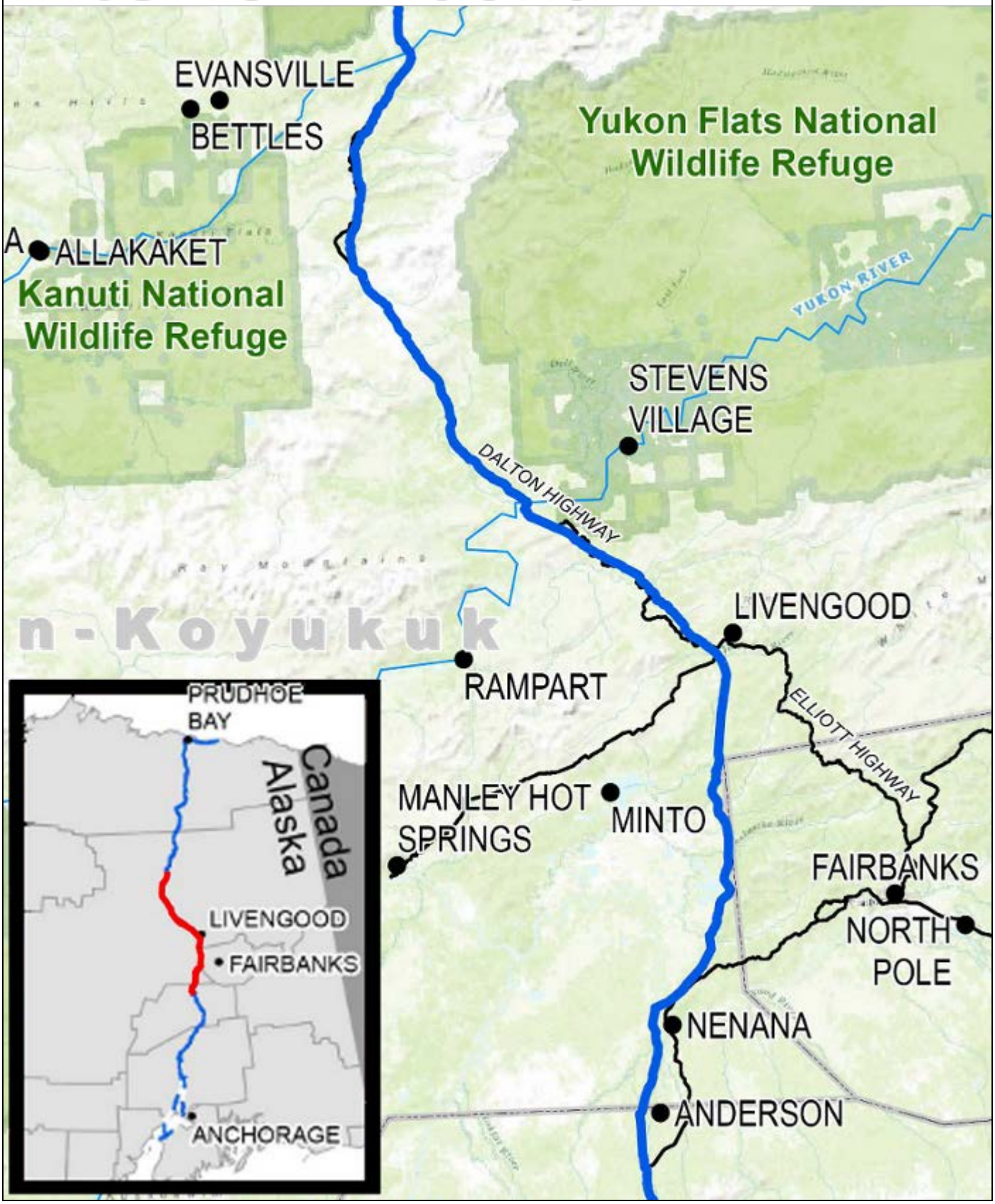


Prudhoe Bay and the Coastal Plain

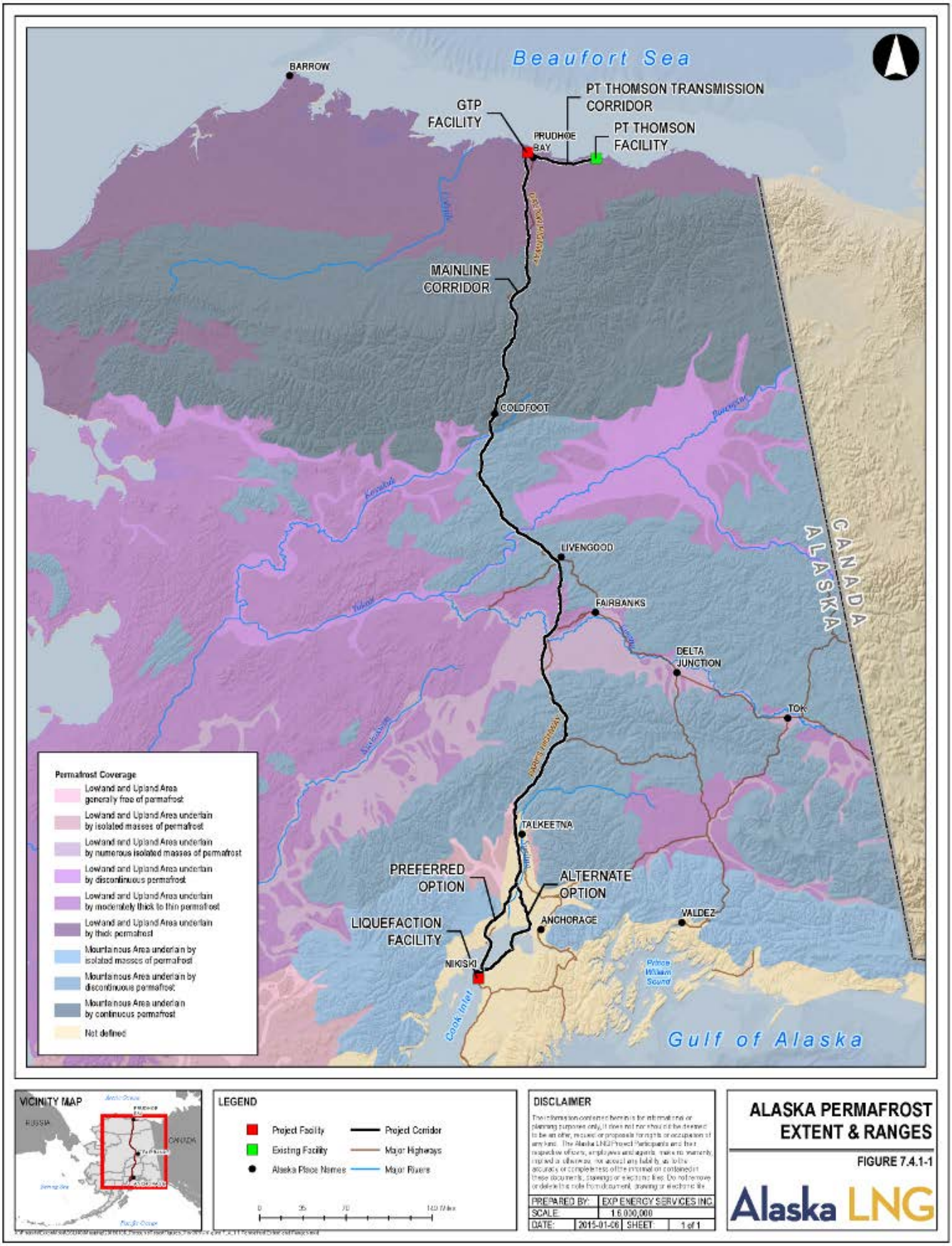


Foothills and Brooks Range

