4.2 Surface Water

This section describes the analysis of potential impacts to surface water from construction and operations of the proposed Port MacKenzie Rail Extension. Section 4.2.1 describes the surface water study area, Section 4.2.2 describes the methods employed to analyze impacts to surface water, Section 4.2.3 describes the affected environment (existing conditions), and Section 4.2.4 describes potential environmental consequences (impacts) to surface water.

4.2.1 Study Area

The proposed Port MacKenzie Rail Extension would be northwest of Anchorage on the west side of the Knik Arm. The area is within the Matanuska-Susitna Borough (MSB or Borough) Susitna River valley, bounded by the Susitna River on the west, Knik Arm of Cook Inlet on the south and east, and Parks Highway and the existing ARRC main line on the north. The Susitna River watershed is approximately 20,752 square miles; it is the fifth largest basin in Alaska, comprising more than half of the Cook Inlet drainage basin (USGS, 1999). Surface drainage in the area is generally to the west and south. Subsequently, areas either drain into Cook Inlet, Knik Arm, or the Susitna River, which also discharges to Cook Inlet (ARRC, 2008). The study area for surface waters is the area within the proposed rail line 200-foot ROW.

4.2.2 Analysis Methodology

The Applicant performed a hydrologic review of the study area to identify surface water resources, including pre- and post-project drainage patterns, flow rates, and floodplain limits and encroachments (ARRC, 2008). The Applicant also identified stream and river crossings from MSB's Geographic Information System Division data based on tax parcel maps and orthoimagery. After the Applicant's analysts identified crossing locations, they delineated crossing-location drainage areas with the Environmental Systems Research Institute ArcHydro computer program. After computing flow directions based on a U.S. Geological Survey 2 arc-second (30-meter) digital elevation map, analysts obtained a flow accumulation grid for the study area and then used ArcHydro to delineate the drainage area of each crossing location based on the flow direction and accumulation patterns. Analysts subsequently checked and refined the computer-generated delineations using Geological Survey digital topographic quadrangle maps. Several minor refinements to crossing locations resulted from SEA field studies in 2008. Analysts calculated the design flow used to size hydraulic structures for mapped streams for the 100-year flood event, as recommended by the American Railway Engineering and Maintenance-of-Way Association.

Crossing structures would consist of bridges and culverts. Crossing structures identified as "drainage structures" would be determined by the Applicant during the final design process and could include multi-plate culverts, pre-cast arches, and single or multiple short-span bridges. In addition, the Applicant would extend existing culverts and construct new bridges for rail sidings proposed along the existing ARRC main line where any of the alternatives would connect to the main line. The hydrologic review report is a preliminary analysis that determined the approximate locations of crossings and types of conveyance structures; final locations, conveyance structures, and structure sizes would be determined during final design and permitting. SEA conducted an independent review of the Applicant's methodology and hydrologic review report.

SEA used the results of the Applicant's hydrologic review report to qualitatively analyze potential impacts to surface water from the proposed Port MacKenzie Rail Extension. The analysis incorporated review of existing ARRC project descriptions, ARRC's voluntary proposed mitigation measures, and further review of waterbodies using Geographic Information Systems. SEA collected stream-characteristic and water-quality data at ARRC-proposed stream crossing locations in the summer of 2008 (Noel *et al.*, 2008) and considered these data in the analysis of potential impacts to surface water. SEA's surface water impact analysis focuses on general impacts to water quality and hydrology, which are based on rail line construction activities and conveyance structures proposed at each crossing. This section also addresses potential impacts to water quality during rail line operation. Other parts of this EIS address potential impacts to other resources associated with or that depend on surface waters, such as fisheries (Section 5.4 and Appendix F), floodplains (Section 4.4), navigation (Chapter 12), wetlands (Section 4.5 and Appendix C), essential fish habitat (Section 5.4 and Appendix G), and subsistence (Chapter 7).

4.2.3 Affected Environment

4.2.3.1 Hydrologic Environment

Surface waters in the study area include streams and rivers, lakes, and wetlands. Smaller streams join to form larger streams; the continued joining eventually forms rivers that ultimately flow into lakes, or wetlands. The interconnected system of moving waterbodies is a watershed. Watersheds are defined by the drainage basins or drainage divides, and can be discussed on small, local scales or on large scales. One watershed or basin can be comprised of multiple sub-watersheds or sub-basins.

The proposed Port MacKenzie Rail Extension would lie within the following nine watersheds (see Figure 4.2-1):

- Little Willow Creek watershed (172 square miles) receives drainage from Rogers Creek and many unnamed tributaries in the Talkeetna Mountains. Little Willow Creek begins at its headwaters in the Talkeetna Mountains and flows approximately 43 miles through MSB before discharging into the Susitna River. Six miles of the Willow Segment would transect this watershed.
- Willow Creek watershed (254 square miles) receives drainage from many small tributaries in the Talkeetna Mountains. Willow Creek begins at its headwaters in the Talkeetna Mountains and flows approximately 40 miles through MSB before discharging into the Susitna River. One mile of the Willow Segment would transect this watershed.
- The Susitna River watershed is extensive (6,160 square miles) and includes many major river tributaries. The Lower Susitna River sub-basin receives drainage from Little Willow Creek, Willow Creek, Rolly Creek, Fish Creek, and other small unnamed creeks before discharging into Cook Inlet. Approximately 8 miles of the Willow Segment would transect this watershed.

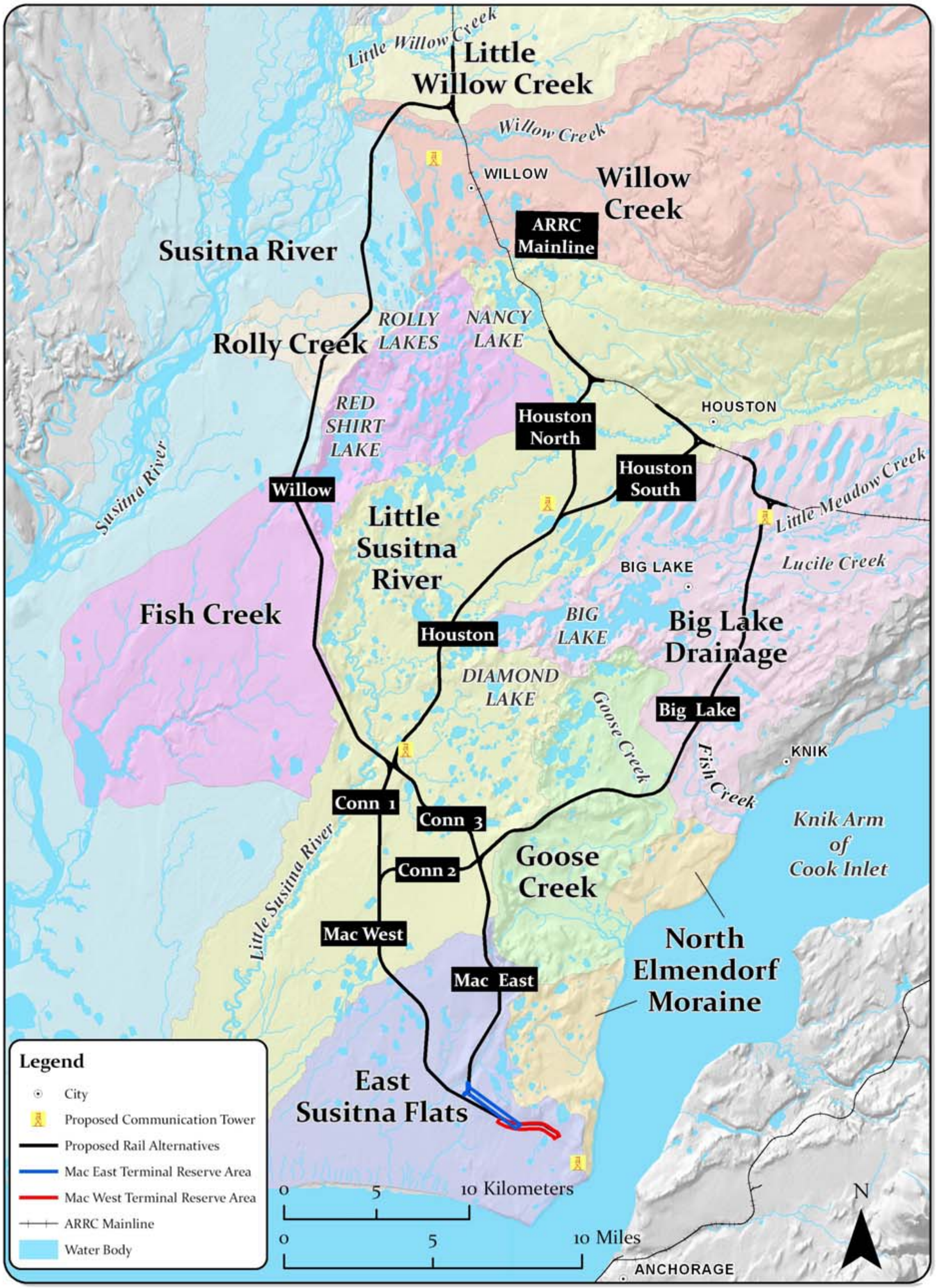

Figure 4.2-1. Watersheds in the Proposed Port MacKenzie Rail Extension Study Area

