Wetland Functional Assessment
Final

STERLING
HIGHWAY MILE POST 45 TO 60
ALASKA

Prepared for:

State of Alaska
Department of Transportation and
Public Facilities

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Acronyms

ADF&G	Alaska Department of Fish and Game
ADOT&PF	Alaska Department of Transportation and Public Facilities
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
CFR	Code of Federal Regulations
EFH	Essential Fish Habitat
GIS	Geographic Information Systems
GPS	Geographical Positioning System
H&H	Hydrology and Hydraulics
HGM	Hydrogeomorphic
MP	Milepost
NPP	Net Primary Production
NWI	National Wetland Inventory
PJD	Preliminary Jurisdictional Determination
SEIS	Supplemental Environmental Impact Statement
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
WET	Wetland Evaluation Technique

1.0 INTRODUCTION

The Alaska Department of Transportation and Public Facilities (ADOT&PF) has identified a need to improve the Sterling Highway in the Cooper Landing and Kenai River area. The proposed highway project would resolve summer traffic congestion and other issues for travelers on the Sterling Highway between milepost (MP) 45 and 60. While the project name is MP 45-60, the actual improvements would be between MP 45 and 58. HDR Alaska, Inc. has been contracted by ADOT&PF to provide engineering and environmental support for preparation of a supplemental environmental impact statement (SEIS) for the project. The project area is shown in Figure 1.

Federal regulations and policies require transportation projects to avoid wetlands where possible and minimize impacts to wetlands if there is no practicable alternative with fewer adverse environmental impacts. Project area wetlands were identified and mapped in the autumn of 2003 and summer of 2004, and a preliminary jurisdictional determination (PJD) was submitted to the U.S. Army Corps of Engineers (USACE) in October 2004. Additional wetland mapping for proposed staging, waste, and borrow sites was provided as a supplement to the PJD in May 2005. The data and mapping presented in the PJD is the basis for this functional assessment.

This report briefly describes the wetland identification process, the extent and types of wetlands found in the project area, identifies functions and values of those types of wetlands, and compares the wetland impacts (in terms of acres) of the alternatives currently under consideration. Wetlands, as referenced in this assessment, are "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 Code of Federal Regulations [CFR] Part 328.3(b)). In general, this report does not discuss unvegetated "waters of the U.S." including the Kenai River, Kenai Lake and various tributaries. These waterways are addressed in the draft SEIS (HDR 2008), the Essential Fish Habitat (EFH) Assessment (HDR 2006a), and the Hydrology and Hydraulics (H&H) Summary (HDR 2006b). This report does discuss ponds, because these waterbodies are included in the palustrine wetland system.

A few data changes have occurred since the submittal of the PJD. Alignments have changed and this has caused acreages to differ between this report and the PJD. Locations of streams were modified using information presented in the H&H Study (HDR 2006b). Seeps, drainage features, and larger streams were field verified by HDR hydrologists using handheld global positioning system (GPS) receivers for the H&H study. Locations were photographed and data collected regarding flow characteristics in terms of determining the necessary conveyance structures that would be required at crossing locations of each proposed alternative. Streams illustrated on the 2004 and 2005 PJD maps were replaced with the new information and are included on the attached map set. This information was used to help determine if and how wetland complexes were connected to navigable waters and to help assess potential wetland functions. Additionally, in 2009 a 117.6-acre area situated outside of the previous mapping limits was added to the project area to encompass a modification of the Juneau Creek Alignment. Wetlands within this add-on area have been field verified, the findings added to a revised PJD, and boundaries are now shown on the attached Figures.

2.0 BACKGROUND INFORMATION

The project area lies within the Upper Kenai River watershed, paralleling a section of the Kenai River between Kenai Lake and Skilak Lake. The watershed, bounded by the Kenai Mountains, encompasses over 540,000 acres. Wetlands and streams within the project area drain into the Kenai River.

Waterbodies in the project area include the lower reach of Kenai Lake, Kenai River, Russian River, Juneau Creek, Cooper Creek, Fuller Creek, Bean Creek, smaller unnamed creeks, and several ponds. Uplands are extensive within the project area, covering nearly 85 percent of the PJD mapping area (HDR 2004b).

Plant communities within the region are subject to regularly occurring wildfires. These wildfires often shape the species composition of the forested communities. Early successional plant species including aspen, alders, willows, and birch dominate recently burned areas. Climax forests are typically dominated by white spruce on well-drained sites and black spruce on poorly drained sites. Because of the predominance of upland forest climax communities in the project area, the impact of the spruce bark beetle infestation has been substantial.

Several soil surveys have been completed for portions of the Kenai Peninsula (Davidson 1989, Van Patten 1984, Davis et al. 1980). The soils within the project area can vary from thin soils on steep unstable topography to deep soils on the alluvial benches that may be either well drained or overlie deposits of relatively impermeable glacial till (Davidson 1989). The well-drained soils in the area are generally sandy loams. Organic soils, which can be several feet thick, are present on wet toe slopes, in closed depressions, and along small streams (Van Patten 1984).

3.0 METHODS

3.1 Wetland Delineation

Wetland mapping for the Sterling Highway MP 45 – 60 Project was completed in three phases: (1) office-based preliminary mapping, (2) field delineation, and (3) final delineation and reporting. Additional information regarding methodology for determining wetland boundaries is included in the PJD (HDR 2004b).

3.1.1 Office-Based Preliminary Mapping

Scientists prepared preliminary maps of wetlands and other waters of the U.S. in a broad project area encompassing all the project alternatives and their surrounding areas. Wetland areas were delineated based on vegetation characteristics (e.g., lower plant growth form and low-density stands), hydrologic indicators (such as stream locations and ponding), and topographic clues (such as concave topography). Information sources included:

- Aerial photographs and topographic mapping with 10-foot contour intervals from Aerometric U.S.
- U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) maps for quadrangles Seward C-8, Seward B-8, Kenai C-1, and Kenai B-1 (USFWS 2009).
- Existing Geographic Information Systems (GIS) layers including streams, water bodies, vegetation cover mapping, and topography from Forest Service Geodata Clearinghouse (U.S. Forest Service 2009).
- Soil Survey of the Road Corridor on the Kenai Peninsula, Chugach National Forest (Davidson 1989).
- Soils of the Cooper Landing Area, Alaska (draft report)(Van Patten 1984).

- Soil Resource Inventory of the Kenai Peninsula, Chugach National Forest, Alaska (Davis et al. 1980).
- Plant Community Types of the Chugach National Forest: Southcentral Alaska (DeVelice et al. 1999).

