5.4 Fisheries Resources

This section describes fisheries resources in the proposed Port MacKenzie Rail Extension study area and potential impacts from the project on these resources. Section 5.1 describes the regulatory setting for fisheries, Section 5.4.1 defines the study area, Section 5.4.2 describes the analysis methodology, Section 5.4.3 describes the affected environment (existing conditions), Section 5.4.4 describes potential environmental consequences (impacts) to fisheries resources from the proposed rail line, and Section 5.4.5 describes unavoidable environmental consequences of the proposed action to fisheries resources.

5.4.1 Study Area

The study area for fisheries resources is the surface waters within the Susitna River basin that are bounded on the west by the Susitna River, on the south by Cook Inlet, on the east by Knik Arm, and on the north by the existing ARRC main line (Figure 5.4-1).

5.4.2 Analysis Methodology

OEA's analysis of potential impacts to fisheries resources from proposed rail line construction and operation for each rail line crossing considered information available on current and potential anadromous and resident fish use; existing habitats; anadromous and resident fish habitat requirements; anadromous and resident fish seasonal movement patterns; proposed crossing or conveyance types and sizes; potential stream blockage; and the stream contributions to important recreational, commercial, or subsistence/personal-use fisheries. OEA identified potential instream fish habitat through review of stream-crossing characteristics as described in Section 4.2, Surface Water; reported anadromous fish presence and habitat use data (Johnson and Daigneault, 2008); and fish habitat data collected at or near proposed stream crossings during OEA field investigations in 2008 (Noel *et al.*, 2008).

In addition, in response to comments on the Draft EIS, OEA performed a GIS geomorphic analysis to characterize further the fish habitat potential upstream of the proposed rail crossings. Also in response to comments, OEA used a conservative approach with this analysis by including all waterbodies currently supporting fisheries and waterbodies with the potential to support fisheries, even if they currently do not. The results of this analysis do not alter prior information included in the Draft EIS; rather, in this Final EIS, they are presented and considered in conjunction with the prior information in assessing potential impacts. In this Final EIS, streams, rivers, lakes, and ponds were analyzed as fish-bearing if: 1) they are cataloged anadromous waters (Johnson and Daigneault, 2008), 2) they are connected to a cataloged anadromous water, 3) fish habitat was determined to be present during OEA stream-crossing investigations in 2008 (Noel *et al.*, 2008), or 4) the GIS geomorphic analysis conducted showed stream connectedness and anadromous and/or resident fish habitat potential upstream of each crossing (Figure 5.4-2).

The GIS geomorphic analysis was used to apply a fisheries model to estimate habitat potential for several fish species upstream of proposed drainage structure locations (see Appendix F). The model incorporated previously published species-specific models of biological performance to

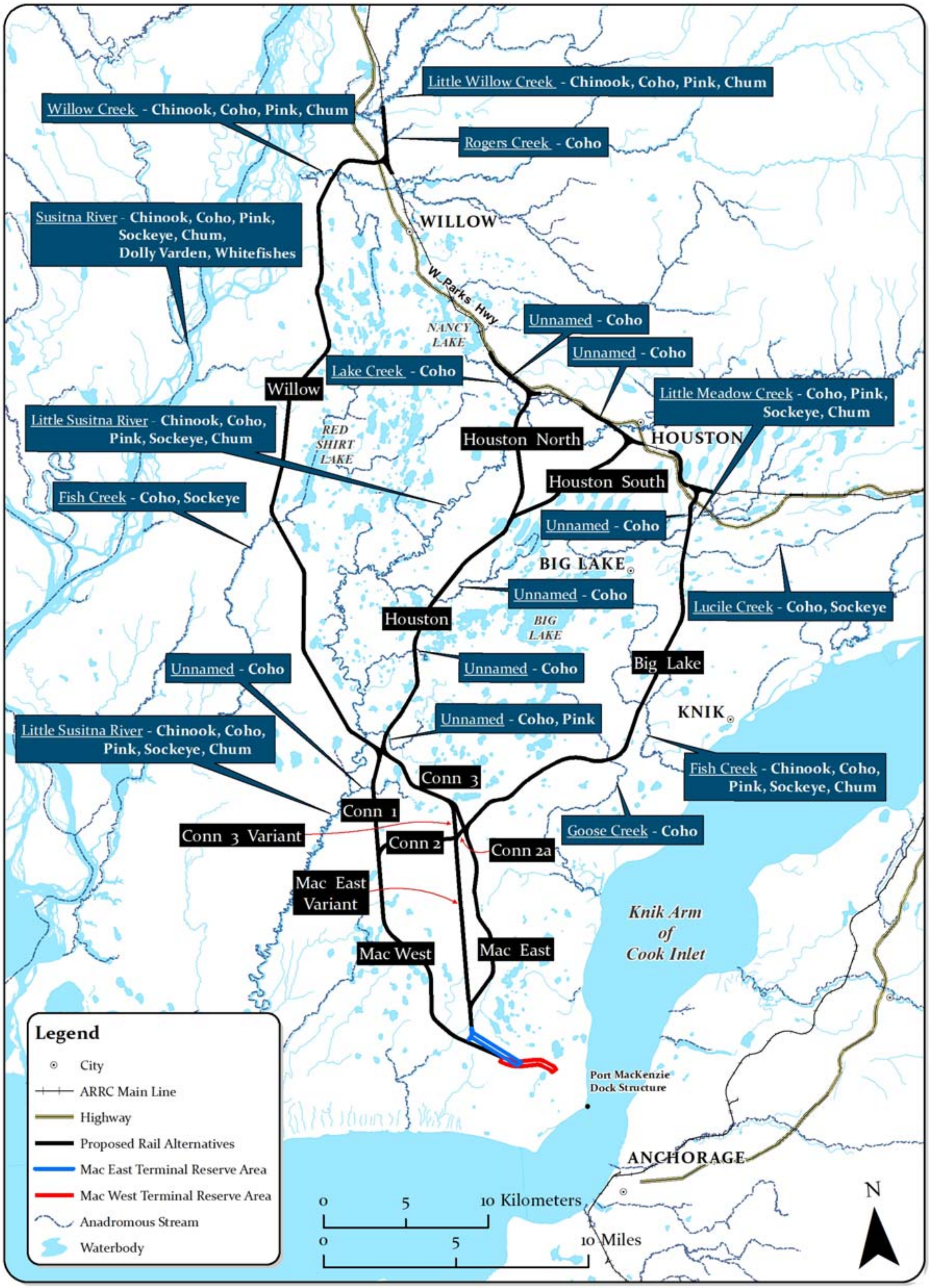

Figure 5.4-1. Waters in the Study Area Documented as Important for Chinook, Chum, Coho, Pink, and Sockeye Salmon under Alaska Statute 16.05.871(a) (Johnson and Daigneault, 2008)

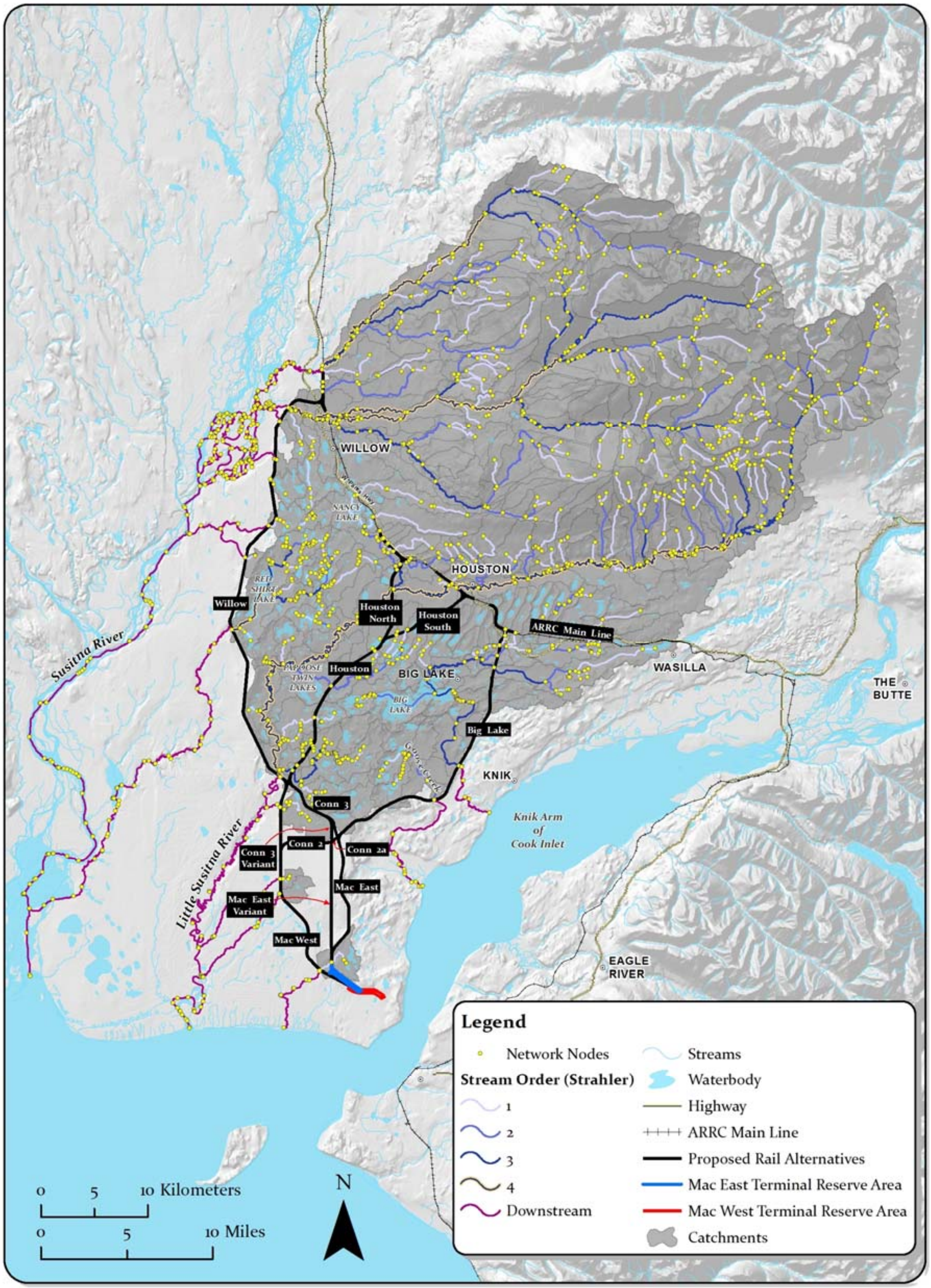

Figure 5.4-2. Overview of Surface Water Connections within the Study Area

estimate the relative potential of habitat associated with crossings, segments, and alternatives. The biological performance models were selected from publicly available literature based on their applicability to the affected environment and on their data requirements. All of the models used in the analysis were populated using geomorphic information such as accessible watershed size, stream gradient, stream order, or other surface water information (see Section 4.2). This information was used to produce estimates of accessible or suitable habitat to generate estimates of potential adult fish abundance. The estimates of potential fish abundance were generated to provide a basis for comparison between segments, segment combinations, and alternatives. The resulting index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. It was used to compare the geographic quantity and geomorphic quality of fisheries habitat associated with the project alternatives. The index does not represent forecasts or estimates of actual biological performance. As such, this information was not considered to inform designation of anadromy at stream crossings.