- Rolly Creek watershed (13 square miles) receives drainage from North Rolly Lake and many minor tributaries. Rolly Creek drains approximately 7 miles through MSB before discharging into the Susitna River. Four miles of the Willow Segment would transect this watershed.
- Fish Creek watershed (111 square miles) receives drainage from Lynx Creek and many small creeks in the Red Shirt Lake area. This watershed drains approximately 30 miles through MSB before discharging into Flat Horn Lake and then into the Susitna River. Eight miles of the Willow Segment would transect this watershed.
- The Little Susitna River watershed (373 square miles) receives drainage from Lake Creek and other small unnamed tributaries. The Little Susitna River begins in the Talkeetna Mountains at Hatcher Pass and flows approximately 122 miles through MSB and discharges into Cook Inlet (Wasilla SWCD, 2009). All of the rail line segments would transect this watershed, ranging from 2 miles for the Big Lake Segment to 10 miles for Houston.
- Big Lake Drainage Area watershed (120 square miles) receives drainage from Meadow Creek, Little Meadow Creek, Lucile Creek, Big Lake, and Fish Creek. It drains approximately 52 miles through MSB before discharging into the Knik Arm. Fourteen miles of the Big Lake Segment would transect this watershed.
- Goose Creek watershed (43 square miles) receives drainage from Stephens Lake and many small unnamed tributaries in the study area. It flows for approximately 14 miles before discharging into Knik Arm. Six miles of the Big Lake Segment would transect this watershed.
- East Susitna Flats watershed (66 square miles) is a nearly flat drainage system of many small unnamed streams discharging into Cook Inlet. About 8 miles of the Mac East Segment and 9 miles of the Mac West Segment would transect this watershed.

These watersheds can contain several distinct hydrologic regimes – high-gradient, high-elevation mountainous areas and low-gradient, low-elevation areas with lakes and wetlands. The Talkeetna Mountains, north of the Little Susitna River in the upper drainage area of the Little Susitna River, Willow Creek, and Little Willow Creek, have greater relief and a better-developed drainage patterns. This is due to the differential glacial erosion that took place in this area; however, drainage is still complicated by post-glacial surface morphology. In the lower drainage area of the Little Susitna River and all of the study area south of the Little Susitna River, the landscape is dominated by hundreds of small, irregular lakes. Most of these lakes are formed in kettle moraines where the land surface was shaped primarily by retreating glacial ice. They are not usually associated with stream systems. There are also a large number of drainage and outlet lakes, typically found in the central areas of watersheds where one of the main streams or tributary flows through or out of the lake. The abundance of these lakes indicates that the water inputs to area lakes by precipitation, surface runoff, and groundwater inflow are typically greater than water losses through evaporation and groundwater outflow (ARRC, 2008).

High- and low-gradient geomorphic areas have differing effects on the nine principal watersheds the proposed rail line alternatives would intersect. Four of these watersheds, Susitna, Little Susitna, Willow Creek, and Little Willow Creek, have their headwaters in the Talkeetna Mountains. More than half of the Willow Creek and Little Willow Creek watersheds are made up of mountainous terrain; their stream flow is dominated by high-elevation snow fields and rapid response to summer storms. The Susitna and Little Susitna watersheds have a smaller portion of their area in the Talkeetna Mountains; a larger portion of their watersheds are dominated by low-lying, low-gradient areas that moderate the water flow influence of the mountainous terrain. The Fish Creek, Rolly Creek, East Susitna Flats, Goose Creek, and Big Lake Drainage watersheds exclusively contain low-lying, low-gradient landforms that tend to retard runoff and reduce stream flow. All of the watershed areas can be characterized by increasing flows from spring ice breakup beginning in mid April and snowmelt runoff continuing from May to July; rainfall runoff from May to September; and fall freeze-up and stream flow recession from October through April (ARRC, 2008).

4.2.3.2 Water Quality Conditions

Federal and state water quality standards are designed to maintain the beneficial uses of state waters. Beneficial use can be defined based on the purpose for using the water and based on non-wasteful use of the water. Beneficial uses include aquatic life and agricultural, drinking, recreational, and other uses. Typical baseline water quality elements include color, dissolved oxygen, total dissolved solids, petroleum hydrocarbons, pH, residues, temperature, turbidity (suspended solids), and others.

Maintenance of the Federal and state water quality standards is required in all land use actions in Alaska. The proposed Port MacKenzie Rail Extension could impact waters that Federal and state agencies have designated as “fresh water aquatic life.”

Alaska Department of Environmental Conservation (ADEC) document 18 AAC 70 “Water Quality Standards” (ADEC, 2008a) and U.S. Environmental Protection Agency (USEPA) document “Quality Criteria for Water, 1986” (EPA, 1986) describe water quality standards for fresh water aquatic life. Table 4.2-1 lists and describes some of the Federal and State of Alaska water quality standards.

Table 4.2-1
Federal and Alaska Water Quality Standards for Fresh Water in Natural Environments[a]
(page 1 of 2)

Parameter	Criteria
Alkalinity	Alkalinity is a measure of the pH-buffering capacity of water or water's resistance to change in pH (*i.e.*, the capacity of water to neutralize acids). This capacity is caused by the water's content of carbonate, bicarbonate, hydroxide, and occasionally borate, silicate, and phosphate. Alkalinity is expressed in milligrams per liter of equivalent calcium carbonate. Alkalinity less than 20 milligrams per liter of calcium carbonate can be harmful to aquatic life.
Color	Color can indicate dissolved organic material, inadequate treatment, high disinfectant demand, or possible excessive production of disinfectant by-products or inorganic contaminants, including metal. Color points begin at 0. A point is the equivalent of a milligram of the substance in question per liter. Color or apparent color may not reduce the depth of the compensation point (the point at which there is just enough light for a plant to survive) for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life. For all waters without a seasonally established norm for aquatic life, color or apparent color may not exceed 50 color units or the natural condition, whichever is greater.

Table 4.2-1
Federal and Alaska Water Quality Standards for Fresh Water in Natural Environments[a]
(page 2 of 2)

Parameter	Criteria
Dissolved Oxygen	Dissolved oxygen is the amount of gaseous oxygen dissolved in the water. Oxygen enters water through aeration (rapid movement) diffused from the surrounding air or as a waste product of photosynthesis. Dissolved oxygen must be greater than 7 milligrams per liter in waters used by anadromous or resident fish. In no case may dissolved oxygen be less than 5 milligrams per liter to a depth of 20 centimeters in the interstitial waters (water occupying interstices or pore volumes in rock) of gravel used by anadromous or resident fish for spawning. For waters not used by anadromous or resident fish, dissolved oxygen must be greater than or equal to 5 milligrams per liter but may not exceed 17 milligrams per liter. In no case may dissolved oxygen be greater than 17 milligrams per liter. The concentration of total dissolved gas may not exceed 110 percent of saturation at any point of sample collection. Dissolved oxygen below 1 to 2 milligrams per liter or beyond 110 percent can be harmful to aquatic life.
Total Dissolved Solids	Total dissolved solids are the combined content of all inorganic and organic substances in a molecular, ionized, or micro-granular suspended form. Total dissolved solids are measured only in fresh water, because the salinity of sea water comprises ions that are counted as total dissolved solids. Total dissolved solids may not exceed 1,000 milligrams per liter. Water may not have concentration of total dissolved solids if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life. Most aquatic ecosystems can tolerate total dissolved solids levels of 1,000 milligrams per liter. Total dissolved solids levels can be inferred from conductivity.
Petroleum Hydrocarbons	Petroleum hydrocarbons are contaminants with the potential to impact human and environmental health (and because they could be carcinogenic, mutagenic, or teratogenic). Total aqueous hydrocarbons in the water column (the water from the top of substrate to the surface of the water) may not exceed 15 micrograms per liter. Total aromatic hydrocarbons in the water column may not exceed 10 micrograms per liter. There may be no concentrations of petroleum hydrocarbons, animal fats, or vegetable oils in shoreline or bottom sediments that cause deleterious effects to aquatic life. Surface waters and adjoining shorelines must be virtually free from floating oil, film, sheen, or discoloration.
pH	pH is the measure for acidity, basic or alkaline, and is a logarithmic scale measure of hydrogen ion. “Pure water” has a neutral pH, equal to 7.0 on the logarithmic scale. pH levels below 7 are considered acidic, and greater than 7 are basic or alkaline. The water quality standard requires that pH not be less than 6.5 or greater than 8.5, nor vary more than 0.5 pH unit from natural conditions.
Residues	Residues are floating solids, debris, sludge, deposits, foam, scum, or any other material or substance that occurs in water as a result of human activity. Residues may not, alone or in combination with other substances, be present in concentrations or amounts that form objectionable deposits that are undesirable or a nuisance to aquatic or other species.
Temperature	Water temperature may not be caused to exceed 20 degrees Celsius (°C) at any time. The following maximum temperatures may not be exceeded, where applicable: (1) migration routes, 15 °C, (2) spawning areas, 13 °C, (3) rearing areas, 15 °C, and (4) egg and fry incubation, 13 °C. For all other waters, the weekly average temperature may not exceed site-specific requirements needed to (1) preserve normal species diversity and (2) prevent the appearance of nuisance organisms (i.e., must be such that the nuisance organisms are prevented from appearing).
Turbidity	Turbidity is the cloudiness or haziness of fluid caused by suspended solids generally invisible to the naked eye. Turbidity may not exceed 25 nephelometric turbidity units above natural conditions. For all lake waters, turbidity may not exceed 5 nephelometric turbidity units above natural conditions.