3.1.2 Field Delineation

Scientists verified wetland boundaries in the field during autumn 2003 and summer 2004. Additional areas were visited in fall of 2009. Ground-truthing of the preliminary mapping included identification of wetlands based on the methodology described in the USACE Wetland Delineation Manual (USACE 1987). Additional observations were made along the Cooper Creek Alternative because of perched wetlands along that route (pre-mapping did not indicate the presence of these wetlands).

Prior to fieldwork, locations of characteristic plant communities occurring at different landform positions, representative wetland or upland sites (based on aerial photography interpretation), and questionable areas were selected using GIS. These selected field sampling locations were uploaded into handheld GPS units. Once in the field, wetland scientists used these predetermined waypoints to navigate to areas of investigation. Geographic coordinates were logged at all data collection locations. In addition to wetland determination forms, wetland functional assessment forms modeled after a hydrogeomorphic approach were completed at the majority of wetland sites to provide information on wetland functions. A blank wetland function data form used during the fieldwork is included in Appendix 1. While in the field, wetland scientists identified physical features that contribute to or prevent certain functions from occurring. Examples of such indicators include the wetland's location relative to streams, the wetland's vegetation type, the amount of open water present, and the wetland's topographic position and location in the watershed.

Geographic coordinates were also collected whenever a proposed alignment crossed a stream. Additional data on project area streams were obtained during a fish presence study conducted in 2004 (HDR, 2004a) and a H&H study conducted in 2005 (HDR, 2006b).

3.1.3 Office-Based GIS Mapping and Final Delineation

Upon returning from the field, the project team amended the office-delineated wetland boundaries. Wetland types were classified based on a review of field notes, data forms, and site photographs. Boundaries were digitized with the project's alignment corridors using existing spatially rectified base mapping, georeferenced aerial photographs, and the project's alignments. Wetland types were coded using the Cowardin et al. (1979) NWI classification system. Wetland connections to navigable waters were also analyzed during this phase of wetland delineation. Final wetland mapping was prepared for a ¼-mile-wide corridor along each alternative and for the area adjacent to the existing Quartz Creek material site. Figure 4 shows the additional areas added to the PJD in 2009 to accommodate an alignment alternative of the Juneau Creek Alignment.

The attached figures (Figures 2 through 10) delineate wetland/upland boundaries, the boundaries between wetland types, and "other waters of the U.S." in the project area. Approximately 10 percent (439.6 acres) of the 4,532-acre mapped area was identified as wetland (Table 1). The remainder of the project area, approximately 90 percent (4,092.4 acres) of the mapped area, lacked one or more of the required three parameters to support classifying the area as wetland and is also not a waterbody (Table 1). Project area wetlands were grouped into five general categories based on their dominant vegetation form. The wetland types within the mapped area are forested wetland, deciduous shrub thicket wetland, shrub bog, emergent wetland, and ponds. The acreage of each type, as presented in the PJD, is included on Table 1.

Table 1: PJD Mapping Summary

Mapped Type	Total Mapped Acres	Percent of Project Area
Forested Wetland	223.5	4.9%
Deciduous Shrub Thicket Wetland	63.0	1.4%
Shrub Bog	64.0	1.4%
Emergent Wetland	78.6	1.7%
Ponds	10.5	0.2%
Upland (non-wetland)	4,092.4	90.3%
Total	**4,532.0**	**100%**

3.2 Wetland Functional Assessment

The purpose of this report is to describe wetland functions that project area wetlands may perform. Concurrent with this assessment, other project-related studies are being compiled for the SEIS that further evaluate natural resources. Where available, information from these studies was included in this functional assessment. Additionally, wetland scientists have been actively assembling and reviewing readily available reference material for the Upper Kenai River watershed. This effort is limited to reference material that is judged appropriate to developing an understanding of area wetlands, their landform position, and any information that can be related to an area's potential to perform wetland functions.

The American Society for Testing and Materials (ASTM) defines wetland functions as the chemical, physical, and biological processes or attributes that contribute to the self-maintenance of a wetland and relate to the ecological significance of wetland properties without regard to subjective human values (ASTM 1999). Individual wetlands vary with respect to what functions they perform and their capacity to perform those functions. This is influenced by the many site-specific wetland characteristics (Novitzki et al. 1997). In this functional assessment topographic setting, size, vegetation type, hydrological input and output, and wildlife information were all used to identify the particular functions of mapped wetlands.

This wetland functional assessment was largely based on professional judgment of scientists and resource managers, in combination with extrapolation from relevant scientific and wetland management literature for the surrounding region. Several existing methods offered useful concepts that were adapted and simplified for construction of a process that would best serve this project. These methods include:

- *Southeast Alaska Freshwater Wetland Assessment Method* (USACE 1999)
- *Wetland Functions Characterization Tool for Linear Projects* (Null et al. 2000)
- *The Operational Draft Guidebook for Reference Based Assessment of the Functions of Precipitation-Driven Wetlands on Discontinuous Permafrost in Interior Alaska using the Hydrogeomorphic Approach* (Alaska Department of Environmental Conservation 1999)

- *Wetland Evaluation Technique (WET); Volume I. Literature review and evaluation rationale* (Adamus et al. 1991)
- *The Highway Methodology Workbook Supplement, Wetland Functions and Values, A Descriptive Approach* (USACE 1995)
- *A Rapid Procedure for Assessing Wetland Functional Capacity, based on Hydrogeomorphic (HGM) Classification* (Magee and Hollands 1998)

A literature review was also conducted regarding physical and ecological processes that occur in project area wetland types. Using the above listed methods, field data forms were developed for the project that allowed wetland scientists to collect data that aided in the assessment of project area wetland functions (Appendix 1). Wetland function data forms were completed in the field during the wetland delineation. The function data forms allowed scientists to identify physical features that may indicate whether or not a wetland performs a certain function. The completed data forms were used in combination with information obtained from the literature review to identify potential wetland functions and values for project area wetlands.

Many functional assessment methodologies identify primary and secondary indicators of a particular function. Primary indicators are features observed in the field that illustrate a wetland's ability to perform the function. Secondary indicators include features that may demonstrate the wetland's ability to perform a function, but additional supporting data is needed. A primary indicator alone often serves as evidence of a function, but multiple secondary indicators are required to draw the same conclusion. Functional assessment methods typically identify primary and secondary indicators within the description of a particular function, and these indicators were then noted if observed in the field. Similarly, indicators of disfunction are noted in many assessment methods, and these indicators were also noted when observed in the field (e.g., the absence of vegetation indicating disfunction for food chain support). The information that project scientists used in their judgment of functions for each wetland is described in the following section.