As described in Section 4.2, 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. This review also included a preliminary determination of the types and sizes of conveyance structures for many of the anticipated water crossings. As indicated in Section 5.4.4, channel-width data collected during OEA's 2008 field studies at fish-bearing stream crossings were found to not always match the size of the conveyance structure identified by the Applicant during the earlier preliminary design. OEA determined that it would not be reasonable to use the potential impacts that would be anticipated for these undersized structures to distinguish between alternatives because the hydrologic review and Applicant-proposed conveyance structures are preliminary, and the final conveyance structure types and sizes would be determined during final permitting and design. ARRC would base final conveyance structure designs on the reasonable terms, conditions, and design criteria that would result from the ADF&G Fish Habitat Permit that would likely ensure a conveyance structure size similar to the channel width to maintain flow conditions suitable for fish passage.

5.4.3 Affected Environment

Lakes, rivers, ponds, and perennial and intermittent streams along the proposed rail line alternatives provide habitat for fish either throughout or during portions of the year. Most streams in the study area are likely to contain resident and/or anadromous fish, and some streams could contain fish of conservation concern as identified in Alaska's Comprehensive Wildlife Conservation Strategy (Table 5.4-1). Study area waters might support spawning, foraging, rearing, refuge, and/or migratory use by fish. The proposed project would affect notable fish-bearing waters in this area, including the Little Susitna River, Fish Creek, Willow Creek, Rogers Creek, Lake Creek, Goose Creek, Lucile Creek, Little Meadow Creek, and several unnamed tributary streams (Figures 5.4-1 and 5.4-2). Fish present in the study area include resident (life cycle does not include migration into marine waters) and anadromous (life cycle includes migrations to marine waters) species. Anadromous fish commonly present in the study area include all 5 Pacific salmon: Chinook (king), chum (dog), coho (silver), pink (humpy), and sockeye (red); eulachon (hooligan); and Dolly Varden (Johnson and Daigneault, 2008). In the study area, there could be anadromous fish populations using one or more different life-history strategies, including freshwater residents, freshwater migratory, and saltwater migratory.

Table 5.4-1
Fish Potentially Present in the Port MacKenzie Rail Extension Study Area[a]

Common Name	Species	Potential Use[b]	Anadromy (Y/N)	Conservation Concern[c] (Y/N)
American Shad	*Alosa sapidissima*	–	Y	N
Arctic Char	*Salvelinus alpinus*	R,S	N	N
Arctic Grayling	*Thymallus arcticus*	R,S	N	N
Arctic Lamprey	*Lampetra camtschatica*	S	Y	N
Bering Cisco	*Coregonus laurettae*	R	Y/N	Y
Burbot	*Lota lota*	R,S	N	N
Chinook (King) Salmon	*Oncorhynchus tshawytscha*	C,R,S	Y	N
Chum (Dog) Salmon	*Oncorhynchus keta*	C,R,S	Y	N
Coastrange Sculpin	*Cottus aleuticus*	–	N	N
Coho (Silver) Salmon	*Oncorhynchus kisutch*	C,R,S	Y	N
Dolly Varden	*Salvelinus malma*	R	Y/N	N
Eulachon (Hooligan)	*Thaleichthys pacificus*	S	Y	Y
Humpback Whitefish	*Coregonus pidschian*	R,S	Y/N	N
Lake Trout	*Salvelinus namaycush*	R	N	N
Longnose Sucker	*Catostomus catostomus*	S	N	N
Ninespine Stickleback	*Pungitius pungitius*	–	N	Y
Northern Pike	*Esox lucius*	R,S	N	N
Pacific Lamprey	*Lampetra tridentate*	S	Y/N	Y
Pink (Humpy) Salmon	*Oncorhynchus gorbuscha*	C,R,S	Y	N
Pond Smelt	*Hypomesus olidus*	–	N	N
Rainbow Smelt	*Osmerus mordax*	S	Y/N	Y
Rainbow Trout	*Oncorhynchus mykiss*	R	Y/N	Y
Round Whitefish	*Prosopium cylindraceum*	R	N	N
Slimy Sculpin	*Cottus cognatus*	–	N	N
Sockeye (Red) Salmon	*Oncorhynchus nerka*	C,R,S	Y/N	N
Threespine Stickleback	*Gasterosteus aculeatus*	–	N	Y

[a] Sources: ADF&G, 2007; Johnson and Daigneault, 2008; Mecklenburg *et al.*, 2002; Morrow, 1980.
[b] Potential Use Codes: C = commercial, R = recreational, S = subsistence/personal use.
[c] Species of Conservation Concern are listed in the Alaska's Comprehensive Wildlife Conservation Strategy (ADF&G, 2006).

Study area fresh waters support recreational, commercial, and personal-use fisheries for salmon, rainbow trout, Dolly Varden, eulachon, and northern pike, with limited opportunities for lake trout and burbot. Northern pike are not native to Southcentral Alaska, although they are present naturally throughout most of the state. In Southcentral Alaska, northern pike are considered an invasive species that may negatively impact healthy populations of Chinook salmon, coho salmon, and rainbow trout in some lakes and streams (ADF&G, 2009a). There are also native fish such as sculpins, suckers, sticklebacks, and smelt in the study area that play a crucial role in the aquatic ecosystem, providing prey for terrestrial animals and freshwater and anadromous fish (ADF&G, 2006; Groot and Margolis, 1991). Table 5.4-1 lists fish potentially present in the study area. Appendix F provides supporting information on regional recreational, commercial, and personal-use fisheries in the study area.

Cook Inlet salmon – Chinook (king), chum (dog), coho (silver), pink (humpy), and sockeye (red) – are federally regulated. Thus, the habitat for these species is protected under the Essential Fish Habitat provisions of the Magnuson-Stevens Fishery Management and Conservation Act, 16 U.S.C. §§ 1801-1883. The Magnuson-Stevens Act defines Essential Fish Habit as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Figure 5.4-1 shows anadromous streams documented as supporting Essential Fish Habitat protected fisheries in the study area (Johnson and Daigneault, 2008), and Figure 5.4-2 shows all streams that are documented and have potential Essential Fish Habitat based on the GIS geomorphic analysis described in Section 4.2. Salmon runs in the study area begin in May as Chinook salmon travel upstream to spawn and continue through September when coho salmon spawn throughout area streams (Table 5.4-2). Appendices F and G provide supporting information on crossing-specific fish habitat conditions, documented fish presence, and an analysis of potential project construction and operation effects on Essential Fish Habitat and aquatic animals of conservation concern.

Table 5.4-2
Salmon Spawning Run Timing within the Port MacKenzie Rail Extension Study Area[a]

Salmon and Streams	May	June	July	August	September
Chinook Salmon					
Parks Highway Streams					
Susitna River Streams					
Little Susitna River					
Lower					
Upper					
Chum Salmon (less abundant)					
Susitna River Streams					
Coho Salmon					
Parks Highway Streams					
Susitna River Streams					
Little Susitna River					
Lower					
Upper					
Pink Salmon (abundant in even years)					
Susitna River Streams					
Sockeye Salmon					
Susitna River Streams					
Little Susitna River					

[a] Source: ADF&G, 2009b.

5.4.4 Environmental Consequences

5.4.4.1 Proposed Action

Rail line construction would require multiple stream crossings at locations that have fish or fish habitat. Project construction methods and timing, the type of stream crossing structure installed, and daily operation procedures would influence the severity and types of potential impacts to fish and fish habitat at each stream crossing. The primary impacts of crossing structures to fish and fish habitat would be loss and degradation of instream habitats due to placement of structures, alteration of stream hydrology and water quality due to increased erosion and sedimentation, and blockage of movements. Section 4.2 describes potential alterations to stream hydrology and water quality from conveyance structures.

Each stream crossing would result in site-specific impacts to aquatic and riparian habitats. Stream channel characteristics such as area of runs, glides, riffles, and pools; water velocities; channel substrates such as cobble, gravel, sand, and silt; bank morphology and composition; water quality; bank vegetation; and unblocked access interact to determine fish use and habitat suitability for eggs, larvae, and juvenile or adult fish. The type of crossing structure used at a crossing would also influence potential impacts to fish and fish habitat through habitat loss, alteration, degradation, and access.

Common Impacts

Construction Impacts

Rail line construction would result in short-term disturbance and long-term fish habitat loss and modification at stream crossings along the proposed rail line. The following paragraphs describe the types of potential construction-related impacts to fish and fish habitats that would be common to all proposed rail line stream crossings.

Loss or Alteration of Instream and Riparian Habitats

During construction, there would be a temporary loss of instream habitat where water was diverted from the existing stream channel to facilitate installation of bridge pilings, bank armoring, or culverts. Bridge abutments or instream pilings, armoring around abutments and the nearby banks, and installation of instream culverts would remove stream bed and shoreline areas that would otherwise be available for fish use. Bridge and culvert installation would cause the loss of rearing, foraging, and cover habitat along the banks; scouring of spawning areas through removal of instream large woody debris; loss of overhanging bank habitat structure and vegetation; and alteration of stream flows.

During construction, the riparian corridor would be cleared of vegetation as necessary for bridge, culvert, and access road construction. Riparian corridors along stream banks provide important instream habitat protection from stream bank erosion and sedimentation. Stream bank vegetation moderates stream temperature in summer, provides cover for fish to hide from predators, and provides a velocity refuge for juvenile fish (Marcus *et al.*, 1990). Removal of riparian vegetation and disturbance of stream banks could result in increased erosion, increased sediment loading to the stream, increased turbidity, elevated water temperatures, reduced productivity, and a reduction in overall habitat complexity (Hicks *et al.*, 1991; Waters, 1995). Sedimentation resulting from construction activities would temporarily impact juvenile fish, eggs, and larvae in nearby spawning beds and invertebrate forage production (Waters, 1995).