[a] Sources: ADEC, 2008a; EPA, 1986

SEA field crews collected baseline surface water quality data during August 2008 at proposed crossing sites along the proposed Port MacKenzie Rail Extension (Noel *et al.*, 2008). Crews collected data via visual observation from a helicopter and from on-the-ground testing and observations. Crews did not collect on-the-ground data from crossings that were inaccessible due to lack of adequate and safe road access or landing zones for the helicopter, or from crossings where the aerial survey indicated there was no waterbody and a ground visit was not warranted.

Table 4.2-2 summarizes water quality values collected at sampling sites along the proposed alternative segments and compares the data to Federal and Alaska water quality standards. These sampling points coincide with proposed waterbody crossing points along the proposed rail line segments. The records included in the table reflect sampling locations where water was present. Figure 4.2-2 shows the sample locations in relation to the proposed crossing sites.

Table 4.2-2
Summary of Water Quality Data in Streams Collected in 2008[a,b]

Segment and Crossing Mile Post	Date Collected	Flow (m/s)	Dissolved Oxygen (mg/L)	Temperature (°C)	Turbidity (NTUs)	Total Dissolved Solids (mg/L)	pH (s.u.)	Conductivity (µS/cm)
Water Quality Standard			7 - 17	≤ 20	≤ 25[c]	≤ 1000	6.5 - 8.5	≤ 500[d]
Big Lake								
B-16.6	8/12/2008	No Data	12.5	14.1	67	80	7.7	115
B-15.9	8/12/2008	No Data	10.6	11.2	2	130	6.7	199
B-15.2	8/12/2008	No Data	12.0	10.2	22	150	7.5	230
B-9.0	8/12/2008	No Data	12.0	15.0	1.0 to 2.0	100	7.4	150
B-6.4	8/13/2008	0.5	7.1	16.8	0	90	7.5	135
Connector 1								
C1-2.6	8/14/2008	No Data	9.9	13.8	4	130	7.6	201
Houston								
H-9.6	8/14/2008	0.4	8.0	18.0	29	30	7.1	40
H-6.3	8/14/2008	No Data	10.5	13.8	4	50	7.8	87
H-4.3	8/14/2008	No Data	10.4	13.4	3	60	7.1	94
H-0.8	8/14/2008	No Data	11.9	16.7	120	120	7.5	179
Houston North								
MP-179.9	8/15/2008	< 1	12.6	11.7	12	60	7.4	101
MP-179.4	8/15/2008	< 1	12.8	11.0	11	60	7.5	100
MP-179.0	5/15/2008	0.5 to 1	11.2	12.2	3	40	7.2	55
MP-178.5	8/15/2008	No Data	11.8	13.6	5	70	7.3	114
HN-4.8	8/16/2008	0.4	10.1	10.7	10	80	7.1	130
HN-4.4	8/16/2008	8 to 10	7.4	18.4	71	80	7.0	117
HN-3.2	8/15/2008	No Data	12.9	13.2	100	60	7.6	97
Houston South								
MP-175.0	8/16/2008	0	9.8	12.4	3	90	7.6	140
MP-174.3	8/15/2008	No Data	12.5	11.3	100	60	7.7	90
HS-1.0	8/16/2008	< 0.5	9.7	15.8	130	70	7.6	68
Mac East								
ME-4.5	8/13/2008	0.5	11.0	13.6	5	90	7.7	144
Mac West								
MW-11.0	8/13/2008	No Data	10	14.7	92	140	7.1	200
MW-10.1	8/13/2008	1.5	12.3	6.2	15	160	6.9	240
MW-4.6	8/13/2008	0.5 to 1	9.7	12.8	4	100	7.5	160
Willow								
MP-190.3	8/16/2008	No Data	11.9	15.6	64	80	7.2	127
MP-189.0	8/16/2008	No Data	10.1	13.6	27	60	6.8	80
W-24.0	8/16/2008	No Data	11.8	11.4	12	50	6.2	70
W-20.9	8/14/2008	No Data	11.5	11.9	27	80	7.3	118
W-16.7	8/17/2008	No Data	7.2	13.7	9	80	6.9	120
W-10.0	8/14/2008	0.9	10.7	18.9	54	60	7.1	90
W-0.6	8/15/2008	No Data	12.3	14.1	5	70	7.6	110

[a] Sources: ADEC, 2008a; EPA 1986; Noel *et al.*, 2008
[b] m/s = meters per second; mg/L = milligram/liter; °C = degrees Celsius; NTU = nephalometric turbidity units; pH = measure of the acidity or the alkalinity of a solution; u. = standard units; µS/cm = micro-siemens per centimeter; < = less than; ≤ = less than or equal to.
[c] Turbidity may not be 25 NTUs above natural conditions
[d] Conductivity is not a water quality standard, but acceptable range for aquatic life. TDS levels can be inferred from conductivity.

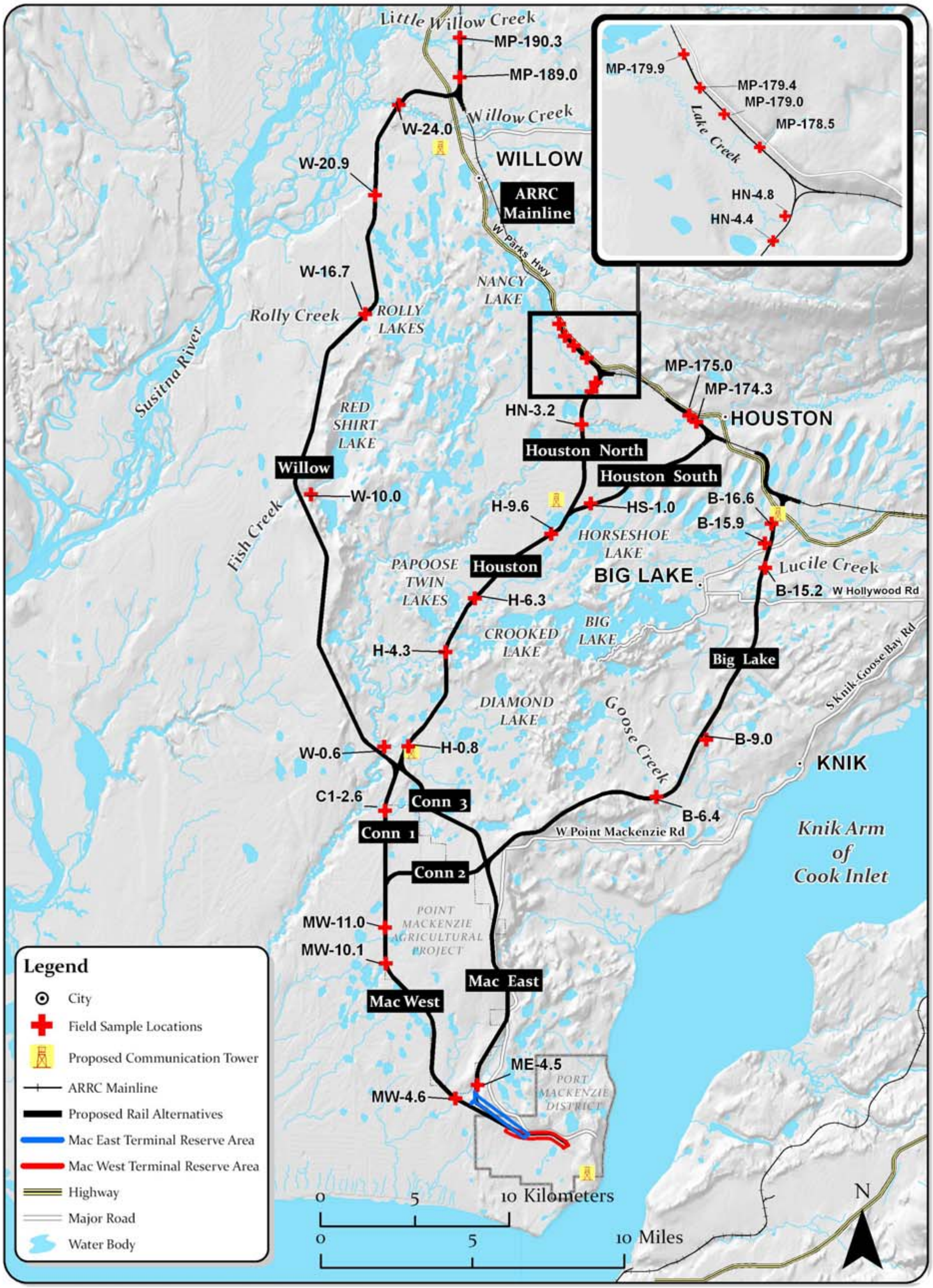

Figure 4.2-2. Sample Locations and Proposed Crossing Sites

The 2008 field data suggests that water quality at the proposed crossings met the current Federal and Alaska water quality standards during the collection dates. Turbidity values ranged from 0 to 130 nephalometric turbidity units, and these one-time values cannot be used to determine standard compliance. Unlike other water quality parameters, turbidity does not have a fixed value for its standard; the water quality standard for turbidity is site specific and may not be 25 nephalometric turbidity units or more above the natural conditions of the site because of human activities.