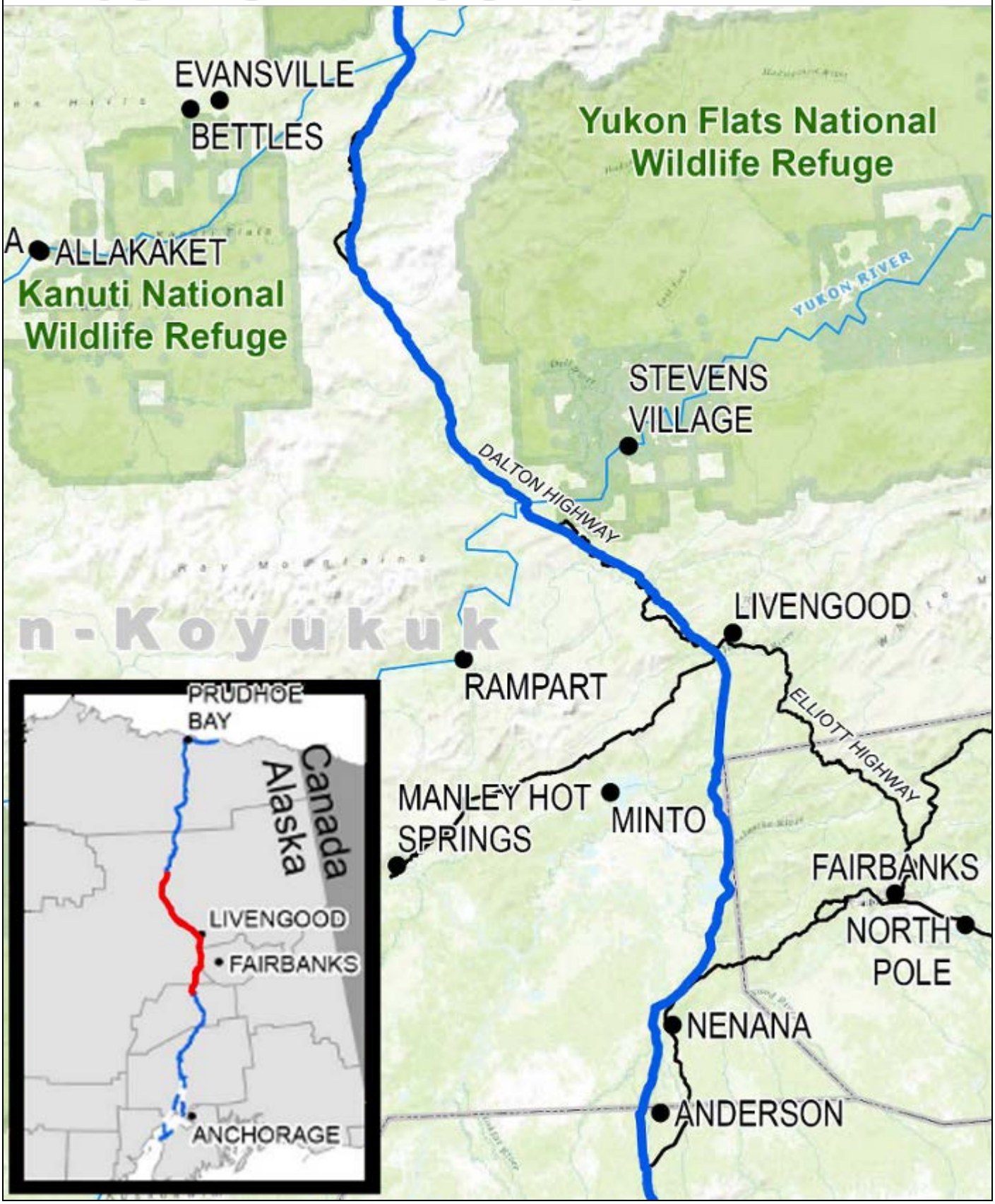
Interior Alaska



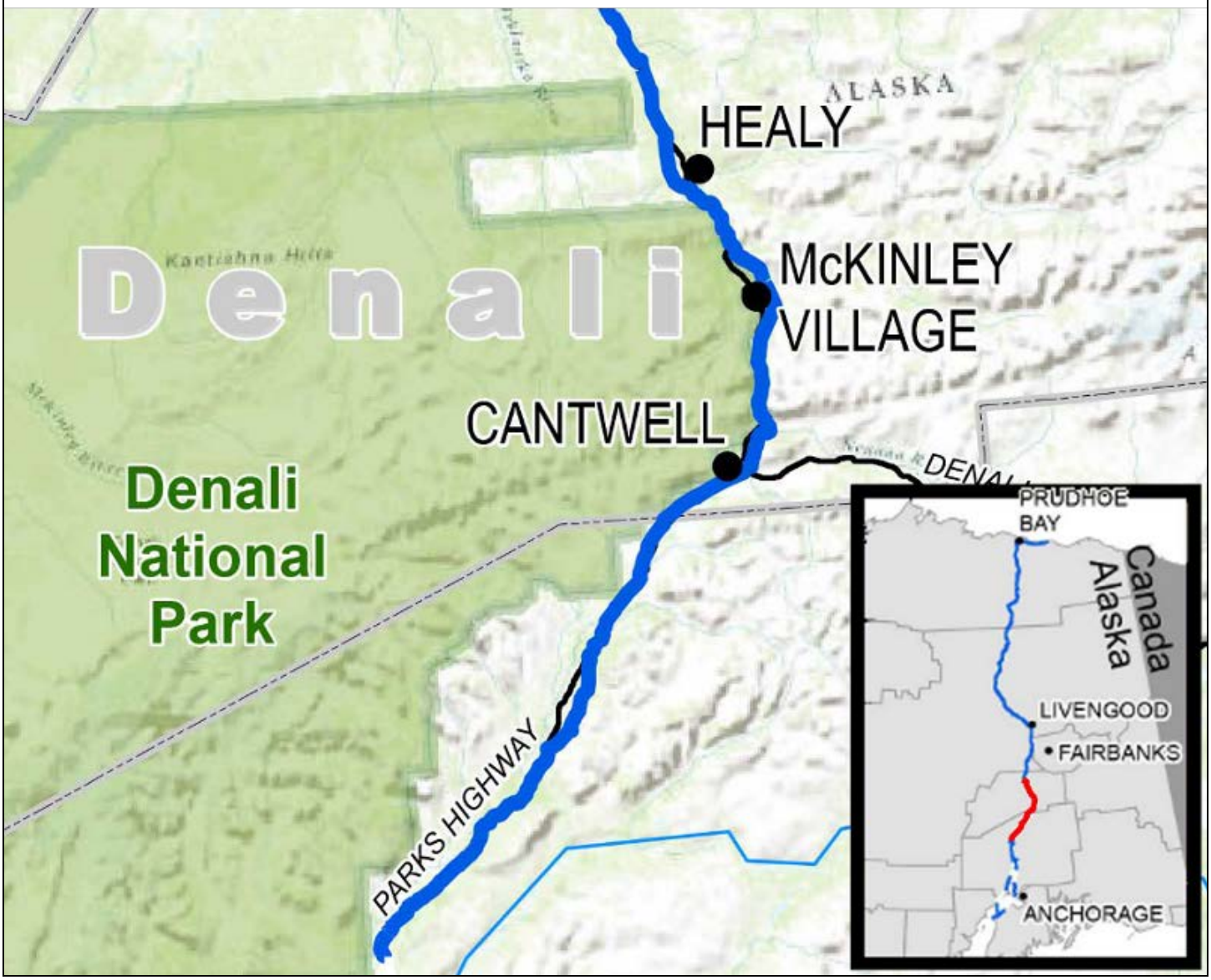
Alaska permafrost extent