Mortality from Instream Construction

During construction, there could be direct mortality of fish if equipment were driven through a stream bed. Redds, eggs, and fry within or downstream of the construction site could be lost or their viability reduced through sedimentation, excessive vibration, and scour caused by construction equipment. Movement of construction equipment could cause compaction of the soils and gravels in the stream bed, resulting in the death of larval fish and eggs. In areas where there is a soft sediment bottom, equipment movement could create areas that redirect stream flow, and portions of the stream bed could become dry and isolated, resulting in mortality of fish as they become isolated from free-flowing waters. Water diversions and temporary dewatering could also impact developing eggs and pre-emergent fry (Becker *et al.*, 1982; 1983; Holland, 1987) through desiccation or freezing. Eggs, larvae, and juvenile fish would be more susceptible to mortality from instream construction because larger fish would be expected to avoid equipment and could move away from the construction area.

Blockage of Fish Movement

Depending on timing, construction-related activities could block fish movements. Construction methods that depend on water diversions during open-water construction could create temporary physical barriers to fish passage or alter stream flows sufficiently to create either high- or low-water conditions that prevent fish movements within and between lakes, tributaries, and rivers to rearing or spawning habitats. Connectivity between tributaries and mainstem habitats is particularly important for maintaining productivity of juvenile salmonids (Bramblett *et al.*, 2002). Instream construction could temporarily reduce stream flows sufficiently to block upstream migration of adult salmon or displace juvenile or small fish from rearing and foraging habitats due to high flows. Blocked spawning fish might attempt to use inadequate spawning areas, which could result in uncertain survival of eggs, larvae, and juvenile fish, and could contribute to reduced productivity.

Degradation of Water Quality

Clearing of vegetation, grading, construction of the access road, and placement of bridges and culverts would expose soil to erosion from wind, rain, stream flow, and runoff. Erosion delivers sediment to streams, which can degrade water quality and reduce fish habitat quality and productivity through sedimentation and turbidity (Waters, 1995). While increased erosion and sedimentation might be temporary during construction, increased fine sediments reduce oxygen exchange, which results in lower survival of eggs and larvae in spawning gravels (Grieg *et al.*, 2005). High turbidity could result in avoidance behavior, reduced foraging success in sight-feeding fish (Barrett *et al.*, 1992), induced physiological stress, and increased mortality (Waters, 1995).

Fuel leaks from construction equipment could reduce water quality and result in toxic affects to fish and aquatic invertebrate forage. Spills and leaks could enter the water either directly as equipment crosses streams or indirectly with runoff from bridges and adjacent road beds or rail beds.

Alteration of Stream Hydrology

Construction activities could cause changes in flow patterns through the hyporheic zone, the region beneath a stream bed where there is mixing of shallow groundwater and surface water. Excavation and vegetation clearing would dislodge fine sediments that could infiltrate the hyporheic zone and clog interstitial spaces, and vibrations from construction equipment can cause substrates to settle and become compacted (Sear, 1995; Huggenberger *et al.*, 1998). Hyporheic flow and groundwater upwelling (springs) are important in salmonid egg development (Brown and Mackay, 1995; Baxter and McPhail, 1999). There could be permanent changes in subsurface flow from bank and substrate armoring, instream support structures, and changes in channel morphology caused by bridges and culverts interrupting lateral stream migration.

Ice dams also could form in areas where bridges and culverts constrict stream channels. Ice dams could cause scour of the stream bed and erosion along the upstream side of affected streams. The movement of the ice and rush of water when the dam fails could damage spawning beds.

Noise and Vibration Impacts

Depending on the timing of construction, there could be potential impacts to salmonids from underwater pile driving noise and vibration during bridge construction. Exposure to pile driving vibration and noise could displace juvenile fish, trigger avoidance behavior, and disrupt the sense of hearing in fish and the function of the lateral line, the sensory organ that detects vibration (Hastings *et al.*, 1996; McCauley *et al.*, 2003). Whereas it is possible that fish could swim away from a sound source, thereby decreasing exposure to sound, eggs are often stationary or move very slowly and could be exposed to extensive human-generated sound if it is presented in the surrounding water column or substrate. However, data are limited or inconclusive concerning the effects of sound, including pile driving noise, on developing eggs (Hastings and Popper, 2005; California Department of Transportation, 2009). The few studies on the effects on fish eggs, larvae, and fry are insufficient to reach any conclusions with respect to the way sound would affect survival (Hastings and Popper, 2005).

Operation Impacts

Many potential impacts to stream crossings initiated during construction would continue to contribute to impacts to fisheries resources during rail line operation. Operation-related impacts would be common for all stream crossings along the proposed rail line.

Loss or Alteration of Instream and Riparian Habitats

Bridges that have abutments or pilings in the stream bed cause permanent losses of fish spawning and rearing habitats, as discussed above. Instream bridge supports could lead to upstream scour and downstream scour or bed-load deposition, which extends the area of instream habitat the structure affects. Bridges and open-bottom culverts also create shade that results in degradation and loss of overhanging riparian vegetation that juvenile fish use for cover and forage. Bridges typically require placement of riprap, which permanently displaces vegetation that filters runoff, resulting in a permanent loss of juvenile rearing habitat along the hardened bank beneath bridges (Schmetterling *et al.*, 2001; Fischenich, 2003).

Closed-bottom culverts (circular or oblong culverts constructed of corrugated steel or concrete) placed directly in the stream bed would cause permanent loss of any existing spawning and rearing habitats, alter stream flow and stream bottoms on either end of the culverts, and change adjacent riparian habitat. When culverts are installed, fill is usually placed around the culvert, and stream banks upstream and downstream of the culvert are reinforced with riprap. During high-water events, water would bypass improperly sized culverts and create scour pools, causing additional stream bank erosion. As erosion continues over time, there could be additional loss of habitat as more riprap is added.

Bridge abutments and culverts could impede the transport of large woody debris, which provides rest areas, shade, and cover for fish and substrate for aquatic vegetation and invertebrates (House and Boehne, 1986; Marcus *et al.*, 1990). When large woody debris is cleared from conveyance structures, removal of the debris from the stream system would result in loss of this habitat structure and an interruption in the downstream transport of large woody debris unless the debris is placed in the stream on the downstream side of the conveyance structure.

Culverts placed in the soft substrate across wetlands could sink over time, creating ponds on the upslope side of the rail bed and drying on the down slope side of the rail bed. If a culvert blocks water flow, nutrients would no longer be cycled through wetlands to receiving waters, which would affect nutrient input to aquatic plants and animals that provide forage for fish. If surface water exchange between wetlands and streams was interrupted, stream flows could be reduced and riparian vegetation along the stream corridor could begin to decline, which would result in erosion, bank sloughing, and increased sedimentation during high-water conditions.

Blockage of Fish Movement

Improperly imbedded and maintained culverts and the surrounding fill could change the ability of the culvert to convey water. Flooding levels exceeding the culvert design could result in the culvert becoming more deeply embedded in the stream bed, and over time the culvert opening could become inefficient at passing fish to upstream habitats. Habitat loss would increase as culverts failed and fish movements were blocked, preventing fish populations from accessing upstream and downstream habitats.

Bridges and culverts could also create constrictions, restricting the downstream movement of large woody debris important for productive salmonid habitats (House and Boehne, 1986), or cause the formation of ice, causing ice jams and flooding. Water in undersized culverts often freezes solid and is slow to melt due to the insulation of road or rail embankments, blocking spring movements of fish to foraging and spawning habitats.

Degradation of Water Quality

Maintenance activities such as clearing drainage ditches could cause an increase in turbidity and sedimentation over background levels in streams. ARRC does not propose to transport hazardous materials along the proposed rail line; however, spills of nontoxic bulk materials could have physical impacts if spills occurred at or near stream crossings. See Chapter 11 for a discussion of rail safety and the movement of materials.

Impacts by Segment and Segment Combination

All segments and segment combinations would cross streams or waterbodies that provide habitat for fish, and this habitat could be affected by rail line construction and operation. The paragraphs below describe notable site-specific impacts to fish and fish habitats by rail line segments and segment combinations. Appendix F describes site-specific conditions at each fish or fish habitat-bearing stream crossing.

Southern Segments and Segment Combinations

The southern segments/segment combinations would cross streams at up to 3 locations each (6 total) that support fish or fish habitat, with 1 stream crossing cataloged as supporting anadromous fish (C1-2.6) (Table 5.4-3, Figure 5.4-3). Table 5.4-3 presents fisheries data for the southern segments based on stream crossing investigations in 2008 (Noel *et al.*, 2008) and available ADF&G data (ADF&G, 2009c; Johnson and Daigneault, 2008). The crossing locations for the Mac East Segment and Mac East Variant Segment are identical, so crossing information for the Mac East Segment was used for both segment crossings. ARRC has proposed to use bridges for 3 crossings and closed-bottom culverts (circular or oblong culverts constructed of corrugated steel or concrete), which would be buried to approximately 40 percent of their diameter where possible, for 3 crossings. Some of the proposed culverts along the southern segments and segment combinations were preliminarily selected and sized by the Applicant based on the lateral flow of the stream and, at some locations, are narrower than the observed wetted width of the crossing. Flooding previously washed out a culvert at a road crossing near the MW-4.6 crossing (Record 95, Noel *et al.*, 2008). Of the southern segments and segment combinations, the Mac West-Connector 1 Segment Combination would cross the most fish-bearing streams, while the Mac East-Connector 3 Segment Combination, the Mac East Segment, the Mac East Variant-Connector 2a Segment Combination, and the Mac East Variant-Connector 3 Variant Segment Combination would cross the fewest fish-bearing streams (Table 5.4-4). Field reconnaissance revealed a lack of habitats capable of supporting spawning or overwintering for resident game fish or anadromous fish at the southern segment and segment combination crossing locations (Noel *et al.*, 2008). Stream-crossing sites along the southern segments and segment combinations primarily support summer rearing and migration of fish (Table 5.4-3).