There are no U.S. Geological Survey water quality monitoring sites within the ROW of any of the alternative segments or downstream of any alternative segment crossings. Three Geological Survey water quality stream gauges are upstream of the project area on the Little Susitna River, the Susitna River, and Willow Creek. All three stations are upstream of the developed areas of MSB, and the nearest station to an alternative segment (Willow Creek station) is more than 8 miles upstream of the Willow Segment crossing. In addition, most of the available data were collected between 1952 and 1986, prior to the substantial growth MSB experienced in recent years. However, it is noteworthy that during the period of record, all water quality parameters met Federal and State of Alaska water quality standards except iron concentrations at the Little Susitna River station.

The Wasilla Soil and Water Conservation District collected water temperature data for the Little Susitna River at Houston. This data collection location is where ARRC proposes a bridge for the rail siding on the Houston South Segment. Most of the temperature samples were less than or equal to 10 degrees Celsius (°C), and two samples were 14°C, all well below the standard of 20°C.

According to ADEC, one waterbody in the study area is listed on the Section 303(d) list of impaired waters (Big Lake). The proposed Port MacKenzie Rail Extension would not cross Big Lake. Waterbodies are placed on the list if (1) the water quality standard(s) are exceeded, (2) the waterbody is impaired for one or more designated uses by a pollutant(s), and (3) the water body requires a total maximum daily load limitation or waterbody recovery plan to attain Alaska's water quality standards (18 AAC 70). Big Lake in Wasilla (approximately 2.2 miles from the Houston Segment and 1.9 miles from the Big Lake Segment; see Figure 4.2-2) is on the Section 303(d) list of impaired waters for non-attainment of the petroleum hydrocarbon water quality standard. ADEC collected water quality information at Big Lake beginning in the open water months of 2004 and 2005. Petroleum hydrocarbon concentrations appear to be influenced by the use of motorized watercraft. The area of impairment is estimated to be 1,250 acres (ADEC, 2008b).

4.2.4 Environmental Consequences

This section describes potential impacts to surface water hydrology and water quality as a result of the construction activities, conveyance structures proposed at each crossing, and proposed rail line operations. Section 4.2.4.1 describes potential impacts under the proposed action; Section 4.2.4.2 describes potential impacts under the No-Action Alternative. The impacts description provides a general guideline for understanding the potential effects of the proposed project because the location and/or design characteristics of some temporary construction facilities and rail line structures would be determined only during final design and permitting. Other parts of this EIS address potential impacts to other resources associated with or that depend on surface waters, such as fisheries (Section 5.4 and Appendix F), floodplains (Section 4.4), navigation (Chapter 12), wetlands (Section 4.5 and Appendix C), essential fish habitat (Section 5.4 and Appendix G), and subsistence (Chapter 7).

4.2.4.1 Proposed Action

Common Construction Impacts

Construction activities associated with the proposed rail line could result in short-term impacts to the flow and quality of surface water. The following paragraphs describe potential construction-related impacts that SEA anticipates would be common to all alternative segments.

Construction of the Rail Line and Unpaved Access Road

Construction of the rail line and unpaved access road would result in negligible impacts to water quality impacts except in areas were the rail line and access road would be near, adjacent to, or span waterbodies. In these areas, ROW clearing, grading, and construction of the rail line and access road would expose soil to the erosive forces of wind, rain, and surface runoff during construction and until temporarily disturbed areas were revegetated. The resulting impacts to water quality could include:

- Increased erosion and sediment availability/transport to watercourses during spring ice breakup, snowmelt, or rainstorms
- Nutrient loading associated with sediments that could contribute to changes in water quality
- Small petrochemical leaks from construction equipment that could enter a waterbody either directly as equipment crossed a waterbody or with surface runoff

If sediments were disturbed and entrained, the effect would be short term and temporary, lasting only during the construction period. Any turbid waters that could result from construction would return to background conditions once the fine material settled. SEA would not expect long-term impacts to water quality from rail construction activities.

Excavation of Borrow Areas

ARRC might obtain subballast and fill material from borrow areas established within the rail line ROW. Borrow areas would be identified by the Applicant during final design and permitting, but local shallow-water areas (former borrow areas) could be targeted areas for further extraction. Removal of material could disrupt these shallow-water areas, including disturbing sediment, increasing turbidity, and generally degrading water quality. If sediment were disturbed and entrained, the effect would be temporary and would last only during the construction and extraction period. Turbidity levels would return to background conditions after the fine material settled. SEA would expect no long-term impacts to water quality. Potential new borrow areas might also be identified in surface-water areas. ARRC has not established the location, timing, or duration of borrow activity. Depending on the annual and seasonal variation of flood stage and hydraulics of the waterbodies at the borrow areas, there could be impacts to water quality. Impacts could include short-term impacts, such as erosion of the borrow area, and flooding and increased erosion and sediment transport within the waterbodies. If borrow areas were developed in a floodplain and near to a waterbody, excavation could alter the hydraulics and conveyance of the watercourse during flood storage, which could lead to a short-term increase in flood storage, or alteration of channel alignment through rapid channel avulsion into the borrow areas.

Construction of Staging Areas

The proposed rail line could require construction of staging areas for temporary storage of equipment and materials. According to the Applicant, the objective would be to place staging areas within the proposed ROW at relatively flat, previously disturbed areas with established access to existing public roads. If the Applicant placed a staging area in or near a waterbody or floodplain, grading and filling associated with re-contouring and staging-area construction could disrupt natural drainage patterns during flooding episodes of major streams, during high runoff periods along seasonal drainages, or along shallow overland flow paths. Blockages or diversions to areas with insufficient flow capacity could result in seasonal or semi-permanent impoundments. Also, redirected surface flows could increase stream velocities at isolated locations where there could be increased bank scour or overbanking.

Clearing, grading, and filling associated with constructing staging areas would temporarily expose soil to the erosive forces of wind, rain, and surface runoff during construction and until the area was revegetated. If near a waterbody, this ground disturbance could mobilize sediment and increase turbidity, which could result in an overall degradation of water quality. The effect would be temporary and would last only during the construction period. Turbidity levels would return to background conditions after the fine material settled. In addition, small petrochemical leaks from construction equipment could enter a waterbody either directly or with surface runoff. SEA would not expect long-term impacts to water quality from constructing staging areas.

Construction and Installation of Bridges and Culverts

Common impacts that could result from the culvert and bridge construction and installation along the ROW would include the following:

- Sloughing, sheet rilling, and erosion of streambanks and riparian areas
- Increased stages and velocities of floodwater (due to temporary constrictions) possibly concurrent with increased backwater flooding
- Increased channel scour, bank erosion, and downstream sedimentation
- Blockage, convergence, or changes to the natural drainage during construction in the channel
- Communication between surface waters and groundwater in geotechnical boreholes that would be drilled to determine the suitability of the substrate at the crossing

Culvert construction and installation could result in impacts to water quality from localized disturbance of the streambank to gain access to the channel, and disturbance of the channel bed during culvert placement. In addition, if a culvert occupied only a small portion of the channel and ARRC covered the remaining channel width in fill, there would be additional streambank and channel disturbances and loss of channel area. These activities could result in increases in turbidity and sediment loads, and changes to natural drainage. Bed and bank disruption could also lead to increased sediment load downstream of the crossing; this impact, however, would generally be short term and temporary, and conditions would return to background levels after ARRC finished construction. The extension of existing culverts along the ARRC main line could affect water quality through disturbance of the existing rail embankment by exposing soils to erosive forces, which could increase sedimentation and turbidity. SEA would not expect culvert extensions to significantly affect existing flow conditions at the culverts.

Construction and installation of proposed bridges could result in impacts to water quality and flow, with the level of impact depending on (1) whether the proposed bridge would be a full or partial span, (2) the amount of in-channel work necessary for construction of piers and abutments, and (3) the angle of the bridge in relation to the river/stream (perpendicular or oblique). Consequently, the degree of bank and channel disturbances could vary substantially and at some sites could alter waterbody flow, bank erosion, and sedimentation processes. Based on the design and the need to work in the channel to construct piers and footings or along the stream banks to construct abutments, there could be impacts. In general, bridges typically result in fewer impacts to streams than culverts because they are able to maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, and provide less restriction to flow than culverts.