3.2.1 Hydrologic Functions

Groundwater Recharge

Wetlands are often located near groundwater recharge or discharge areas (Adamus Resource Assessment 1987). Groundwater recharge is the infiltration of groundwater from a wetland into the underlying aquifer. Wetlands with permeable substrates and wetlands higher in a watershed are presumed to be more effective in recharging aquifers, since water can more easily move vertically through surface soils into the underlying aquifer. Topography can also contribute to a wetlands' ability to recharge groundwater; low areas, often with shallow groundwater, often serve as recharge sites. Many wetlands seasonally alternate between groundwater recharge and discharge, adapting to changing seasonal water regimes (Magee and Hollands 1998).

Groundwater Discharge

Groundwater discharge is the net upward movement of water from an aquifer to the surface (Mitsch and Gosselink 1993). Groundwater discharge wetlands often have no observed inlet but do have an outlet. Discharge wetlands are often found at the base of steep slopes where the groundwater surface intersects with the land surface (Mitsch and Gosselink 1993). Groundwater discharge is likely important in areas that are near the Kenai River or any of its tributaries because this function may directly improve water quality of downstream fish habitat.

Stream Flow Moderation

By holding water within its soils or on its surface, a wetland may delay the release of water downslope and downstream during and after rain storms. This delayed release may reduce the magnitude of peak stream flows and associated flood stages and reduce bank erosion and channel bed scour. Likewise, slow release of water from wetlands may sustain stream flows during dry seasons (Adamus Resource Assessment, Inc. 1987) and may help provide a continuous source of outflow and organic matter into the Kenai River.

While it is possible for an individual wetland to be singularly effective in flood control, but more often moderation of stream flow is the result of the interrelated functioning of a series of wetlands and water bodies within a watershed (National Wetlands Technical Council 1978). Floodplain wetlands along project area streams often serve as temporary storage areas for overbank flows. The temporary storage of surface water, combined with the slowing of floodwater velocities by floodplain vegetation, serves to reduce flood peaks and increase duration of flow (Novitzki 1978).

Wetlands with a surface outlet and wetlands along streams moderate surface flows to varying degrees. Wetlands without continually saturated soils are presumed to perform this function more effectively as their capacity to store water during storm events is higher. Additionally, wetlands with dense vegetation and those situated across flatter slopes can slow water more than other wetland types (USFWS 1984, Thompson 1998).

Shoreline, Stream Bank, and Soil Stabilization

Wetland vegetation can stabilize stream banks and waterbody margins in various ways. Vegetation can bind and stabilize substrates, it can absorb wave and current action, and it can trap sediments during periods of inundation. The effectiveness of shoreline vegetation in controlling erosion depends on the root depth, the width of the vegetated bank, the efficiency of the vegetation in trapping sediments, the soil composition of the bank or shore, the height and slope of the bank or shore, and the elevation of the toe of the bank relative to mean high water (USFWS 1984). In Alaska streams, erosion and collapse of undercut banks can reduce the availability of cover, degrade water quality, and reduce the suitability of coarse sediment important for salmon spawning, at least temporarily (Adamus Resource Assessment 1987). The vegetation in wetlands also stabilizes soils against erosion by water that may pass through by sheetflow and shallow subsurface flow. Wetlands that perform shoreline, stream bank, and soil stabilization functions often are observed with open water, may be subject to erosive forces present (such as a flowing stream), and often are scrub-shrub forests (Adamus et al. 1987).

3.2.2 Water Quality Functions

Sediment Retention and Pollutant Removal

Water passing through a wetland area can be slowed by uneven topography and dense vegetation, causing suspended sediment to drop and be bound by the vegetation and topography itself, often resulting in signs of sedimentation. These nutrients, dissolved solids, and other suspended particles can be broken down or degraded to become inactive, or can be incorporated into the soil, absorbed by vegetation, or lost to the atmosphere by evaporation (Magee and Hollands 1998). This retention of sediment can improve water quality in downstream aquatic systems by effectively removing suspended sediments and toxicants from the water regime. Wetlands can perform a contaminant removal function by receiving and storing toxins and immobilizing them by accumulation in organic soil layers. Wetlands can also retain nutrients, incorporating them into plant tissue and sometimes into the peat soil.

Wetlands with constricted or no outlets are likely to retain sediment and remove pollutants, based on the greater length of time water stays in a wetland with a restricted outlet instead of a defined or unrestricted outlet. Depositional environments, including topographic basins, are typical of wetlands performing this function, since the function performance is related to the residence time of water within the wetland (Magee and Hollands 1998). Forested wetlands appear to show the strongest correlation to performance of this function (Magee and Hollands 1998), although the function is not exclusive to forested wetlands, but rather corresponds to cover distribution for retention of sediment and particulates. In addition, pronounced microtopography creates small basins and eddies for suspended material to be deposited, as does the presence of dead woody material. Wetlands with these characteristics are assumed to perform sediment retention and pollutant removal functions.

The stability of that aquatic environment within the Kenai River may also be related in some part to water quality improvement functions of surrounding wetlands. In addition to possible human induced chemical pollutants, natural pollutants such as sediment and suspended silt particles from glacially fed streams may reduce water quality. Winter avalanches along the steep slopes of the bordering Kenai Mountains may deposit debris directly into wetland areas. Wetlands located in these avalanche run-out zones may retain much of that debris and reduce its output into the Kenai River and its tributaries.

3.2.3 Ecological Functions

Food Chain Support

Nutrients can enter wetlands in one form and leave in another. Plants may be consumed directly by vertebrates and invertebrates or chemically and physically altered through decomposition. Decomposition and the rate at which nutrients are transformed to forms usable by plants likely influence net primary production (NPP) and, ultimately, food chain dynamics. The rate of decomposition and the degree to which nutrients and organic carbon are transported out of the wetland affect the wetland's role in the aquatic food chain. Wetlands with surface flow outlets, wetlands that flood, wetlands with high NPP of palatable plant species, and those used by highly mobile fish and wildlife species likely export high levels of organic matter that support food webs outside of the wetland itself. Wetland systems that have lower levels of nutrients, lower pH, peat soils, and evergreen vegetation likely have lower NPP.