Table 5.4-5 shows the southern segment and segment combination results of the potential adult fish abundance model and selected geomorphic data inputs, such as accessible watershed size, slope, stream length, and other surface water information. Fish-bearing waters and upstream habitat along the Mac West-Connector 1 Segment Combination have the highest estimated index of fish habitat potential among all southern segments and segment combinations. Fish-bearing waters and upstream habitat along those segments and segment combinations containing the Mac East and Mac East Variant segments have the lowest estimated index of fish habitat potential among all southern segments and segment combinations. Fish-bearing waters and upstream habitat along all southern segments and segment combinations have the highest estimated fish abundance for sockeye salmon and the lowest fish abundance for Dolly Varden. As previously

Table 5.4-3
Fish-Bearing Streams Crossed by the Southern Segments[a]

Segment/ Crossing Location	Crossing Identification	Stream Name	ADF&G Anadromous Catalog Number[b]	Waterbody	Fish	Wetted Width[d] (feet)	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[c]	Habitat[b] SP	R	M	OW	Potential Blockage[e]
Mac West													
MW-11.0	MW-084R	Inlet to Horseshoe Lake	0.8 mile upstream from COr	Stream	Resident	11	Culvert	36	--	Y	Y	--	No
MW-10.1	MW-085	Inlet to Horseshoe Lake	Edge of COr in Horseshoe Lake	Spring	Resident	9	Culvert	48	--	Y	--	--	No
MW-4.6	MW-095	Unnamed	1.3 miles upstream from COp	Stream	Resident	35	Culvert	48	--	Y	Y	--	No
Mac East													
ME-4.5	ME-078	Unnamed	2.3 miles upstream from COp	Stream	Resident	6	Bridge	28	--	Y	P	--	Yes - DS
Mac East Variant													
MEV-4.5	ME-078	Unnamed	2.3 miles upstream from COp	Stream	Resident	6	Bridge	28	--	Y	P	--	Yes - DS
Connector 1													
C1-2.6	C1-026	Little Susitna Tributary	247-41-10100-2080: COpr	Stream	Anadromous	27	Bridge	56	--	Y	Y	--	No

[a] Sources: ADF&G, 2009c; Johnson and Daigneault, 2008; Noel *et al.*, 2008.

[b] Anadromous catalog codes: K = Chinook salmon, CH = chum salmon, CO = coho salmon, P = pink salmon, S = sockeye salmon, p = present, r = rearing, s = spawning. Habitat abbreviations: Rearing (R), Migration (M), and Overwintering (OW) habitats for either or both anadromous and resident fish species; Spawning (SP) habitat evaluated for resident trout, Arctic grayling, Dolly Varden, and anadromous salmon (*i.e.*, gravels and upwelling suitable for spawning are present at crossing site).

[c] Culverts are closed cylindrical structures; size is diameter (HDR Alaska, Inc. and TNH-Hanson, LLC, 2008; Pochop, 2008).

[d] For some crossings, wetted width includes channel width and the width of any surrounding wetlands. However, the proposed conveyance structure is sized to convey actual lateral flow.

[e] Y = verified, -- = not present, P = probable. Potential Blockage abbreviations: BD = beaver dam, US = artificial – upstream, DS = artificial – downstream.

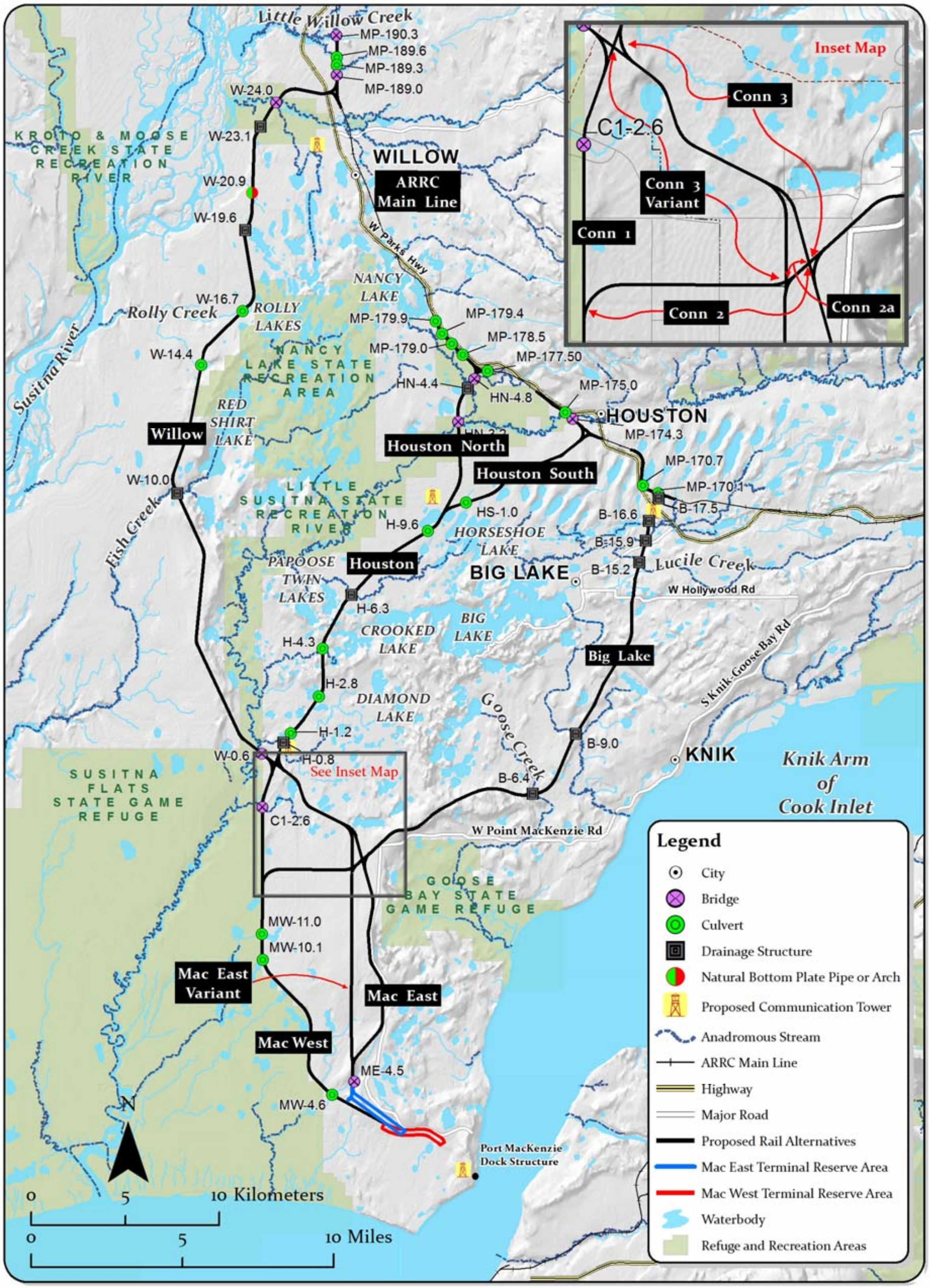

Figure 5.4-3. Fish-Bearing Streams Crossed by the Port MacKenzie Rail Extension Alternatives (Johnson and Daigneault, 2008; ADF&G, 2009c; Noel *et al.*, 2008)

Table 5.4-4
Summary of Fish-Bearing Streams Crossed by the Southern Segments and Segment Combinations

	Mac West-Conn 1	Mac West-Conn 2	Mac East-Conn 3	Mac East	Mac East Variant-Conn 2a	Mac East Variant-Conn 3 Variant
Total Fish-Bearing Stream Crossings	**4**	**3**	**1**	**1**	**1**	**1**
Fish Communities[a]						
Anadromous	1	0	0	0	0	0
Resident	3	3	1	1	1	1
Habitat[a]						
Spawning	0	0	0	0	0	0
Rearing	4	3	1	1	1	1
Migration	3	2	1	1	1	1
Overwintering	0	0	0	0	0	0
Potential Blockages[a]						
None	4	3	0	0	0	0
Natural – Beaver Dams	0	0	0	0	0	0
Artificial – Upstream	0	0	0	0	0	0
Artificial – Downstream	0	0	1	1	1	1
Artificial – Upstream and Downstream	0	0	0	0	0	0
Conveyance Structure						
Bridge	1	0	1	1	1	1
Culvert	3	3	0	0	0	0
Drainage Structure	0	0	0	0	0	0
Relocation	0	0	0	0	0	0

[a] Sources: ADF&G, 2009c; Johnson and Daigneault, 2008; Noel *et al.*, 2008.

Table 5.4-5
Summary Comparison of Estimated Fish Habitat Potential for Fish-Bearing Streams Crossed by the Southern Segments and Segment Combinations

	Mac West-Conn 1	Mac West-Conn 2	Mac East-Conn 3	Mac East	Mac East Variant-Conn 2a	Mac East Variant-Conn 3 Variant
Watershed Geomorphic Characteristics						
Upstream Watershed Area (acres)	8,800	4,595	2,048	2,048	2,048	2,048
Mean Elevation (feet)	134	132	153	153	153	153
Average Slope (percent)	1.1	1.1	2.1	2.1	2.1	2.1
Mean Rugosity[b]	1.0	1.0	1.0	1.0	1.0	1.0
Mean Annual Precipitation (inches)	20	20	20	20	20	20
Lake Area (acres)	185	116	59	59	59	59
Accessible Stream Length (miles) [c]	6.6	3.3	1.7	1.7	1.7	1.7
Index of Fish Habitat Potential[a,d]	**7,100**	**3,700**	**2,300**	**2,300**	**2,300**	**2,300**
Fish Species						
Chinook	1,351	825	317	317	317	317
Sockeye	3,718	1,991	1,488	1,488	1,488	1,488
Coho	1,274	622	291	291	291	291
Dolly Varden	165	35	4	4	4	4
Lake Trout	472	267	165	165	165	165

[a] The index of fish habitat potential is determined using previously published analyses that were based on the number of fish per unit area produced in monitored locations where both the amount of habitat and the number of fish produced by that habitat are known. As applied in this EIS, the index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. The index does not represent forecasts or estimates of actual future or past biological performance.

[b] Rugosity is an index of topographic variability of a surface, and is an indicator of the "roughness" or "bumpiness" of the landscape within a watershed.

[c] The length of a stream that is accessible by anadromous fish because (1) it has a connection to the ocean and (2) it has a natural gradient that is not a barrier to fish migration.

[d] Totals may not equal sum of numbers due to rounding.

stated, the resulting index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. The index does not represent forecasts or estimates of actual biological performance. As such, this information was not considered to inform designation of anadromy at stream crossings.

Northern Segments and Segment Combinations

The northern segments and segment combinations would cross fish-bearing streams at up to 12 locations each (38 total), including 14 crossings of streams with resident fish or fish habitat and 24 crossings of streams that support anadromous fish (Table 5.4-6, Figure 5.4-3). Table 5.4-6 presents fisheries data for the northern segments based on stream crossing investigations in 2008 (Noel *et al.*, 2008) and available ADF&G data (ADF&G, 2009c; Johnson and Daigneault, 2008). The Willow Segment would cross the Little Susitna River and Susitna River drainages, including 6 streams with resident fish or fish habitat and 6 streams that support anadromous fish (Table 5.4-6). The Houston-Houston North Segment Combination would cross the Little Susitna River and Little Susitna drainages, including 6 crossings of streams with resident fish habitat or providing connectivity to fish habitat and 8 crossings of streams that support anadromous fish (Table 5.4-6).