Common Operations Impacts

Rail line operations could affect both the hydrology and quality of surface water. Operations impacts to surface waters would consist of long-term impacts that could result from the presence of the rail line and access road embankment, conveyance structures, and movement of trains along the rail line. The following paragraphs describe operations-related impacts that SEA anticipates would be common to all the proposed rail line segments.

Bridges and Culverts

The presence of bridges and culverts in or over a channel could alter channel hydraulics, which could increase channel scour and erosion processes (lateral migration, channel reorientation, bank undercutting) that could lead to an increase in sediment transport loads and downstream sedimentation. The approach direction (perpendicular or oblique), size of culvert, and the length of affected streambank and channel width would vary. Therefore, the degree of bank and channel infringement could also vary substantially, as would the extent of erosion and sedimentation. Culverts would likely result in greater potential impacts to flow and water quality due to the potential of culverts to constrict and alter flows more than bridges.

The presence of bridges could affect water quality as a result of altered flow hydraulics that could increase scour, erosion, and sedimentation. The level of impact would depend on the number of in-channel piers used to support the bridge and whether the proposed bridge was a full or partial span. The approach direction (perpendicular or oblique) and type of bridge construction (single partial span, single clear span, multiple-pier partial span, multiple-pier clear span), placement of abutments and/or in-channel piers, and the length of affected streambank and channel width would vary by structure. Therefore, the degree of bank and channel infringement could also vary substantially, as would the extent of erosion and sedimentation. Bridges typically result in fewer impacts to streams than culverts because they are able to maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, provide less restriction to flow than culverts, and generally require less instream maintenance over time than culverts.

Rail Line and Unpaved Access Road Operations

In general, use of the rail line and unpaved access roads would result in negligible impacts to rivers and streams except in areas where the rail line and roads would be near waterbodies. When the rail line or roads would be near or adjacent to waterbodies, the potential consequences to water quality during spring ice break-up, snowmelt, or rainstorms could include increased transport of fine-grained sediments and increased concentrations of pollutants that could alter waterbody chemistry and pH. In addition, fugitive dust generated by rail operations and vehicles using gravel access roads, and chemicals used for access-road maintenance could affect water quality. The relative degree of water quality degradation would vary, depending on stream type, location, and habitat value. Small petrochemical leaks from trains or vehicles using the access road could also affect water quality if the pollutant entered a waterbody directly or via surface runoff.

Impacts by Segment

This section describes potential impacts associated with specific rail line segments by building on the common impacts to hydrology and water quality (see previous section) where project design information and environmental data are available to reasonably distinguish between the alternative segments. Factors used to differentiate between alternative segments could include the number of waterbody crossings, number of major waterbody crossings, number of new bridges and culverts, number of culvert extensions, acreage of wetlands and other waters in and adjacent to the ROW, presence of highly erodible soils, and multiple- or single-span bridges.

Because each proposed drainage structure would be identified by the Applicant during final design as a culvert or a bridge, this discussion of potential impacts to surface waters does not include their impacts for comparative purposes, other than to count them as crossings. In addition, the Applicant has indicated additional culverts might be needed for equalization across wetlands or for drainages that have not been identified. Because these culverts might or might not be installed and the actual numbers or locations have not been determined, they are not included in the following description of potential impacts.

Table 4.2-3 details waterbody crossings by rail line segments and includes crossing identification numbers so readers can match each crossing to corresponding figures.

Southern Segments/Segment Combinations

Table 4.2-4 provides summary details of waterbody crossings for each southern segment.

Table 4.2-3
Waterbody Crossings by Segment/Segment Combinations[a] (page 1 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Southern Segments/Segment Combinations				
Mac West	MW-12.0	Unidentified	Culvert	48
	MW-11.0	Unidentified stream	Culvert	36
	MW-10.1	Unidentified stream; inlet to Horseshoe Lake	Culvert	48
	MW-9.3	Wetland	Culvert	48
	MW-8.8	Wetland	Culvert	48
	MW-8.3	Unidentified	Culvert	48
	MW-7.8	Unidentified	Culvert	48
	MW-7.2	Unidentified	Culvert	48
	MW-6.8	Unidentified	Culvert	48
	MW-6.3	Unidentified	Culvert	48
	MW-5.2	Unidentified	Culvert	48
	MW-4.6	Unidentified stream; drains to Cook Inlet	Culvert	48
	MW-3.7	Wetland	Culvert	48
	T-1.2	Wetland	Culvert	48
	T-0.9	Unidentified	Culvert	48
Mac East	ME-7.4	Wetland	Culvert	48
	ME-4.5	Unidentified stream; direct to Cook Inlet	Culvert	36
	ME-2.5	Wetland	Culvert	48
Connector 1 Segment	C1-3.0	Wetland	Culvert	48
	C1-2.6	Unidentified stream; tributary to the Little Susitna River	Culvert	72
	C1-2.3	Wetland	Drainage structure	ND
	C1-1.1	Wetland	Culvert	48
	C1-0.9	Wetland	Culvert	48
	C1-0.7	Wetland	Culvert	48
	C1-0.2	Wetland	Culvert	48
Connector 2 Segment	C2-2.3	Unidentified	Culvert	48
	C2-1.9	Unidentified	Culvert	48
	C2-1.7	Unidentified	Culvert	48
	C2-0.2	Wetland	Culvert	48
Connector 3 Segment	C3-3.6	Wetland	Culvert	36
	C3-3.0	Wetland	Culvert	48
	C3-2.2	Wetland	Culvert	24
	C3-1.5	Unidentified	Culvert	36
Northern Segments				
Willow	MP-190.3	Unidentified stream; tributary to Little Willow Creek	Bridge	ND
	MP-189.6	Wetland	Culvert	36
	MP-189.3	Wetland	Culvert	36
	MP-189.0	Rodgers Creek	Bridge	ND
	MP-188.2	Wetland	Culvert	48
	W-25.6	Wetland	Culvert	48
	W-25.5	Wetland	Culvert	48
	W-24.8	Wetland	Culvert	48

Table 4.2-3
Waterbody Crossings by Segment/Segment Combinations[a] (page 2 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments (continued)				
Willow (continued)	W-24.0	Willow Creek	Bridge	ND
	W-23.1	Wetland	Drainage structure	ND
	W-22.7	Unidentified	Culvert	48
	W-21.4	Unidentified	Culvert	48
	W-20.9	Unidentified stream; tributary to Susitna River	Culvert	36
	W-19.6	Wetland	Drainage structure	ND
	W-16.7	Unidentified stream; tributary to Rolly Creek	Culvert	72
	W-16.4	Unidentified stream; tributary to Rolly Creek	Culvert	48
	W-15.8	Unidentified	Culvert	48
	W-14.4	Unidentified stream; tributary to Rolly Creek	Culvert	36
	W-13.8	Unidentified	Culvert	48
	W-10.0	Fish Creek	Drainage structure	ND
	W-8.6	Unidentified	Culvert	36
	W-2.4	Unidentified	Culvert	48
	W-0.6	The Little Susitna River	Bridge	ND
Houston South	MP-175.0	Unidentified stream	Culvert	48
	MP-174.3	The Little Susitna River	Bridge	ND
	MP-173.3	Wetland	Culvert	48
	HS-1.9	Wetland	Culvert	48
	HS-1.4	Unidentified stream; tributary to Little Horseshoe Lake	Culvert	48
	HS-1.0	Stream; tributary to Little Horseshoe Lake	Culvert	36
	HS-0.8	Wetland	Culvert	48
Houston	H-9.6	Outflow Muleshoe Lake; inflow Colt Lake	Culvert	48
	H-9.4	Unidentified	Culvert	48
	H-8.3	Wetland	Culvert	48
	H-7.1	Wetland	Culvert	48
	H-6.3	Unidentified stream; tributary to the Little Susitna River	Drainage structure	ND
	H-5.8	Wetland	Culvert	36
	H-4.3	Unidentified stream; tributary to the Little Susitna River	Culvert	72
	H-2.8	Wetland	Culvert	48
	H-1.9	Wetland	Culvert	48
	H-1.2	Wetland	Culvert	24
	H-0.8	Unidentified stream; outlet of Diamond Lake	Drainage structure	ND