In addition, wetlands with high plant species diversity are indicative of a large gene pool for wetland plant species, and therefore of the food chain. A wetland's water regime is the most important feature in consideration of its ability to perform food chain support, since the water regime controls the dominant vegetation types as well as influences animal mobility and access.

Fish Habitat

Fish species can be dependent on wetland habitats for early development, rearing, and development, due to their relative cover, low water velocity, and abundance of food sources. Wetlands with open water and ponds that are adjacent to anadromous fish streams can provide important spawning and rearing habitat for fish species. Wetlands with surface water present, a defined and consistent inlet and outlet, and moderate vegetation interspersion are likely to provide fish habitat (Adamus, et al. 1987).

Wildlife Habitat

Many faunal species are highly wetland-dependent at certain times of the year. Riparian areas support preferred browse species for moose, as well as providing important moose calving and wintering habitats. Many birds, including waterfowl and some shorebirds, depend on wetland habitats during all or part of their life histories. Because many animals require more than one vegetation type during at least part of their life cycle, the density and diversity of plant species in a wetland can be an indicator of a wetland's ability to perform this function. Although some species prefer large areas of homogeneous cover, in general, a wetland with high interspersion or edge can be a good indicator of species diversity and abundance (Magee and Hollands 1998). Wildlife habitat is also dependent on plant species diversity, which is dependent upon the water regime. Wetlands with open water, a wet water regime, and stable hydrology (not a slope wetland) have potential for providing wildlife habitat. The presence of microrelief can also aid in providing wildlife habitat, by improving the plant species diversity as well as providing desirable locations for nests or burrows.

3.2.4 Socioeconomic Uses and Values

Wetland values are the benefits to humans that are derived from a wetland's features, processes, or setting. If something has "value" it is deemed worthwhile, beneficial, or desirable. Wetland values are not easily measured, and no scientific basis exists for assessing values (Adamus, et al. 1987). Values are often subjective and may be specific to certain groups or individuals. Wetlands within the project area may support some of the following values:

Consumptive Uses

Wetland characteristics may be valuable for "consumptive" uses such as subsistence harvesting (e.g., fishing, hunting, and berry picking) and the support of commercial harvesting of natural resources. Consumptive uses of Cooper Landing-area wetlands may include subsistence and personal harvests of wetland dependent fish, wildlife, and plant resources. Wetlands with high plant species diversity, that support wildlife habitat, and that are subject to area land management plans allowing for the collection of food sources are likely to perform this function because of their use. According to the Alaska Department of Fish & Game (ADF&G), only 0.18 pounds of small land mammals are harvested per capita per year in the Cooper Landing area, indicating that trapping of small game is not widespread (HDR 2008). This low consumption of small land mammals indicates that trapping opportunity is considered minimal in the area.

Non-consumptive Uses

Wetland characteristics may also be valuable for "non-consumptive" uses such as providing long-distance views and views of a diversity of vegetation types, recreational and educational uses, easy winter access, and flood control protection of downstream developments. Nordic skiing, hiking, and bird watching are all examples of wetland non-consumptive uses. The predominant non-consumptive wetland use in the Cooper Landing area is likely recreation. Wetlands that perform this function through this use are likely open, accessible, support wildlife habitat, and are near open water features.

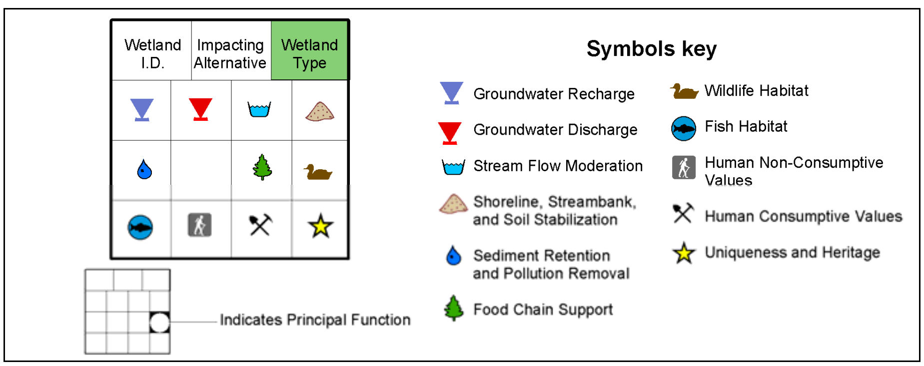
Uniqueness and Heritage

Wetlands that are regionally rare or unique may be considered to have value over more common types of wetlands. In addition, wetlands near known archaeological sites within the Squilantnu Archaeological District are valued for their role in the cultural heritage of Alaska Natives. Wetlands that correspond with identification of artifacts or cultural sites are assumed to perform this function.

4.0 RESULTS AND DISCUSSION

A description of each major wetland type (forested wetland, deciduous shrub thicket wetland, shrub bog, emergent wetland, and ponds) mapped within the project area is presented below along with an evaluation of potential wetland functions that may be impacted by project alternatives. Functions of potentially impacted wetlands are identified for each wetland type on Tables 2 through 6, are summarized by area of impact and alignment corridor on Table 7, and are graphically shown on Figures 12 through 20. The inset below (Graphic 1) outlines the method used on Figures 12 through 20 to graphically show potentially impacted functions at each corresponding wetland within proposed alternative footprints.

Graphic 1: Graphical Approach to Wetland Functional Assessment Figures



The graphical approach shown above is modeled off a similar approach presented in The Highway Methodology Workbook Supplement, Wetland Functions and Value: A Descriptive Approach (USACE 1995)

4.1 Forested Wetlands

Forested wetlands are the most abundant wetland type mapped in the project area; covering approximately 223.5 acres (5.1 percent) of the mapped 4,414.4-acre area. This wetland type was dominated by an overstory of black spruce (greater than 20 feet tall) with an understory comprised of a mix of low-bush cranberry, crowberry, cloudberry, Barclay's willow, bog blueberry, Sitka alder, northern Labrador tea, meadow horsetail, field horsetail, and bluejoint reedgrass. All forested wetlands sampled in the field had saturated soils and evidence of drainage features (i.e., low-lying depressions, swales, rivulets, etc.). Soils in these wetlands varied; some sites had histosols with sulfidic odor, while others had a thinner organic horizon (6-10 inches deep) atop mineral soil with redoximorphic features.

Project alternative footprints impact 7 forested wetland polygons. The current functions of each wetland were assessed separately and are described by functional category below. Results are summarized on Table 2.