The Houston-Houston South Segment Combination would also cross the Little Susitna River and Little Susitna drainages, including 4 streams with resident fish habitat or providing connectivity to fish habitat and 5 streams that support anadromous fish (Table 5.4-6). The Big Lake Segment would cross the Big Lake and Goose Creek drainages, including 1 crossing of a stream with resident fish habitat or providing connectivity to fish habitat and 8 crossings of streams that support anadromous fish (Table 5.4-6). Collectively, the proposed northern segment crossings include 7 bridges, 12 drainage structures, 17 culverts, 1 natural bottom plate pipe or arch structure, and 1 stream bed relocation (Table 5.4-6). Of the 17 potential northern segment culverts, 35 percent would be smaller than the wetted width of the stream crossing (Table 5.4-6). Some of these culverts are existing culverts that would be extended, while some are proposed new culverts. Some of the proposed new culverts along the northern segments and segment combinations were preliminarily selected and sized by the Applicant based on the lateral flow of the stream and, at some locations, are narrower than the observed wetted width of the crossing. The Houston-Houston North Segment Combination would cross the most fish-bearing streams, while the Houston-Houston South Segment Combination and Big Lake Segment would cross the fewest fish-bearing streams (Table 5.4-7). Field reconnaissance revealed that 14 of the crossing locations along the northern segments would cross habitats capable of supporting spawning and 21 crossing locations could support overwintering for resident game fish or anadromous fish (Noel *et al.*, 2008) (Table 5.4-6). Most (67 percent) of the streams the Willow Segment would cross have no potential blockages, such as culverts at existing road or rail line crossings of the stream, while all of the streams the Big Lake Segment would cross have potential blockages due to ineffective culverts (Table 5.4-7).

For the northern segments and segment combinations, Table 5.4-8 shows the results of the potential adult fish abundance model that were generated using geomorphic information such as accessible watershed size, stream gradient, stream order, or other surface water information. Fish-bearing waters and upstream habitat along the Willow Segment have the highest estimated

Table 5.4-6
Fish-Bearing Streams Crossed by the Northern Segments[a] (page 1 of 3)

Segment/ Crossing Location	Crossing Identifica-tion	Stream Name	ADF&G Anadromous Catalog Number[b]	Water-body	Fish	Wetted Width[f] (feet)	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[c]	Habitat[b] SP	R	M	OW	Potential Blockage[g]
Willow													
MP-190.3	W-098	Little Willow Creek Tributary[d]	0.2 mile upstream from COr	Stream	Anadromous	12	Bridge	NA	Y	Y	Y	--	No
MP-189.6	W-099	Unnamed		Stream	Resident	1 to 4	Culvert Extension	36 inches	--	Y	Y	Y	Yes - US
MP-189.3	W-100	Unnamed		Stream	Resident	1 to 2	Culvert Extension	36 inches	--	Y	Y	--	Yes - US
MP-189.0	W-101R	Rogers Creek	247-41-10200-2130-3020: COr	Stream	Anadromous	47	Bridge	NA	Y	Y	Y	Y	No
W-24.0	W-106	Willow Creek	247-41-10200-2120: CHs, COsr, Ksr, Ps	Stream	Anadromous	98	Bridge	NA	Y	Y	Y	Y	No
W-23.1	W-107	Willow Creek Tributary	0.3 mi upstream COr	Stream	Resident	2	Drainage Structure	NA	--	Y	Y	Y	Yes - DS
W-20.9	W-110	Susitna River Tributary[e]	Nominated	Stream	Anadromous	7	Natural Bottom Plate Pipe or Arch Structure	8-10 feet	Y	Y	Y	Y	Yes - US
W-19.6	W-112	Unnamed		Stream	Resident	1 to 2	Drainage Structure	NA	--	Y	Y	--	No
W-16.7	W-113	Rolly Creek Tributary	1.6 miles upstream COp	Stream	Resident	32	Culvert	72 inches	--	Y	Y	Y	No - BD
W-14.4	W-116	Rolly Creek Tributary	3.2 miles upstream COp	Stream	Resident	2	Culvert	36 inches	--	Y	Y	Y	No - BD
W-10.0	W-118R	Fish Creek	247-41-10200-2020: COr, Sp	Stream	Anadromous	15	Drainage Structure	NA	Y	Y	Y	Y	No - BD
W-0.6	W-121R	Little Susitna River	247-41-10100: CHs, COs, Ks, Ps, Sp	Stream	Anadromous	105	Bridge	NA	Y	Y	Y	Y	No

Table 5.4-6
Fish-Bearing Streams Crossed by the Northern Segments[a] (page 2 of 3)

Segment/ Crossing Location	Crossing Identifica-tion	Stream Name	ADF&G Anadromous Catalog Number[b]	Water-body	Fish	Wetted Width[f] (feet)	Conveyance Type[c]	Diameter (inches) or Bridge Length (feet)[c]	Habitat[a] SP	R	M	OW	Potential Blockage[g]
Houston North Segment													
MP-179.9	HN-056	Unnamed		Stream	Resident	3	Culvert Extension	48 inches	--	Y	Y	--	Yes - US
MP-179.4	HN-061R	Unnamed		Stream	Resident	3	Culvert Extension	60 inches	Y	Y	Y	--	Yes - US
MP-179.0	HN-063R	Unnamed		Stream	Resident	1.7	Culvert Extension	36 inches	Y	Y	Y		Yes - US
MP-178.5	HN-065R	Lake Creek Tributary	247-41-10100-2231-3026: COr	Stream	Anadromous	6.3	Culvert Extension	48 inches	Y	Y	Y	--	Yes - US
MP-177.5	None	Lake Creek Tributary	247-41-10100-2231-3018-4011: COr	Stream	Anadromous	< 2	Culvert Extension	48 inches	--	Y	--	--	Yes - US & DS
HN-4.8	HNM-122R	Lake Creek Tributary	247-41-10100-2231-3018: COr	Stream	Anadromous	9	Bridge	28 Feet	--	Y	--	--	Yes - US
HN-4.4	HNM-123	Lake Creek	247-41-10100-2231: COr, Sp	Stream	Anadromous	20	Drainage Structure	NA	--	Y	Y	Y	Yes - US & DS
HN-3.2	HN-067R	Little Susitna River	247-41-10100: CHs, COs, Kp, Ps, Sp	Stream	Anadromous	98	Bridge	NA	Y	Y	Y	Y	No
Houston South Segment													
MP-175.0	HS-070R	Little Susitna Tributary	247-41-10100-2255: COr	Stream	Anadromous	14	Culvert Extension	48 inches	--	Y	Y	Y	Yes - US
MP-174.3	HS-071R	Little Susitna River	247-41-10100: CHp, COs, Ks, Ps	Stream	Anadromous	47	Bridge	~80 feet	Y	Y	Y	Y	No
HS-1.0	HS-075R	Little Susitna Tributary	0.4 mi upstream from lake with COr	Stream	Resident	18	Culvert	36 inches	--	Y	Y	--	Yes - US
Houston Segment													
H-9.6	H-040R	Inlet to Colt Lake		Stream	Resident	4	Culvert	48 inches	--	Y	Y	Y	No
H-6.3	H-044	Little Susitna Tributary	247-41-10100-2150: COr	Stream	Anadromous	16	Drainage Structure	NA	--	Y	Y	Y	Yes - US
H-4.3	H-046	Little Susitna Tributary	247-41-10100-2100: COr, Kr	Stream	Anadromous	5	Culvert	72 inches	--	Y	Y	Y	Yes - US & DS
H-2.8	H-047	Unnamed		Wetland	Resident	1 to 2	Culvert	48 inches	--	--	Y	--	No
H-1.2	H-049	Unnamed		Wetland	Resident	1 to 3	Culvert	24 inches	--	Y	Y	--	No
H-0.8	H-050R	Little Susitna Tributary	247-41-10100-2090: Ps, COsr	Stream	Anadromous	14	Drainage Structure	NA	Y	Y	Y	Y	No

Table 5.4-6
Fish-Bearing Streams Crossed by the Northern Segments[a] (page 3 of 3)

Segment/ Crossing Location	Crossing Identifica-tion	Stream Name	ADF&G Anadromous Catalog Number[b]	Water-body	Fish	Wetted Width[f] (feet)	Convey-ance Type[c]	Diameter (inches) or Bridge Length (feet)	Habitat[b] SP	R	M	OW	Potential Blockage[g]
Big Lake Segment													
MP-170.7	BL-001R	Outlet Loon Lake		Stream	Resident	2.5	Culvert Extension	48 inches	--	Y	Y	--	Yes - US & DS
MP-170.1	BL-003	Outlet Cheri Lake	247-50-10330-2050-3025: COr	Stream	Anadromous	1.5	Culvert Extension	60 inches	--	Y	Y	--	Yes - US & DS
B-17.5	None	Inlet to Long Lake relocated channel	247-50-10330-2050-3025: COr	Stream	Anadromous	<1	Drainage Structure	NA	--	Y	Y	--	Yes – US & DS
B-17.1 to B-17.6	None	Inlet to Long Lake	247-50-10330-2050-3025: COr	Stream	Anadromous	<1	Stream Relocation	2,440 feet of relocation	--	Y	Y	--	Yes - US & DS
B-16.6	BL-007R	Inlet to Long Lake	247-50-10330-2050-3025: COr	Stream	Anadromous	7	Drainage Structure	NA	--	Y	Y	--	Yes - US & DS
B-15.9	BL-008	Little Meadow Creek	247-50-10330-2050-3050: CHp, COrs, Pp, Ss	Stream	Anadromous	28	Drainage Structure	NA	Y	Y	Y	Y	Yes - US & DS
B-15.2	BL-010R	Lucile Creek	247-50-10330-2050-3030: Sp, COr	Stream	Anadromous	12	Drainage Structure	NA	--	Y	Y	Y	Yes - US & DS
B-9.0	BL-019R	Fish Creek	247-50-10330: CHp, COrs, Kp, Ps, Sp	Stream	Anadromous	30	Drainage Structure	NA	Y	Y	Y	Y	Yes - US & DS
B-6.4	BL-022R	Goose Creek	247-50-10360: COsr, Kr	Stream	Anadromous	6	Drainage Structure	NA	--	Y	Y	Y	Yes - DS

[a] Sources: Johnson and Daigneault, 2008; Noel *et al*., 2008.
[b] Anadromous catalog codes: K = Chinook salmon, CH = chum salmon, CO = coho salmon, P = pink salmon, S = sockeye salmon, p = present, r = rearing, s = spawning. Kr = Chinook rearing observed but not noted in ADF&G Anadromous Catalog. Habitat abbreviations: Rearing (R), Migration (M), and Overwintering (OW) habitats for either or both anadromous and resident fish species; Spawning (SP) habitat evaluated for resident trout, Arctic grayling, Dolly Varden, and anadromous salmon (i.e., gravels and upwelling suitable for spawning are present at crossing site).
[c] Culverts are closed cylindrical structures; size is diameter. Culvert Extension is an extension of an existing culvert. Drainage structures could include open bottom box culverts, multi-plate culverts, pre-cast arches, or single or multiple short-span bridges; type and size will be determined during final design and permitting. Bridges are single or multiple 28-foot short-span bridges. (HDR Alaska, Inc. and TNH-Hanson, LLC, 2008; Pochop, 2008). NA = Not Available.
[d] Spawning substrates, adult coho salmon and juvenile salmonids observed (Noel *et al*., 2008).
[e] Nominated for the Anadromous Stream Catalog based on data from survey (Noel *et al*., 2008).
[f] For some crossings, wetted width includes channel width and the width of any surrounding wetlands. However, the proposed conveyance structure is sized to convey actual lateral flow.
[g] Y = verified, -- = not present, P = probable. Potential Blockage abbreviations: BD = beaver dam, US = artificial – upstream, DS = artificial – down stream.