Table 4.2-3
Waterbody Crossings by Segment/Segment Combination[a] (page 3 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments (continued)				
Houston North	MP-179.9	Unidentified stream	Culvert	48
	MP-179.8	Unidentified	Culvert	48
	MP-179.7	Unidentified	Culvert	36
	MP-179.6	Unidentified	Culvert	36
	MP-179.5	Unidentified	Culvert	48
	MP-179.4	Unidentified stream	Culvert	60
	MP-179.1	Unidentified	Culvert	48
	MP-179.0	Unidentified stream	Culvert	36
	MP-178.9	Unidentified	Culvert	36
	MP-178.5	Unidentified stream; tributary to Lake Creek	Culvert	48
	MP-178.1	Unidentified	Culvert	48
	MP-177.8	Unidentified	Culvert	36
	MP-177.5	Unidentified	Culvert	48
	HN-4.8	Unidentified stream; tributary to Lake Creek	Culvert	72
	HN-4.4	Lake Creek	Drainage structure	ND
	HN-3.2	The Little Susitna River	Bridge	ND
	HN-2.7	Wetland	Culvert	48
	HN-1.2	Wetland	Culvert	48
Big Lake	MP-170.7	Unidentified	Culvert	48
	MP-170.5	Unidentified stream	Culvert	60
	MP-170.1	Unidentified stream; outlet of Cheri Lake	Culvert	60
	B-18.3	Unidentified stream; inlet to Long Lake	Drainage structure	ND
	B-17.4	Unidentified stream	Drainage structure	ND
	B-16.6	Unidentified stream; inlet to Long Lake	Drainage structure	ND
	B-15.9	Little Meadow Creek	Drainage structure	ND
	B-15.8	Unidentified	Culvert	48
	B-15.2	Lucille Creek	Drainage structure	ND
	B-15.1	Unidentified stream; tributary to Lucille Creek	Culvert	36
	B-14.8	Wetland	Culvert	36
	B-14.5	Wetland	Culvert	48
	B-14.3	Wetland	Culvert	24
	B-13.5	Wetland	Culvert	48
	B-12.7	Wetland	Culvert	48
	B-11.9	Wetland	Culvert	24
	B-9.9	Wetland	Culvert	24

Table 4.2-3
Waterbody Crossings by Segment/Segment Combination[a] (page 4 of 4)

	Mile Post	Waterbody Type[b]	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[d]
Northern Segments (continued)				
Big Lake (continued)	B-9.0	Fish Creek	Drainage structure	ND
	B-8.4	Wetland	Culvert	24
	B-7.2	Wetland	Culvert	36
	B-6.4	Goose Creek	Drainage structure	ND
	B-5.9	Wetland	Culvert	24
	B-4.1	Unidentified	Culvert	48

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design process and could include multi-plate culverts, pre-cast arches, or bridges
[d] ND = No data; to be determined during final permitting and design.

Table 4.2-4
Summary of Waterbody Crossings along the Southern Segments/Segment Combinations[a]

	Mac West-Connector 1	Mac West-Connector 2	Mac East-Connector 3	Mac East
Numbers of Crossings				
Total Crossings	22	19	7	3
Types of Waterbodies				
Wetlands	10	5	5	2
Streams	4	3	1	1
Unidentified[b]	8	11	1	0
Types of Crossings				
Bridges	0	0	0	0
Drainage Structures[c]	1	0	0	0
Culverts	21	19	7	3
Culvert Extensions	0	0	0	0

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design and permitting and could include multi-plate culverts, pre-cast arches, or bridges.

Mac West-Connector 1 Segment Combination

The Mac West-Connector 1 Segment Combination would cross 22 waterbodies with 1 drainage structure (culverts or bridges, depending on permitting and final design) and 21 culverts (see Figure 4.2-3). This segment combination would require more crossings than the other southern segment combinations, which would increase the potential for impacts to water quality and hydrology during rail line construction and operations. In addition, this segment combination would have the most acreage of wetlands and other waters of the U.S. (279 acres; see Section

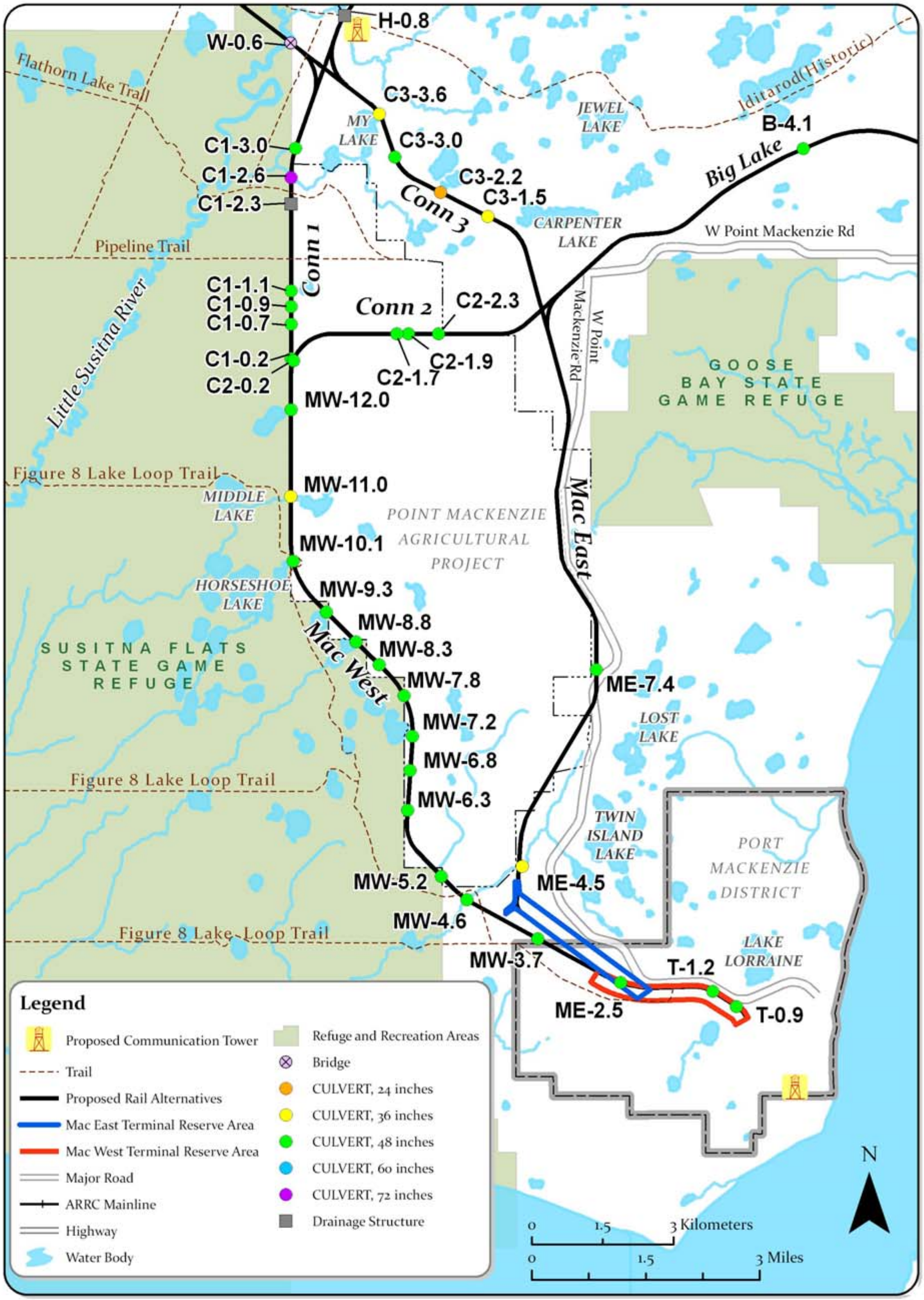

Figure 4.2-3. Mac East, Mac West, and Connector Segment Crossings Proposed Port MacKenzie Rail Extension

4.5, Wetland Resources) in and along the ROW, which would increase the potential for impacts to water quality and alteration of hydrology in those areas. This segment combination would involve the lowest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the other southern segment combinations; however, the number of crossings and in-water work that would be required would be greatest for this segment combination. This segment combination would not cross any major rivers or streams. Overall, SEA anticipates that this segment combination would result in the greatest impact to surface waters of all the southern segment combinations.

Mac West-Connector 2 Segment Combination

The Mac West-Connector 2 Segment Combination would cross 19 waterbodies with 19 culverts (see Figure 4.2-3). This segment combination would require the second largest number of crossings compared to the other southern segment combinations, which would give it a higher potential for impacts to hydrology and water quality than the other southern segment combinations. In addition, this segment combination would have the second largest acreage of wetlands and other waters of the U.S. (236 acres; see Section 4.5, Wetland Resources) in and along the ROW, which would increase the potential for impacts to water quality impacts and alteration of hydrology. This segment combination would involve the second lowest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the other southern segment combinations. The Mac West-Connector 2 Segment Combination would not cross any major rivers or streams.

Mac East-Connector 3 Segment Combination

The Mac East-Connector 3 Segment Combination would cross seven waterbodies with seven culverts (see Figure 4.2-3). This segment combination would involve the second smallest number of crossings compared to the other southern segment combinations, which would give it a comparatively low potential for impacts to water quality and hydrology during rail construction and operations. In addition, this segment combination would involve the second lowest acreage of wetlands and other waters of the U.S. (106 acres; see Section 4.5, Wetland Resources) in and along the ROW, which would give it a lower potential for impacts to water quality impacts and alteration of hydrology. This segment combination would involve the greatest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) of the southern segment combinations. However, the smaller number of crossings and amount of in-water work that would be required compared to the Mac West-Connector 1 Segment Combination and the Mac West-Connector 2 Segment Combination would likely result in a lower direct impact to water quality. This segment combination would not cross any major rivers or streams.