Table 2: Functions of Potentially Impacted Forested Wetlands

Impacted Wetland ID (See Figures 11-20)	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
2		x			x	x	x				
26	x				x	x	x				
37		x			x	x	x			x	
38		x				x	x			x	
39		x			x	x	x				
40	x				x	x	x				
44		x				x	x				
Total	**2**	**5**	**-**	**-**	**5**	**7**	**7**	**-**	**-**	**2**	**-**

- *<u>Groundwater Recharge:</u>* Two areas of forested wetland are situated within low-lying areas where surface and sub-surface runoff are expected to be slow or restricted, increasing each wetlands opportunity to recharge the underlying aquifer. Conditions at 5 of the 7 forested wetlands are not conducive to recharging groundwater, including their landform positions (e.g., slopes, mounds, near stream drainages, or on perched flats) and surface drainage features (e.g., unrestricted outlets).

- *<u>Groundwater Discharge:</u>* Groundwater discharge is expected to occur at 5 out of the 7 forested wetlands. These wetlands are located on moderate slopes or positioned at toeslopes where opportunity for discharging groundwater is greatest. As mentioned above, the other 2 forested wetlands (wetlands 26 and 40) are situated across flat or low-lying depressions, areas more conducive to recharging groundwater than discharging it.

- *<u>Stream Flow Moderation:</u>* There is no evidence indicating that any of the 7 forested wetlands moderate stream flow. None of the wetlands border streams or are within areas where outlets may impact stream hydrology.

- *<u>Shoreline, Stream Bank, and Soil Stabilization:</u>* Similar to the stream flow moderation function, none of the 7 forested wetlands are within close proximity to streams, therefore the opportunity to perform shoreline functions is lacking.

- *<u>Sediment Retention and Pollution Removal:</u>* Forested wetlands with well-developed micro-topography most likely have the opportunity to improve water quality in the project area. Additionally, wetlands abutting the Sterling Highway have a greater chance to retain sediment and any pollutants from highway runoff before it enters nearby drainages. In the potentially impacted areas, 5 out of the 7 forested wetlands would have the capacity to perform these water quality functions.

- *Food Chain Support:* Forested wetlands typically have a high proportion of palatable plant species because of dense canopy structure. The availability of this plant material to detrital and herbivore-based food webs is generally high because forested wetlands also support excellent protective cover for wildlife to use while feeding. Common berry producing plants available to wildlife include crowberry, high-bush cranberry, low-bush cranberry, cloudberry, and bog blueberry. All of the potentially impacted forested wetlands likely perform this function.

- *Wildlife Habitat*: All 7 forested wetlands likely provide suitable habitat features for a variety of birds and mammals. Post's (1996) literature survey of animal use of black spruce wetlands indicates that black spruce forests support a diversity of birds, particularly songbirds and raptors, as well as many mammals and the wood frog. Moose typically calve in open, black spruce habitats, usually near surface water (Bailey and Banks 1980). Black spruce bogs in the Kenai National Wildlife Refuge have also been identified as providing habitat for a variety of wildlife species including Lincoln's sparrow, masked shrew, arctic shrew, Barrow's goldeneye, and spotted sandpiper (Bailey 1984). Wetlands near the Kenai River and its tributaries could serve as wildlife travel corridors as well.

- *Fish Habitat:* Forested wetlands generally do not perform any direct fish habitat functions; however, forested wetlands may indirectly support functions that influence habitat quality for anadromous and resident fish. Specifically, improvements to water quality, nutrient export, and sediment retention functions indirectly provide clean, nutrient-rich fish habitat along the Kenai River and its tributaries. Direct hydrologic connections between the potentially impacted forested wetlands and project area streams are lacking, therefore it is unlikely that fish habitat functions are performed by these wetlands.

- *Human Consumptive Uses:* Forested wetlands are generally not valuable areas for human consumptive uses. In terms of subsistence uses, forested uplands are generally much more productive than are forested wetlands. Timber in forested wetlands is typically small and of poor quality, and therefore is rarely harvested. Furthermore, deep organic soils are not as well suited for development. No forested wetlands were identified as areas for human consumptive uses.

- *Human Non-consumptive Uses*: Two wetland areas were identified as having indirect non-consumptive values primarily due to their proximity to hiking trails. None of the remaining forested wetlands provide any known direct human non-consumptive uses. All of the forested wetlands in the project area have a mix of saturated soils, sedge tussocks, and thick plant canopies, making the areas difficult to travel through.

- *Uniqueness and Heritage:* Forested wetlands are common throughout the Kenai Peninsula, predominantly occurring west of the project area in the Kenai National Wildlife Refuge. Within the upper Kenai River watershed, forested black spruce wetlands are widespread across broad, flat benches above the Kenai River.

4.2 Deciduous Shrub Thickets

Approximately 63.0 acres of deciduous shrub thicket wetlands were mapped in the project area. Most of these are adjacent to streams or ponds. Characteristics typical of this wetland type include a dense overstory dominated by Sitka alder and Barclay's willow. Traces of black spruce, Lutz spruce, or paper birch were found at some sites. Dominant herbaceous species included meadow horsetail, dwarf dogwood, and bluejoint reedgrass. The majority of deciduous shrub thicket wetlands visited during the field investigation had saturated histosol soils with a sulfidic odor, an indicator of anaerobic soils.

Project alternatives have the potential to impact 17 deciduous shrub thicket wetland polygons. The current functions of each wetland were assessed separately and are described by functional category below. Results are summarized on Table 3.

Table 3: Functions of Potentially Impacted Deciduous Shrub Thicket Wetlands

Impacted Wetland ID (See Figures 11-20)	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
4		x	x	x	x						
5		x			x						
6		x			x						
7		x			x						
9			x	x	x	x	x	x			
12		x			x			x			
13		x			x			x			
14		x			x			x			
15		x	x	x	x	x	x	x			
19	x	x	x		x	x	x				
28			x	x	x		x	x			
29		x	x	x	x	x	x				
30	x										
31		x	x	x	x	x	x	x			
32		x	x	x	x	x	x	x			
33		x	x	x	x	x	x	x			
43		x				x	x	x			
Total	**2**	**14**	**9**	**8**	**15**	**8**	**9**	**10**	**-**	**-**	**-**

- *Groundwater Recharge:* Deciduous shrub thickets are generally considered ineffective at recharging groundwater because of their landform position. This wetland type is frequently located along streams, at the toe of slopes, forest fringes, and bordering roadways; all areas more conducive to groundwater discharge than recharge. However, 2 areas of shrub thicket wetlands are situated within comparatively low-lying, flat areas where groundwater recharge may occur.