Table 5.4-7
Summary of Fish-Bearing Streams Crossed by the Northern Segments and Segment Combinations

	Willow	Houston-Houston North	Houston-Houston South	Big Lake
Total Fish-Bearing Stream Crossings	**12**	**14**	**9**	**9**
Fish Communities[a]				
Anadromous	6	8	5	8
Resident	6	6	4	1
Habitat[a]				
Spawning	6	5	2	2
Rearing	12	13	8	9
Migration	12	12	9	9
Overwintering	9	6	6	4
Potential Blockages[a]				
None	5	5	5	0
Natural – Beaver Dams	3	0	0	0
Artificial – Upstream	3	6	3	0
Artificial – Downstream	1	0	0	1
Artificial – Upstream and Downstream	0	3	1	8
Conveyance Structure				
Bridge	4	2	1	0
Culvert	4	9	6	2
Drainage Structure	3	3	2	6
Natural Bottom Plate Pipe/Arch Structure	1	0	0	0
Relocation	0	0	0	1

[a] Sources: ADF&G, 2009c; Johnson and Daigneault, 2008; Noel *et al.*, 2008.

Table 5.4-8
Summary Comparison of Estimated Fish Habitat Potential for Fish-Bearing Streams Crossed by the Northern Segments and Segment Combinations

	Willow	Houston-Houston North	Houston-Houston South	Big Lake
Watershed Geomorphic Characteristics				
Upstream Watershed Area (acres)	476,142	162,711	137,220	78,347
Mean Elevation (feet)	1,300	1,212	1,418	220
Average Slope (percent)	6.5	7.7	9.1	1.9
Mean Rugosity[b]	1.0	1.0	1.0	1.0
Mean Annual Precipitation (inches)	26	26	28	20
Lake Area (acres)	7,041	2,402	1,543	4,964
Accessible Stream Length (miles)[c]	774.7	289.4	244	74.8
Index of Fish Habitat Potential[a,d]	**264,500**	**90,200**	**68,400**	**77,100**
Fish Species				
Chinook	28,842	11,363	8,332	6,576
Sockeye	79.526	28,622	20,356	51,007
Coho	105,605	34,367	27,093	13,097
Dolly Varden	38,867	11,755	9,632	1,797
Lake Trout	11,678	4,069	3,010	4,618

[a] The index of fish habitat potential is determined using previously published analyses that were based on the number of fish per unit area produced in monitored locations where both the amount of habitat and the number of fish produced by that habitat are known. As applied in this EIS, the index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. The index does not represent forecasts or estimates of actual future or past biological performance.

[b] Rugosity is an index of topographic variability of a surface, and is an indicator of the "roughness" or "bumpiness" of the landscape within a watershed.

[c] The length of a stream that is accessible by anadromous fish because (1) it has a connection to the ocean and (2) it has a natural gradient that is not a barrier to fish migration.

[d] Totals may not equal sum of numbers due to rounding.

index of fish habitat potential among all northern segments and segment combinations. Fish-bearing waters and upstream habitat along the Houston-Houston South Segment Combination have the lowest estimated index of fish habitat potential among all northern segments and segment combinations. Fish-bearing waters and upstream habitat along all northern segments have the highest estimated fish abundance for coho salmon and the lowest estimated fish abundance for lake trout. As previously stated, the resulting index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. The index does not represent forecasts or estimates of actual biological performance. As such, this information was not considered to inform designation of anadromy at stream crossings.

Summary of Potential Impacts by Rail Line Alternative

The primary potential impacts to fisheries from construction and operation of the proposed rail line alternatives would be loss and degradation of instream and riparian habitats due to placement of bridges, drainage structures, and culverts; alteration of stream and wetland hydrology; blockage of fish movements; and increased erosion and sedimentation from the removal of riparian vegetation. Section 4.2, Surface Water, and Section 4.5, Wetlands, describe alterations of stream and wetland hydrology caused by fill and conveyance structures. All crossings of fish-bearing streams would result in some loss or alteration of stream and riparian habitats. Bridged crossings would likely result in a smaller area of instream habitat loss than closed-bottomed culverts (circular or oblong culverts constructed of corrugated steel or concrete). In general, clear-span bridges (those without instream supports) would have less potential to create conditions that could cause loss of spawning habitats.

The proposed project alternatives would require a minimum of 10 and a maximum of 18 crossings of streams that have been documented to contain either fish or fish habitat (Table 5.4-9; Noel *et al.*, 2008). The alternatives requiring the minimum number of fish-bearing stream crossings (10) are the Mac East-Big Lake, Mac East-Connector 3-Houston-Houston South, Mac East Variant-Connector 2a-Big Lake, and Mac East Variant-Connector 3 Variant-Houston-Houston South alternatives. The alternative requiring the maximum number of crossings (18) is the Mac West-Connector 1-Houston-Houston North Alternative. Table 5.4-9 summarizes fish communities, fish habitat use, proposed conveyance structures, and potential existing stream blockages for the 44 fish-bearing stream crossings by alternative. Appendix F describes site-specific conditions at each fish-bearing stream crossing.

Table 5.4-9 presents fisheries data for the 12 alternatives based on stream crossing investigations in 2008 (Noel *et al.*, 2008) and available ADF&G data (ADF&G, 2009c; Johnson and Daigneault, 2008). Table 5.4-10 shows the results of the potential adult fish abundance model that were generated using geomorphic information such as accessible watershed size, stream gradient, stream order, or other surface water information. The proposed alternatives would require between 10 and 18 crossings of streams containing fish or fish habitat and between 5 and 9 crossings of anadromous fish habitats. Field reconnaissance revealed that most streams the alternatives would cross provide for seasonal movements of fish and provide rearing habitats. There are spawning and overwintering habitats at 14 and 21 of the 43 stream crossings, respectively (Table 5.4-6). Depending on alternative, between 2 and 6 streams at proposed crossings provide spawning habitat for resident game fish or anadromous fish and between 4 and 9 streams at crossings provide overwintering habitat (Noel *et al.*, 2008). The proposed alternatives would include from 0 to 5 bridges, 2 to 6 drainage structures, and 2 to 12 closed-bottom culverts. Proposed alternatives include crossings of between 4 and 10 streams with potential blockage from previous crossings that could include ineffective culverts (Table 5.4-9).

Based on the information in Table 5.4-9, all alternatives would cross waters containing important habitat for sustaining recreational and commercial salmon fisheries. The greatest number of salmon-bearing streams crossed by alternatives include the Houston-Houston North and Big Lake segments, and the smallest number crossed by alternatives include the Houston-Houston South Segment Combination. Of the 3 potential crossing locations on the Little Susitna River, the Houston-Houston South Segment Combination crossing (MP-174.3) could require instream

Table 5.4-9
Summary of Fish-Bearing Streams Crossed by Alternatives

	Mac West-Conn 1-Willow	Mac West-Conn 1-Houston-Houston North	Mac West-Conn 1-Houston-Houston South	Mac West-Conn 2-Big Lake	Mac East-Conn 3-Willow	Mac East-Conn 3-Houston-Houston North	Mac East-Conn 3-Houston-Houston South	Mac East-Big Lake	Mac East Var-Conn 2a-Big Lake	Mac East Var-Conn 3 Var-Willow	Mac East Var-Conn 3 Var-Houston-Houston North	Mac East Var-Conn 3 Var-Houston-Houston South
Total Crossings	**16**	**18**	**13**	**12**	**13**	**15**	**10**	**10**	**10**	**13**	**15**	**10**
Fish Communities[a]												
Anadromous	7	9	6	8	6	8	5	8	8	6	8	5
Resident	9	9	7	4	7	7	5	2	2	7	7	5
Habitat[a]												
Spawning	6	5	2	2	6	5	2	2	2	6	5	2
Rearing	16	17	12	12	13	14	9	10	10	13	14	9
Migration	15	15	12	11	13	13	10	10	10	13	13	10
Overwintering	9	6	6	4	9	6	6	4	4	9	6	6
Potential Blockages[a]												
None	9	9	9	3	5	5	5	0	0	5	5	5
Natural – Beaver Dams	3	0	0	0	3	0	0	0	0	3	0	0
Artificial – Up stream	3	6	3	0	3	6	3	0	0	3	6	3
Artificial – Downstream	1	0	0	1	2	1	1	2	2	2	1	1
Artificial - Upstream and Downstream	0	3	1	8	0	3	1	8	8	0	3	1
Conveyance Structure												
Bridge	5	3	2	0	5	3	2	1	1	5	3	2
Culvert	7	12	9	5	4	9	6	2	2	4	9	6
Drainage Structure	3	3	2	6	3	3	2	6	6	3	3	2
Natural Bottom Plate Pipe/Arch Structure	1	0	0		1	0	0	0	0	1	0	0
Relocation	0	0	0	1	0	0	0	1	1	0	0	0

[a] Source: ADF&G, 2009c; Johnson and Daigneault, 2008; Noel *et al.*, 2008.