Mac East Segment

The Mac East Segment would cross three waterbodies with three culverts (see Figure 4.2-3). This segment would involve the fewest crossings compared to the other southern segments/segment combinations. In addition, this segment would involve the lowest acreage of wetlands and other waters (101 acres; see Section 4.5, Wetland Resources) in and along the ROW, but not much lower than the Mac East-Connecter 3 Segment Combination. With the smallest acreage of wetlands and other waters of the U.S. of all the southern segments/segment combinations, SEA anticipates this segment would have a relatively low potential for impacts to water quality and alteration of hydrology in these areas. This segment would not cross any major rivers or streams. Overall, SEA anticipates that this segment would result in the lowest potential impact to surface waters of all the southern segments/segment combinations.

Northern Segments/Segment Combinations

Table 4.2-5 provides summary details of waterbody crossings for each northern segment/segment combinations.

Table 4.2-5
Summary of Waterbody Crossings along the Northern Segments/Segment Combinations[a]

	Willow	Big Lake	Houston-Houston North	Houston-Houston South
Numbers of Crossings				
Total Crossings	23	23	29	18
Types of Waterbodies				
Wetlands	8	10	8	9
Streams	9	10	11	8
Unidentified[b]	6	3	10	1
Types of Crossings				
Bridges	4	0	1	1
Drainage Structures[c]	3	7	3	2
Culverts	13	13	12	13
Culvert Extensions	3	3	13	2

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design and permitting and could include multi-plate culverts, pre-cast arches, or bridges.

Willow Segment

The Willow Segment would cross 23 waterbodies with 4 bridges, 3 drainage structures, 13 culverts, and 3 culvert extensions (see Figure 4.2-4). This segment would involve the second largest number of crossings compared to the other northern segments and segment combinations, which would increase the potential for more impacts to water quality and hydrology compared to the other northern segments and segment combinations. This segment would have the smallest acreage of wetlands and other waters of the U.S. (85 acres, see Section 4.5, Wetland Resources) in and along the ROW compared to the other northern segments and segment combinations. Having the lowest acreage of wetlands and other waters of all the northern segments and segment combinations indicates this segment would have the least potential for impacts to water quality and alteration of hydrology in these areas. This segment would involve the second largest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segments and segment combinations, but the percentage for this segment is much closer to the percentage for the two segment combinations with the lowest percentages than the segment combination with the highest percentage. This segment would cross Rodgers Creek, Willow Creek, the Little Susitna River, and a tributary to Little Willow Creek with bridges. Multiple spans and in-water support piles would likely be required for Rogers Creek, Willow Creek, and the Little Susitna River because their channel widths all exceed ARRC's proposed bridge span length of 28 feet. Compared to other northern segments and segment combinations, this segment would involve the most bridge crossings and bridge

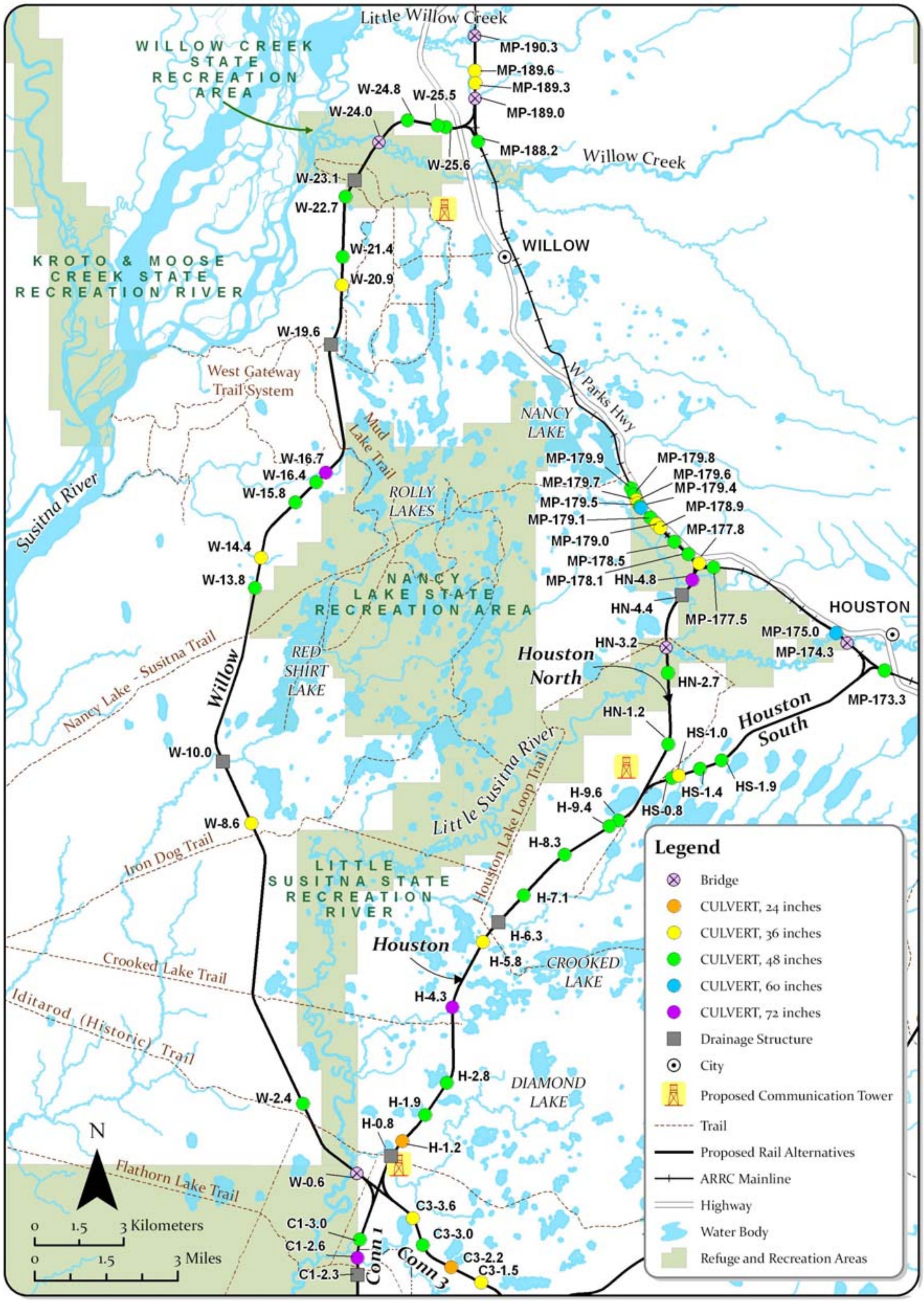

Figure 4.2-4. Willow, Houston, Houston North, and Houston South Segment Crossings Proposed Port MacKenzie Rail Extension

crossings that would require in-water support piles. The tributary to Little Willow Creek would likely have a single span bridge with no in-water support piles because the channel width is less than half of the 28-foot bridge span. The number of new culverts (13) proposed along this segment is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment would also involve one of the smallest number of culvert extensions along the main line.

Big Lake Segment

The Big Lake Segment would cross 23 waterbodies with 7 drainage structures, 13 culverts, and 3 culvert extensions (see Figure 4.2-5). This segment would involve the same number of crossings as the Willow Segment, and impacts to water quality and hydrology would be similar to those for the Willow Segment. In addition, this segment would have the second smallest acreage of wetlands and other waters of the U.S. (111 acres; see Section 4.5, Wetland Resources) in and along the ROW compared to the other northern segment combinations. This segment would have a lower potential for impacts to water quality and alteration of hydrology because it has one of the smallest acreages of wetlands and other waters of all the northern segment combinations. This segment would have the largest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils), far exceeding the percentages for the other northern segment combinations. This could increase the potential for impacts to water quality if ARRC did not implement appropriate best management practices and mitigation measures. This segment would cross Little Meadow Creek, Lucile Creek, Fish Creek, and Goose Creek with drainage structures (culverts or bridges, depending on permitting and final design).

This segment would also require the relocation of approximately 2,440 feet of stream channel from an unnamed anadromous fish stream adjacent to the rail line between Mile Post B-17.1 and Mile Post B-17.6 into two new sections of 2,460-foot-long channel. There could be impacts to the specific stream reach involved and possible upstream and downstream effects. Potential impacts could be positive or negative, depending on the nature of the modification. Potentially, several characteristics of a reach could be altered, including channel morphology, channel hydraulics, sediment erosion and deposition processes, and water quality. Many of the detrimental effects of stream relocation could be avoided, with little compromise in channel efficiency, by employing channel design guidelines that do not destroy the hydraulic and morphologic equilibria of natural streams. These guidelines include minimal straightening; promoting bank stability by leaving trees, minimizing channel reshaping, and employing bank stabilization techniques; and emulating the morphology of natural stream channels.

The number of new culverts (13) proposed along this segment is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment would also require one of the smallest number of culvert extensions along the main line.