- *Groundwater Discharge:* In contrast to recharging groundwater, deciduous shrub thickets are generally effective at discharging groundwater because of their landscape position. Of the 17 shrub thicket wetlands potentially impacted by project alternatives, 14 are expected to have the capacity to discharge groundwater.

- *Stream Flow Moderation:* Shrub thickets bordering drainages likely help moderate stream flows. When the stream floods over its banks, the vegetation and irregularities of the ground surface slow the flow of water and the low areas serve to temporarily store it; this would lessen potential flooding and erosion downstream. Out of the 17 deciduous shrub thicket wetlands, 9 are likely effective at moderating stream flow and reducing flood impacts.

- *Shoreline, Stream Bank, and Soil Stabilization:* Deciduous shrub thickets are the most common wetland type adjacent to drainages in the project area. Therefore, the opportunity to provide shoreline, stream bank, and soil stabilization is high. In areas directly bordering drainages, these wetlands may become inundated during high flood stages, may be exposed to erosive forces, and may receive runoff sediment. 8 of the 17 potentially impacted shrub thicket wetlands are in locations where these functions are likely performed.

- *Sediment Retention and Pollution Removal:* In areas bordering streams, vegetation can bind creek banks and retain sediments deposited during flood events. Riparian areas also serve as important filters of sediments and other pollutants that might otherwise be discharged directly into streams. This is particularly important where wetlands are situated between the roadways and nearby streams. 15 of the 17 potentially impacted deciduous shrub thicket wetlands have the capacity to perform this function.

- *Food Chain Support:* Shrub thickets provide food for moose, beaver, and small birds. In areas adjacent to streams, many different mammals and raptors feed on fish carcasses and leave parts of the decomposing fish on the ground which in turn supplies nutrients to the plant community. Organic material produced from these plants, particularly in the more sloped wetlands and those nearest streams may also wash into streams and support the aquatic food web. A total of 8 of the potentially impacted deciduous shrub thicket wetlands are expected to perform this function.

- *Wildlife Habitat:* This wetland type is well-known for providing excellent habitat for nesting songbirds and abundant cover for small mammals. Shrub thickets bordering streams may also serve as travel corridors and as feeding and resting habitat for many larger species, such as moose, coyote, lynx, and bear. A total of 9 shrub thicket wetlands were identified as potential wildlife habitat areas.

- *Fish Habitat:* Deciduous shrub thickets bordering streams and ponds may provide shade over areas of open water enhancing fish habitat. Deciduous plant species dominating this wetland type typically produce large quantities of annual biomass (e.g., leaves, stems, and seeds) that often fall to the ground, decompose, and are frequently exported to downstream aquatic habitats. Shrub wetlands along streams that support anadromous fish also receive rich nutrient input each year when animals feeding upon the fish leave carcasses. A total of 10 shrub thicket wetlands were identified as sites that have the opportunity to influence fish habitat.

- *Human Consumptive Values and Uses:* No human consumptive uses for this wetland type were identified. Few edible plants are picked for subsistence purposes and hunting opportunities are limited due to the thick canopy with low visibility.

- *Human Non-Consumptive Values and Uses:* No human non-consumptive uses for this wetland type were identified. This wetland type has a dense canopy which makes it difficult to walk through, providing poor hiking opportunities. Moose and small songbirds frequently use this wetland type and may provide minimal opportunity for wildlife watching and birding, however, that use is difficult to measure given the inaccessibility of many of the wetlands.

- *Uniqueness and Heritage*: Deciduous shrub thickets are common throughout southcentral Alaska and the Kenai Peninsula. Their occurrence generally coincides with stream corridors and often borders disturbances and open meadow communities.

4.3 Shrub Bogs

Shrub bogs cover an approximately 64.0-acre area within the mapped corridors. Dominant shrubs in this type of wetland include stunted black spruce (less than 20 feet tall), bog blueberry, dwarf birch, crowberry, northern Labrador tea, shrubby cinquefoil, sweet gale, Sitka alder, and Barclay's willow. Common herbs include bluejoint reedgrass, field horsetail, northern scouring rush, and water sedge. Soils were typically saturated, drainage patterns were common (ephemeral drainages or ponded water in low-lying depressions), and anaerobic histosols were frequently encountered within this wetland type.

Project alternative footprints overlap 8 shrub bog wetland polygons. The current functions of each wetland were assessed separately and are described by functional category below. Results are summarized on Table 4.

Table 4: Functions of Potentially Impacted Shrub Bogs

Impacted Wetland ID (See Figures 11-20)	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
24	x				x		x				
25	x			x	x	x	x				
27	x				x	x	x				
34	x	x	x		x	x	x				
35	x	x	x		x		x				
41	x					x	x				
42	x	x	x	x	x	x	x				
46	x				x	x	x			x	
Total	**8**	**3**	**3**	**2**	**7**	**6**	**8**	**-**	**-**	**1**	**-**

- *Groundwater Recharge:* Similar to other wetland types, the extent which shrub-dominated bogs recharge groundwater is generally determined by their landscape position. Wetlands situated within depressions, across broad flat areas, and within areas where outflow is restricted, the opportunity for the wetland to recharge the underlying aquifer is greatest. Of the 8 potentially impacted wetlands, 6 are located within these landform positions. Two additional wetlands (wetlands 34 and 42) likely also perform this function but at a lesser degree because they are near outflow drainage channels. Outflow from wetlands 25 and 27 is restricted by the highway fill embankment, increasing each sites' opportunity to recharge groundwater.

- *Groundwater Discharge:* At 3 shrub bogs, both groundwater recharge and discharge is expected to occur. Portions of these wetlands are along tributaries to the Kenai River, areas bordering the tributaries would likely discharge groundwater, whereas areas set back from the drainages may recharge it.

- *Stream Flow Moderation:* Several shrub bogs were identified as sites that could moderate stream flow by absorbing rain and runoff before releasing the water into adjacent drainages. Wetlands 34, 35, and 42 likely perform this function effectively because of their close proximity to drainages.

- *Shoreline, Stream Bank, and Soil Stabilization:* Most of the shrub bogs assessed would not perform shoreline functions because they are located well away from areas subject to erosive forces (i.e., drainage channels, ephemeral channels, and steep slopes). Portions of 2 wetland polygons may perform this function because of their proximity to a small tributary to the Kenai River.