Table 5.4-10
Summary Comparison of Estimated Fish Habitat Potential for Fish-Bearing Streams Crossed by Alternatives

	Mac West-Conn 1-Willow	Mac West-Conn 1-Houston-Houston North	Mac West-Conn 1-Houston-Houston South	Mac West-Conn 2-Big Lake	Mac East-Conn 3-Willow	Mac East-Conn 3-Houston-Houston North	Mac East-Conn 3-Houston-Houston South	Mac East-Big Lake	Mac East Var-Conn 2a-Big Lake	Mac East Var-Conn 3 Var-Willow	Mac East Var-Conn 3 Var-Houston-Houston North	Mac East Var-Conn 3 Var-Houston-Houston South
Watershed Geomorphic Characteristics												
Upstream Watershed Area (acres)	484,941	171,510	146,020	82,942	478,190	164,759	139,269	80,395	80,395	478,190	164,759	139,269
Mean Elevation (feet)	1,302	1,157	1,341	215	1,319	1,199	1,400	218	218	1,319	1,199	1,400
Average Slope (percent)	6.4	7.4	8.6	1.8	6.5	7.6	9.0	1.9	1.9	6.5	7.6	9.0
Mean Rugosity[b]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Mean Annual Precipitation (inches)	26	26	27	20	26	26	27	20	20	26	26	27
Lake Area (acres)	7,226	2,587	1,728	5,080	7,100	2,461	1,602	5,023	5,023	7,100	2,461	1,602
Accessible Stream Length (miles)[c]	781.3	296.0	250.6	78.1	776.3	291.0	245.7	76.5	76.5	776.3	291.0	245.7
Index of Fish Habitat Potential[a,d]	**271,400**	**97,000**	**75,500**	**80,800**	**266,800**	**92,500**	**70,600**	**79,400**	**79,400**	**266,800**	**92,500**	**70,600**
Fish Communities Species												
Chinook	30,192	12,713	9,682	7,400	29,159	11,679	8,649	6,892	6,892	29,159	11,679	8,649
Sockeye	83,242	32,339	24,072	52,996	81,013	30,110	21,843	52,494	52,494	81,013	30,110	21,843
Coho	106,879	35,640	28,366	13,718	105,896	34,657	27,383	13,387	13,387	105,896	34,657	27,383
Dolly Varden	39,032	11,920	9,796	1,831	38,871	11,759	9,636	1800	1800	38,871	11,759	9,636
Lake Trout	12,150	4,540	3,481	4,883	11,842	4,233	3,174	4,782	4,782	11,842	4,233	3,174

[a] The index of fish habitat potential is determined using previously published analyses that were based on the number of fish per unit area produced in monitored locations where both the amount of habitat and the number of fish produced by that habitat are known. As applied in this EIS, the index of fish habitat potential assumes relatively undisturbed conditions with unimpaired passage throughout the watersheds. The index does not represent forecasts or estimates of actual future or past biological performance.
[b] Rugosity is an index of topographic variability of a surface, and is an indicator of the "roughness" or "bumpiness" of the landscape within a watershed.
[c] The length of a stream that is accessible by anadromous fish because (1) it has a connection to the ocean and (2) it has a natural gradient that is not a barrier to fish migration.
[d] Totals may not equal sum of numbers due to rounding.

pilings and would affect spawning habitat for 3 salmon species; the Willow Segment crossing (W-0.6) could require 3 or 4 instream pilings and would affect spawning habitat for 4 species of salmon (Table 5.4-6). Alternatives that include the Big Lake Segment would cross Goose Creek, a large unique fen system. A portion of the system would likely have to be drained or filled to provide an area for construction, resulting in the potential disturbance of about 4 acres within the 200-foot ROW. These potential impacts would likely extend outward within the 18-acre high-value wetland and juvenile rearing habitat in the study area.

The ADF&G considers Cook Inlet threespine and ninespine stickleback radiations and Pacific lamprey Species of Conservation Concern (ADF&G, 2006). Of the total 44 potential fish-bearing stream crossings, 19 contain either sticklebacks, Pacific lamprey, or both (see Appendix F). Occurrence of sticklebacks and Pacific lamprey by alternative indicates that the Mac West-Connector 1-Willow Alternative would have the most occurrences of these fish species (10) and the Mac East-Connector 3-Houston-Houston North Alternative and the Mac East-Connector 3-Houston-Houston South Alternative would have the fewest (5) (see Appendix F).

Mac West-Connector 1-Willow Alternative

Construction of the Mac West-Connector 1-Willow Alternative would potentially impact 16 stream crossings that provide fish habitat (Table 5.4-9). Based on field reconnaissance, spawning habitat is present at 37 percent of the stream crossings, and habitats appear suitable for overwintering at 56 percent of stream crossings. Most streams this alternative would cross (94 percent) provide passage for fish during seasonal migrations (Noel *et al*., 2008) (Tables 5.4-3 and 5.4-6). ARRC has proposed to construct bridges at 5 of the 7 anadromous fish crossings, construct drainage structures at 1 of the 7 crossings, and install a natural bottom plate pipe or arch structure at 1 crossing (Tables 5.4-3 and 5.4-6). Two of the 5 bridges could require instream pilings within reaches of the Little Susitna River and Willow Creek with documented spawning habitat for 4 of 5 Pacific salmon. ARRC would use drainage structures to cross 2 resident fish streams; the remaining 7 crossings would be culverts of various sizes. Most stream crossings for this alternative (75 percent) would be in undeveloped areas that do not have potential unnatural blockages from ineffective culverts or other existing crossing structures, although 3 streams have potential beaver dam blockages and 4 stream crossings near Parks Highway have potential upstream or downstream blockages (Table 5.4-9). This alternative would cross 4 waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Rogers Creek, Willow Creek, Fish Creek (Susitna River tributary), and the Little Susitna River. Fish-bearing waters and upstream habitat along this alternative have the highest estimated index of fish habitat potential among all alternatives and have the highest estimated fish abundance for all fish species modeled (Table 5.4-10).

Mac West-Connector 1-Houston-Houston North Alternative

Construction of the Mac West-Connector 1-Houston-Houston North Alternative would involve 18 crossings of streams that provide fish habitat (9 resident fish streams and 9 anadromous fish streams) (Tables 5.4-3 and 5.4-6). Based on field reconnaissance, there is spawning habitat at 28 percent of the stream crossings, and habitats appear suitable for overwintering at 33 percent of stream crossings. Most streams this alternative would cross (83 percent) provide passage for fish during seasonal migrations (Noel *et al.*, 2008). ARRC has proposed to use drainage structures to cross 3 anadromous streams and to construct bridges at the Little Susitna River (HN-3.2), a tributary to the Little Susitna River (C1-2.6), and a tributary to Lake Creek (HN-4.8). The bridge over the Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use culverts to cross the remaining 3 anadromous fish streams and the 9 streams that support resident fish or fish habitats (Tables 5.4-3 and 5.4-6). Many stream crossings along this alternative (50 percent) would be in areas where development has created potential unnatural blockages from ineffective culverts or other existing crossing structures. This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Lake Creek and the Little Susitna River, and many unnamed tributaries to these waters. Development of this alternative could change access to the Little Susitna River and Lake Creek in the Little Susitna State Recreation River near Parks Highway. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac West-Connector 1-Houston-Houston South Alternative

Construction of the Mac West-Connector 1-Houston-Houston South Alternative would involve crossing 13 streams that provide fish habitat (7 resident fish streams and 6 anadromous fish streams; Tables 5.4-3 and 5.4-6). Based on field reconnaissance, there is spawning habitat at 15 percent of the stream crossings, and habitats appear suitable for overwintering at 46 percent of stream crossings (Noel *et al.*, 2008). ARRC has proposed to construct a bridge at a tributary to the Little Susitna River (C1-2.6) and at the Little Susitna River crossing (MP-174.3) next to an existing bridge. Both streams support anadromous fish. The bridge over the Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use 2 drainage structures and 2 culverts to cross the remaining 4 anadromous streams. ARRC has proposed to use culverts to cross the remaining 7 streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6). Based on field reconnaissance, most streams this alternative would cross (92 percent) provide passage for fish during seasonal migrations and provide rearing habitat. A few stream crossings along this alternative (31 percent) are in areas where development has created potential unnatural blockages from ineffective existing culverts (Noel *et al.*, 2008). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including the Little Susitna River and several unnamed Little Susitna tributaries. Fish-bearing waters and upstream habitat along this alternative have the second lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac West-Connector 2-Big Lake Alternative

Construction of the Mac West-Connector 2-Big Lake Alternative would involve crossing 12 streams that provide fish habitat (4 resident fish streams and 8 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 18 percent of the stream crossings, and habitats appear suitable for overwintering at 36 percent of stream crossings. Most streams this alternative would cross (91 percent) provide passage for fish during seasonal migrations and all streams provide rearing habitat (Noel *et al.*, 2008). ARRC has not proposed to construct bridges along this alternative. ARRC has proposed to use 6 drainage structures to cross anadromous streams. ARRC has proposed to use a culvert to cross 1 anadromous stream and would relocate

2,440 feet of anadromous stream channel into two sections of new 2,460-foot-long channel (Table 5.4-3 and 5.4-6). ARRC would cross the 4 streams that support resident fish or fish habitats using culverts (Table 5.4-3 and 5.4-6). Most streams this alternative would cross (73 percent) are in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in the Big Lake and Goose Creek drainages in Southcentral Alaska, including Little Meadow Creek, Lucile Creek, Fish Creek, and Goose Creek. The crossing of Goose Creek would be within a large unique fen system. A portion of the system would likely have to be drained or filled to provide an area for construction, which would result in the potential disturbance of about 4 acres within the 200-foot ROW. These potential impacts would likely extend outward within the 18-acre high-value wetland and juvenile rearing habitat in the study area. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East-Connector 3-Willow Alternative

Construction of the Mac East-Connector 3-Willow Alternative would involve crossing 13 streams that provide fish habitat. Based on field reconnaissance, there is spawning habitat at 47 percent of the stream crossings, and habitats appear suitable for overwintering at 69 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migration and provide rearing habitat (Noel *et al.*, 2008) (Tables 5.4-3 and 5.4-6). ARRC has proposed to construct bridges at 4 of the 6 anadromous fish stream crossings, and construct a drainage structure and a natural bottom plate pipe or arch structure at the remaining 2 crossings (Tables 5.4-3 and 5.4-4, Figure 5.4-3). Two of the 4 bridges could require instream pilings within reaches of the Little Susitna River and Willow Creek with documented spawning habitat for 4 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use a bridge at 1 resident fish stream (ME-4.5), drainage structures to cross 2 resident fish streams, and culverts of various sizes for the remaining 4 crossings. Most stream crossings along this alternative (61 percent) do not appear to have potential unnatural blockages from ineffective existing culverts, although 3 streams have potential beaver dam blockages and 5 stream crossings have potential upstream or downstream blockages (Table 5.4-9). This alternative would cross 4 waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Rogers Creek, Willow Creek, Fish Creek (Susitna River tributary), and the Little Susitna River. Fish-bearing waters and upstream habitat along this alternative have the second highest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East-Connector 3-Houston-Houston North Alternative