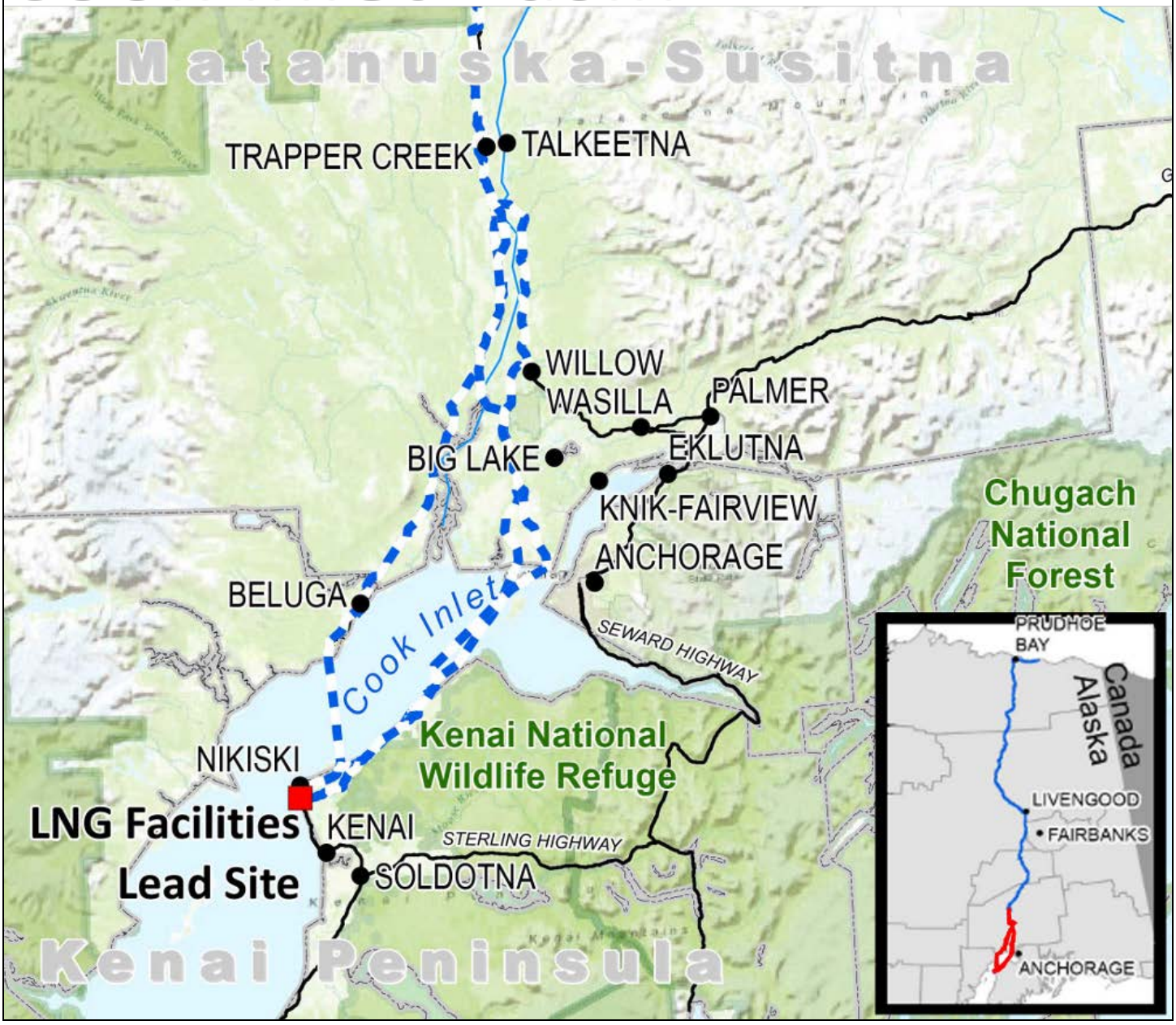
Interior Alaska

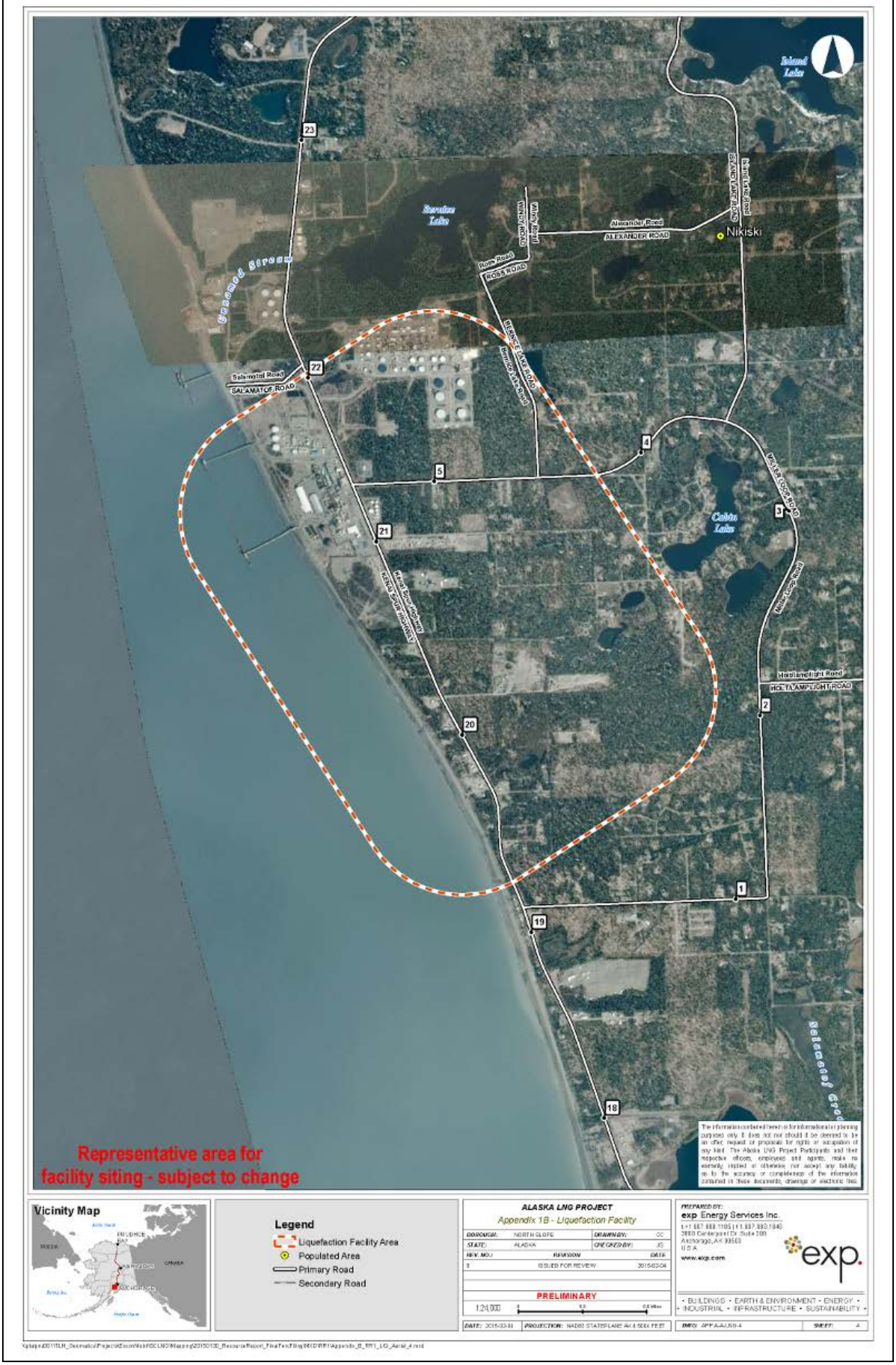


Alaska Range



Cook Inlet Basin




Island Lake
Swanson Lake
Swanson River
Alexander Road
ALEXANDER ROAD
Nikiski
Ross Road
ROSS ROAD
Salamatof Road
SALAMATOF ROAD
Kenai Spur Highway
Cabin Lake
Holt Lamplight Road
HOLT LAMPLIGHT ROAD
Beluga Pipeline
Representative area for facility siting - subject to change
Vicinity Map
Legend
Liquefaction Facility Area
Populated Area
Primary Road
Secondary Road
ALASKA LNG PROJECT
Appendix 1B - Liquefaction Facility
PRELIMINARY
PREPARED BY:
exp Energy Services Inc.