- Sediment Retention and Pollution Removal: Nearly all of the potentially impacted shrub bogs are adjacent to roadways, trails, or other developed areas. These wetlands have the opportunity to retain sediment-laden runoff rather than releasing it into nearby streams or lakes, thus providing this water quality function.

- Food Chain Support: Shrub bogs bordering streams have the opportunity to export dissolved organic matter directly into the stream which supports downstream aquatic ecosystems. Additionally, in the wetter portions of these wetlands, insects may reproduce and flourish, providing a viable food source for both birds and fish. The availability of food for larger wildlife is likely comparable to forested wetlands, both which support a high diversity of fruiting plants and palatable plant species available for browse. A total of 6 of the 8 potentially impacted shrub bogs were identified as performing this function.

- Wildlife Habitat: All of the shrub bogs overlapping project alternative footprints are expected to support usable habitat for wildlife such as moose, bear, and a variety of bird species. Drier, forested fringes of bogs may be used as wildlife corridors and provide nesting habitat for songbirds.

- Fish Habitat: No fish-bearing streams flow through any of the potentially impacted areas of shrub bog, therefore it is unlikely that fish habitat functions are performed by these wetlands.

- Human Consumptive Values and Uses: No distinct consumptive uses of the potentially impacted areas of shrub bog were identified. These wetlands may support small quantities of berries picked by residents and visitors to the area, and some hunters may use this wetland type while traveling through the area looking for game. Other than infrequent visits, humans likely do not utilize this wetland type to a great extent.

- Human Non-Consumptive Values and Uses: One area of shrub bog (wetland 46) was identified as a potential site available for non-consumptive uses due to its proximity to the Bean Creek Trail. No human non-consumptive uses other than aesthetic value were identified for the remaining areas of shrub bog.

- Uniqueness and Heritage: Shrub-dominated bogs are not uncommon in the surrounding region.

4.4 Emergent Wetlands

In the project area, emergent wetlands are located in old sloughs or channels of the Kenai River or on benches on the mountain slopes north of the river. Approximately 78.5 acres of emergent wetlands were identified within the mapped corridors. General characteristics include a dense graminoid mat comprised of a mix of beaked sedge, water sedge, narrow-leaved cotton grass, Chamisso's cotton grass, northern scouring-rush, and few-flowered sedge. Higher areas within emergent wetlands support stunted black spruce, shrubby cinquefoil, dwarf birch, Sitka alder, and northern Labrador tea. Emergent wetlands are the wettest of the project area wetlands; all of the sites visited in the field were saturated at the ground surface or appeared to experience periodic inundation.

Project alternatives have the potential to impact 7 emergent wetland polygons. The current functions of each wetland were assessed separately and are described by functional category below. Results are summarized on Table 5.

Table 5: Functions of Potentially Impacted Emergent Wetlands

Impacted Wetland ID (See Figures 11-20)	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
1		x	x	x	x						
3	x	x	x		x	x					
11	x	x	x		x	x	x				
17	x	x	x		x	x	x				
22	x				x	x					
36	x				x	x	x				
45	x				x	x	x				
Total	**6**	**4**	**4**	**1**	**7**	**6**	**4**	**-**	**-**	**-**	**-**

- *Groundwater Recharge:* Emergent wetlands with restricted outflow, including sites within depressions, sites impounded by the highway embankment, and sites occurring across wide, flat topography are likely effective at recharging groundwater. Of the 7 potentially impacted emergent wetlands, 6 are situated within these conditions and were identified as locations that could recharge groundwater.

- *Groundwater Discharge:* Emergent wetlands that occur at toes of slopes, alongside drainages, and those perched on flat ridges may discharge groundwater. Emergent wetlands that discharge groundwater are thought to have the highest nutrient status and most productive of wetland types in the project area. Portions of 4 emergent wetlands were identified as having topographic features conducive to discharging groundwater; of these, 3 also had depressions within them where groundwater may recharge as well.

- *Stream Flow Moderation:* Emergent wetlands with a restricted outlet, such as those that abut road embankments could perform this function because of their ability to store surface water over time and slowly release it into nearby drainages. Of the 7 potentially impacted emergent wetlands, 4 were identified as having the capacity to perform this function.

- *Shoreline, Stream Bank, and Soil Stabilization:* The majority of emergent wetlands are not within close proximity to a stream or waterbody, therefore they would not have the opportunity to perform shoreline functions. A single wetland (wetland 1) is located alongside the Kenai River and may protect the stream bank from erosive forces and flood events.

- *Sediment Retention and Pollution Removal:* All of the potentially impacted emergent wetlands likely have the opportunity to perform sediment retention or pollution removal functions. Many of the field sampled emergent wetlands had water flowing through them; any sediment or other pollutants within those waters could be retained within the thick organic mats and dense emergent vegetation characteristic of this wetland type.

- *Food Chain Support:* Emergent wetlands tend to be very productive and often have water flowing through them, both surface and subsurface; therefore this wetland type supports conditions conducive to exporting organic carbon directly into drainages. Notably, these nutrient rich wetlands typically produce large quantities of organic biomass annually which provides an abundant, readily available food source for many different organisms.

- *Wildlife Habitat:* Emergent wetlands on the Kenai Peninsula provide habitat for a variety of wildlife including the common snipe, masked shrew, arctic shrew, mink, northern harrier, spotted sandpiper, and short-eared owl (Bailey 1984). These wetlands also provide the grasses and sedges that comprise the spring diet of brown bears. Moose are known to use the open, wet areas for calving. Lake and pond edges that support emergent vegetation are important nesting and brood rearing habitat for waterfowl. The open, low sedge habitat of this wetland type provides birds of prey visibility for aerial hunting of small rodents and songbirds. Habitat nearby existing roadways is likely somewhat degraded due to vehicle disturbance. Of the 7 potentially impacted emergent wetlands, 4 have the highest opportunity to support wildlife.

- *Fish Habitat:* Due to the distant proximity to fish-bearing streams, none of the 7 emergent wetlands assessed directly support fish habitat. One emergent wetland (wetland 1) borders the Kenai River, however, is too high above the river's floodplain to support fish.

- *Human Consumptive Uses:* Emergent wetlands are generally not valued for human consumptive use. Very few plants which are used for subsistence food or material purposes occur in this wetland type. Past uses may have included use of the thick organic mats from these wetlands on cabin rooftops for insulation. Presently, the use of this material is not common.