Construction of the Mac East-Connector 3-Houston-Houston North Alternative would involve crossing 15 streams that provide fish habitat (7 resident fish streams and 8 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 33 percent of the stream crossings, and habitats appear suitable for overwintering at 40 percent of stream crossings. Most streams this alternative would cross (87 percent) provide passage for fish during seasonal migrations (Noel *et al.*, 2008). ARRC has proposed to use drainage structures to cross 3 anadromous streams and to construct bridges at the Little Susitna River (HN-3.2), a tributary to the Little Susitna River (C1-2.6), and a tributary to Lake Creek (HN-4.8). The bridge over the

Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC would use culverts to cross the remaining 3 anadromous fish streams. ARRC has proposed to use a bridge at a resident fish stream (ME-4.5) and 6 culverts at the remaining streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6). Many stream crossings along this alternative (67 percent) would be in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Lake Creek and the Little Susitna River, and many unnamed tributaries to these waters. Development of this alternative could change access to the Little Susitna River and Lake Creek in the Little Susitna State Recreation River near Parks Highway. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East-Connector 3-Houston-Houston South Alternative

Construction of the Mac East-Connector 3-Houston-Houston South Alternative would involve crossing 10 streams that provide fish habitat (5 resident fish streams and 5 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 20 percent of the stream crossings, and habitats appear suitable for overwintering at 60 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migrations and most (90 percent) also provide rearing habitat (Noel *et al.*, 2008). ARRC has proposed to construct a bridge at the Little Susitna River crossing (MP-174.3) next to an existing bridge. The bridge over the Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use 2 drainage structures and 2 culverts to cross the remaining anadromous streams. ARRC would use a bridge to cross 1 resident fish stream (ME-4.5), and culverts to cross the remaining 4 streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6, Figure 5.4-3). Half of the stream crossings along this alternative are in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including the Little Susitna River and several unnamed Little Susitna tributaries. Fish-bearing waters and upstream habitat along this alternative have the lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East-Big Lake Alternative

Construction of the Mac East-Big Lake Alternative would involve crossing 10 streams that provide fish habitat (2 resident fish streams and 8 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 22 percent of the stream crossings, and habitats appear suitable for overwintering at 44 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migrations and provide rearing habitat (Noel *et al.*, 2008). ARRC has proposed to use 6 drainage structures to cross anadromous streams. ARRC has proposed to use a culvert to cross 1 anadromous fish stream and would block a section of an anadromous fish stream with fill and relocate the stream. ARRC has proposed a bridge (ME-4.5) and a culvert to cross the 2 streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6, Figure 5.4-3). All streams this alternative would cross are in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in the Big Lake and Goose Creek drainages in Southcentral Alaska, including Little Meadow Creek, Lucile Creek, Fish Creek, and Goose Creek. The crossing of Goose Creek would be within a large unique fen system. A portion of the system would likely have to be drained or filled to provide an area for construction, resulting in the potential disturbance of about 4 acres within the 200-foot ROW. These potential impacts would likely extend outward within the 18-acre high-value wetland and juvenile rearing habitat in the study area. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives and have the lowest estimated fish abundance for Chinook salmon (Table 5.4-10).

Mac East Variant-Connector 2a-Big Lake

Construction of the Mac East Variant-Connector 2a-Big Lake Alternative would involve crossing 10 streams that provide fish habitat (2 resident fish streams and 8 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 22 percent of the stream crossings, and habitats appear suitable for overwintering at 44 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migrations and provide rearing habitat (Noel *et al.*, 2008). ARRC has proposed to use 6 drainage structures to cross anadromous streams. ARRC has proposed to use a culvert to cross 1 anadromous fish stream and block a section of an anadromous fish stream with fill and relocate the stream. ARRC has proposed a bridge (MEV-4.5) and a culvert to cross the 2 streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6, Figure 5.4-3). All streams this alternative would cross are in areas where development has created potential unnatural blockages from ineffective culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in the Big Lake and Goose Creek drainages in Southcentral Alaska, including Little Meadow Creek, Lucile Creek, Fish Creek, and Goose Creek. The crossing of Goose Creek would be within a large unique fen system. A portion of the system would likely have to be drained or filled to provide an area for construction, resulting in the potential disturbance of about 4 acres within the 200-foot ROW. These potential impacts would likely extend outward within the 18-acre high-value wetland and juvenile rearing habitat in the study area. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives and would produce the lowest estimated fish abundance for Chinook salmon (Table 5.4-10).

Mac East Variant-Connector 3 Variant-Willow

Construction of the Mac East Variant-Connector 3 Variant-Willow Alternative would involve crossing 13 streams that provide fish habitat. Based on field reconnaissance, there is spawning habitat at 47 percent of the stream crossings, and habitats appear suitable for overwintering at 69 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migration and provide rearing habitat (Noel *et al.*, 2008) (Tables 5.4-3 and 5.4-6). ARRC has proposed to construct bridges at 4 of the 6 anadromous fish stream crossings and construct a drainage structure and a natural bottom plate pipe or arch structure at the remaining 2 crossings (Tables 5.4-3 and 5.4-4, Figure 5.4-3). Two of the 4 bridges could require instream pilings within reaches of the Little Susitna River and Willow Creek with documented spawning habitat for 4 of 5 Pacific salmon (Table 5.4-6). ARRC would use a bridge at 1 resident fish stream (MEV-4.5), drainage structures to cross 2 resident fish streams, and culverts of various sizes for the remaining 4 crossings. Most stream crossings along this alternative (61 percent) do not appear to have potential unnatural blockages from ineffective existing culverts, although 3 streams have potential beaver dam blockages and 5 stream crossings have potential upstream or downstream blockages (Table 5.4-9). This alternative would cross 4 waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Rogers Creek, Willow Creek, Fish Creek (Susitna River tributary), and the Little Susitna River. Fish-bearing waters and upstream habitat along this alternative have the second highest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East Variant-Connector 3 Variant-Houston-Houston North

Construction of the Mac East Variant-Connector 3 Variant-Houston-Houston North Alternative would involve crossing 15 streams that provide fish habitat (7 resident fish streams and 8 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 33 percent of the stream crossings and habitats appear suitable for overwintering at 40 percent of stream crossings. Most streams this alternative would cross (87 percent) provide passage for fish during seasonal migrations (Noel *et al.*, 2008). ARRC has proposed to use drainage structures to cross 3 anadromous streams and to construct bridges at the Little Susitna River (HN-3.2), a tributary to the Little Susitna River (C1-2.6), and a tributary to Lake Creek (HN-4.8). The bridge over the Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use culverts to cross the remaining 3 anadromous fish streams. ARRC has proposed a bridge at a resident fish stream (MEV-4.5) and 6 culverts at the remaining streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6). Many stream crossings along this alternative (67 percent) would be in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including Lake Creek and the Little Susitna River, and many unnamed tributaries to these waters. Development of this alternative could change access to the Little Susitna River and Lake Creek in the Little Susitna State Recreation River near Parks Highway. Fish-bearing waters and upstream habitat along this alternative have neither the highest nor lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

Mac East Variant-Connector 3 Variant-Houston-Houston South

Construction of the Mac East Variant-Connector 3 Variant-Houston-Houston South Alternative would involve crossing 10 streams that provide fish habitat (5 resident fish streams and 5 anadromous fish streams). Based on field reconnaissance, there is spawning habitat at 20 percent of the stream crossings, and habitats appear suitable for overwintering at 60 percent of stream crossings. All streams this alternative would cross provide passage for fish during seasonal migrations and most (90 percent) also provide rearing habitat (Noel *et al.*, 2008). ARRC has proposed to construct a bridge at the Little Susitna River crossing (MP-174.3) next to an existing bridge. The bridge over the Little Susitna River could require instream pilings within a reach with documented spawning habitat for 3 of 5 Pacific salmon (Table 5.4-6). ARRC has proposed to use 2 drainage structures and 2 culverts to cross the remaining anadromous streams. ARRC has proposed a bridge to cross 1 resident fish stream (MEV-4.5), and culverts to cross the remaining 4 streams supporting resident fish or fish habitats (Tables 5.4-3 and 5.4-6, Figure 5.4-3). Half of the stream crossings along this alternative are in areas where development has created potential unnatural blockages from ineffective existing culverts (Table 5.4-9). This alternative would cross waters important for sustaining recreational and commercial salmon fisheries in Southcentral Alaska, including the Little Susitna River and several unnamed Little Susitna tributaries. Fish-bearing waters and upstream habitat along this alternative have the lowest estimated index of fish habitat potential among all alternatives (Table 5.4-10).

5.4.4.2 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 impacts to fisheries from the project.

5.4.5 Unavoidable Environmental Consequences of the Proposed Action

To avoid or minimize the potential environmental impacts to fisheries from the proposed rail line, OEA is recommending that the Board impose 28 mitigation measures, including 12 measures volunteered by the Applicant. These measures include requiring: acquisition of appropriate Federal and state permits; maintenance of natural water flow and drainage by installing bridges and equalization culverts; minimization of temporary stream crossings and stream disturbance; design of bridges and culverts for fish-bearing waters to meet NMFS requirements; limitation of construction in anadromous streams during low-flow conditions and following other ADF&G timing recommendations to the extent practicable; utilization of best management practices imposed by the USACE; removal of debris from wetlands and waters at rail line crossings; inspections of culverts to ensure fish passage; implementation of Essential Fish Habitat conservation measures; minimization of detonation impacts to fish-bearing waters; and prior written authorization to narrow an anadromous waterbody within mean high water.

Commenters suggested elevating the proposed rail line on a trestle across wetlands and floodplains to further avoid or reduce impediments to fish movement and migration; however, OEA verified that the cost of such a measure would be approximately $13,000 per foot to build an elevated trestle, as compared to $1,000 per foot to build the rail at ground level. The greater cost of an elevated trestle would make the measure impractical. For example, the elevation of only 1.5 miles of track would increase the anticipated total project cost by approximately 50 percent.

Notwithstanding the recommended mitigation measures, there still would be potential unavoidable impacts to fisheries from the proposed rail line. Potential impacts would include: fish habitat loss and modification at stream crossings along the proposed rail line; loss of rearing, foraging, and cover habitat along the banks within the rail line footprint; loss of overhanging bank habitat structure and vegetation within the rail line footprint; potential changes to natural drainage and altered flood hydraulics; potential for debris jams and overbank flooding upstream of water crossings; potential direct mortality of fish during construction; and potential loss of redds, eggs, and fry due to changes in sedimentation, turbidity, and pollutants during construction.

There is also some chance that there could be additional potential impacts due to culvert or bridge design or maintenance. Recommended mitigation would require water crossing structures to be designed to meet specific hydrologic criteria (such as the 100-year flood), but natural fluctuations in hydrology could create instances where fish passage could be blocked at a culvert or bridge. Culverts would result in greater potential impacts to flow and fish passage than bridges due to the greater potential of culverts to constrict and alter flows more bridges.