Houston-Houston North Segment Combination

The Houston-Houston North Segment Combination would cross 29 waterbodies with 1 bridge, 3 drainage structures, 12 culverts, and 13 culvert extensions (see Figure 4.2-4). This segment combination would involve the most crossings compared to the other northern segment combinations. However, this might exaggerate the level of potential impacts in relation to other segment combinations because 13 of these 29 crossings would be extensions of existing culverts

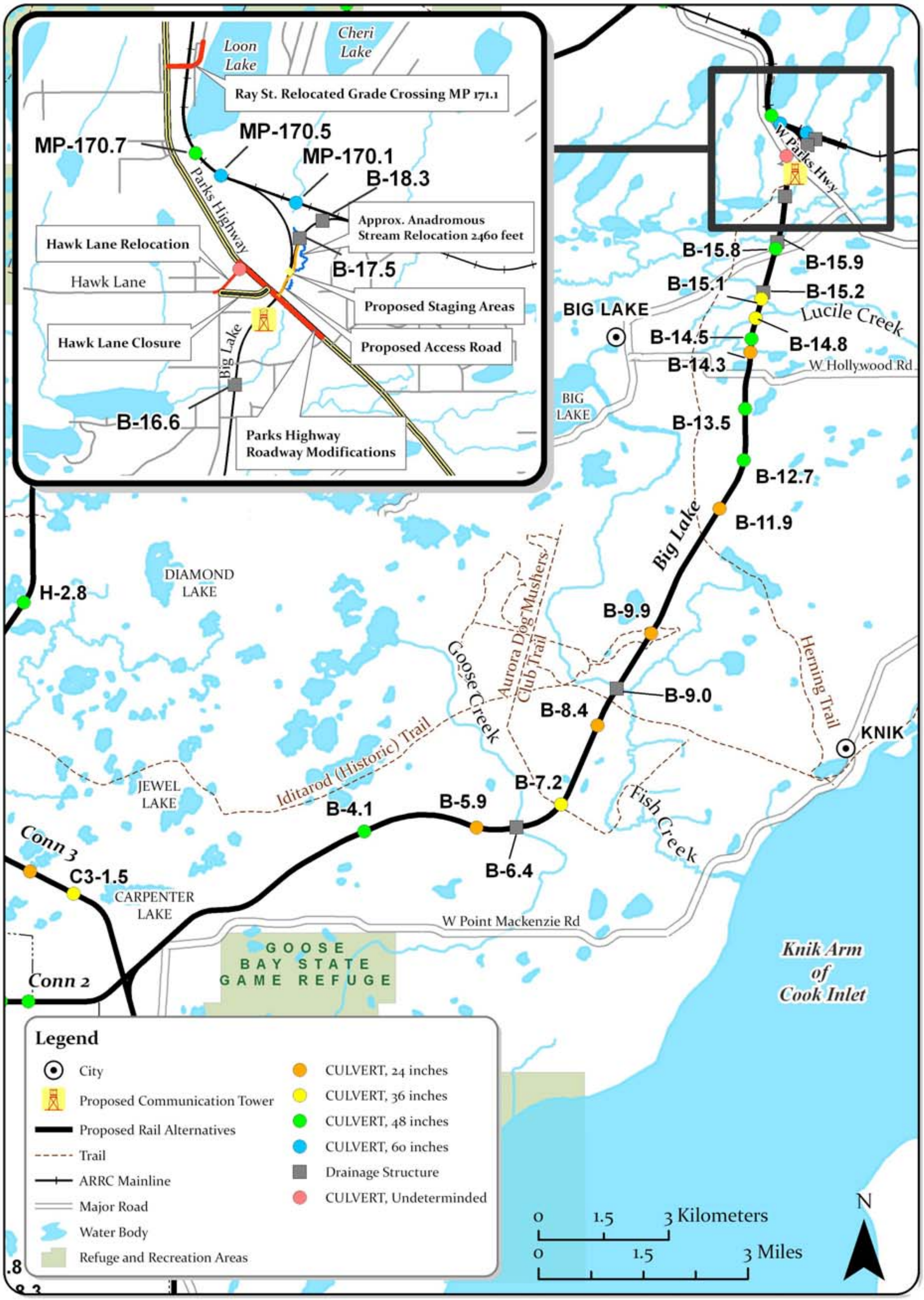

Figure 4.2-5. Big Lake Segment Crossings Proposed Port MacKenzie Rail Extension

under the main line, and extensions to these culverts might not have the same level or intensity of impact as the installation of a new culvert. Sixteen of the 29 crossings would be new. This segment combination would have the largest acreage of wetlands and other waters of the U.S. (198 acres; see Section 4.5, Wetland Resources) in and along the ROW, which could increase the potential for impacts to water quality and alteration of hydrology. This segment combination would have one of the smallest percentages of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segment combinations. This segment combination would cross Lake Creek and the Little Susitna River. Multiple spans and in-water support piles would likely be required for the Little Susitna River crossing because its channel width exceeds ARRC's proposed bridge span length of 28 feet. Compared to other northern segment combinations, this segment combination would require one of the smallest number of bridge crossings. This segment combination would cross Lake Creek with a drainage structure that would be determined during final permitting and design.

The number of new culverts (12) proposed along this segment combination is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment combination would also require the largest number of culvert extensions along the main line.

Houston-Houston South Segment Combination

The Houston-Houston South Segment Combination would cross 18 waterbodies with 1 bridge, 2 drainage structures, 13 culverts, and 2 culvert extensions (see Figure 4.2-4). This segment combination would involve the fewest crossings compared to the other northern segment combinations, and would have the least potential for impacts to water quality and hydrology during rail line construction and operations. This segment combination would have one of the higher acreages of wetlands and other waters of the U.S. (144 acres; see Section 4.5, Wetland Resources) in and along the ROW compared to the other northern segment combinations, which would increase the potential for impacts to water quality and alteration of hydrology in these areas. This segment combination would have the smallest percentage of highly or potentially highly erodible soils (see Section 3.4, Geology and Soils) compared to the other northern segment combinations, but the percentage for this segment combination is similar to two other northern segment combinations. This segment combination would cross the Little Susitna River with a bridge. Multiple spans and in-water support piles would likely be required for the Little Susitna River crossing because its channel width exceeds ARRC's proposed bridge span lengths of 28 feet. Compared to other northern segment combinations, this segment combination would have one of the smallest number of bridge crossings.

The new culverts (13) proposed along this segment combination is not substantially different from the number of new culverts proposed along the other northern segment combinations. This segment combination would also have the smallest number of culvert extensions along the main line.

Summary of Potential Impacts by Alternative

The primary factor to consider when comparing potential impacts to surface water among alternatives is the number of waterbody crossings, because it is this activity that could most directly affect water quality and hydrology during rail line construction and operations. The more in-water work that would result from a larger number of culverts and bridges during construction, the greater the potential for impacts to surface water. In addition, bridges generally would be expected to result in fewer hydrology impacts than culverts, because bridges are able to maintain stream structure and flow characteristics better than culverts, maintain transport of bedload, provide less restriction to flow, and generally require less instream maintenance over time. Other minor factors that can be considered when assessing potential impacts to surface water can include the presence of highly erodible soils, the extension of existing culverts versus constructing new culverts, or the amount of wetlands and other waters of the U.S. near the ROW that could be affected by water quality impacts during construction and operations. However, these potential impacts can be reduced and minimized through best management practices and mitigation measures and are not expected to be primary determining factors when comparing potential impacts to surface water among alternatives.

Table 4.2-6 summarizes waterbody crossings associated with the eight proposed Port MacKenzie Rail Extension alternatives.

Table 4.2-6
Waterbody Crossings by Alternative[a]

	Alternative							
	Mac West-Connector 1-Willow	**Mac West-Connector 1-Houston-Houston North**	**Mac West-Connector 1-Houston-Houston South**	**Mac West-Connector 2-Big Lake**	**Mac East-Connector 3-Willow**	**Mac East-Connector 3-Houston-Houston North**	**Mac East-Connector 3-Houston-Houston South**	**Mac East-Big Lake**
Numbers of Crossings								
Total Crossings	45	51	40	42	30	36	25	26
Types of Waterbodies								
Wetlands	18	18	19	15	13	13	14	12
Streams	13	15	12	13	10	12	9	11
Unidentified[b]	14	18	9	14	7	11	2	3
Types of Crossings								
Bridges	4	1	1	0	4	1	1	0
Drainage Structures[c]	4	4	3	7	3	3	2	7
Culverts	34	33	34	32	20	19	20	16
Culvert Extensions	3	13	2	3	3	13	2	3

[a] Source: ARRC, 2008; Noel *et al.*, 2008.
[b] Unidentified designates an unmapped drainage area.
[c] Drainage structures would be determined during the final design process and could include multi-plate culverts, pre-cast arches, or bridges.

The number of waterbody crossings would range from 25 along the Mac East-Connector 3-Houston-Houston South Alternative to 51 along the Mac West-Connector 1-Houston-Houston North Alternative. The Mac East-Connector 3-Houston-Houston South Alternative would require fewest crossings with the smallest number of drainage structures and culvert extensions, and one of the smallest number of culverts, which would result in the least in-water work and the smallest potential impact during operations. The Mac West-Connector 1-Houston-Houston

North Alternative would require the most crossings, which would require the most in-water work. While this alternative would require one less new culvert than two other alternatives, it would require 13 culvert extensions that would require in-water work.

4.2.4.2 No-Action Alternative

Under the No-Action Alternative, ARRC would not construct and operate the proposed Port MacKenzie Rail Extension, and there would be no surface water impacts from the project.