- *Human Non-Consumptive Uses:* There are no known human non-consumptive uses for the 7 potentially impacted emergent wetlands other than providing aesthetic value.

- *Uniqueness and Heritage:* Emergent wetlands are generally considered to be important areas throughout the Kenai Peninsula because of the habitat functions they perform and because of their common correlation with open water habitats. However, the wetlands specific to the project area are generally abundant in the region and lack any known heritage value.

4.5 Ponds

Most ponds within the project area are located near or directly adjacent to the Kenai River. These ponds are generally small and shallow, and some support aquatic vegetation. Approximately 10.5-acres of ponds cover the mapped project area.

A general description of the functions performed by ponds is provided below. Figures 12 through 20 and Table 6 provide specific function information for each potentially impacted pond.

Table 6: Functions of Potentially Impacted Ponds

Impacted Wetland ID (See Figures 11-20)	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
8	x		x		x	x	x				
10	x		x		x	x	x	x		x	x
16	x		x		x	x	x	x		x	x
18	x	x	x		x	x	x			x	x
20	x				x	x	x	x		x	x
21	x				x	x					
23	x				x	x					
Total	**7**	**1**	**4**	**-**	**7**	**7**	**5**	**3**	**-**	**4**	**4**

- *Groundwater Recharge:* Ponds with restricted outflow of water, such as those abutting the highway embankment or within topographic depressions likely recharge groundwater. All of the potentially impacted ponds meet these conditions.

- *Groundwater Discharge:* A singe pond (wetland 18) is situated at the toe of slope, a location where seeps and springs are commonly found.

- *Stream Flow Moderation:* Ponds are generally not effective at moderating high stream flows because they are generally permanently inundated and cannot store additional flood waters. Ponds that abut the highway embankment could help regulate stream flow during drier times of the year when water is low by slowly releasing its water through the embankment or through underlying soils and into nearby drainages. A total of 4 ponds were identified as having the capacity to help moderate stream flows.

- *Shoreline, Stream Bank, and Soil Stabilization:* Ponds are generally not considered to perform this function, although they may support adjacent flowing drainages abilities to perform this function by providing water storage during flood events.

- *Sediment Retention and Pollution Removal:* All of the potentially impacted ponds have the opportunity to retain sediment or other pollutants. Each are located where they could receive runoff from the Sterling Highway and have the opportunity to retain particulates and pollutants within the runoff. These pollutants are likely ingested by aquatic plants or organisms or accumulate in soils at the pond bottoms. As most of these ponds are near the Kenai River, they likely help improve the water quality of the Kenai River by diverting these particulates and pollutants.

- *Food Chain Support:* Ponds, particularly those with aquatic vegetation, can be nutrient rich habitats as well as sites that supply downstream habitats with nutrients. All of the potentially impacted ponds likely help support the food chain.

- *Wildlife Habitat:* Ponds provide habitat for a variety of water-dependent birds such as ducks, geese, and swans. Pond edges that support emergent vegetation are important nesting and brood rearing habitat for waterfowl. Ponds also support vegetation browsed by moose and provide habitat for frog egg-laying (ADF&G 2001). A total of 5 of the 7 potentially impacted ponds were identified as locations of usable habitat.

- *Fish Habitat:* Ponds can support a variety of fish species. Of the potentially impacted ponds, 3 are likely to directly provide fish habitat and 4 are not connected to fish-bearing rivers by surface water and would likely not support habitat for fish.

- *Human Consumptive Uses:* Although ponds can contain fish, the ponds included in this functional assessment are generally small and likely contain fish smaller than or of different species than those desired by humans for consumptive use.

- *Human Non-Consumptive Uses:* Like emergent wetlands, ponds can provide visitors with open viewing locations and opportunities to see birds and mammals. In the potentially impacted areas, 4 ponds likely provide non-consumptive values and uses.

- *Uniqueness and Heritage:* Like emergent wetlands, ponds are generally considered to be important areas throughout the Kenai Peninsula because of the open water habitats they provide. In the potentially impacted areas, 4 ponds were identified as particularly important due to their immediate proximity to the Kenai River and Sterling Highway.

5.0 SUMMARY OF WETLAND IMPACTS

In accordance with federal law, projects must identify wetland impacts, consider alternatives that avoid impacts, minimize the impacts of the project, and sometimes compensate for unavoidable adverse effects. This project considers four alternatives: the No Build, Cooper Creek, G South, and Juneau Creek. The No Build Alternative would result in no changes to the existing highway, and therefore would not affect wetlands.

Direct impacts to wetlands were determined using GIS by overlaying the wetland layer with the preliminary footprints of the three build alternatives (Figures 2 through 10). Table 7 shows the approximate acreage of wetlands and ponds that would be cut or filled for each alternative (in terms of footprint acres). Additional wetland areas would be disturbed by construction activities and permanently affected by proximity to the highway. Construction impacts to wetlands are discussed in Section 7.

Table 7: Direct impacts to wetlands and ponds

Approximate Area of Fill (acres)				
Wetland Type[1]	**No Build**	**Cooper Creek**	**G South**	**Juneau Creek**
Forested	0	2.3	16.4	24.2
Deciduous shrub	0	1.7	2.9	4.7
Shrub bogs/fens	0	3.7	1.6	2.3
Emergent	0	1.1	1.1	6.4
Ponds	0	2.2	2.2	1.1
Total wetlands and ponds filled	0	11.0	24.2	38.7
Approximate Amount of Fill (cubic yards)				
Location of Fill	**No Build**	**Cooper Creek**	**G South**	**Juneau Creek**
Approximate amount of fill placed in wetlands	0	119,020	518,400	721,640
Approximate amount of fill placed in ponds	0	35,390	36,810	20,820
Total approximate amount of fill placed in wetlands and ponds	0	154,410	555,210	742,460

[1] NWI symbol for wetland types include:
Forested wetlands: PFO4B, PFO4/SS1/EM1B, PFO4/SS1/EM2B, PFO4/SS1B, PFO4/EM2B
Deciduous shrub wetlands: PSS1A, PSS1B, PSS1/EM1B, PSS1/EM2B
Scrub wetlands: PSS1/4B, PSS4/1B, PSS1/EM1B, PSS1/EM2B, PSS4/EM1B, PSS4/EM2B
Emergent wetlands: PEM1F, PEM1C, PSS1/EM1C
Ponds: PUBH

Impacts to wetland functions by each project alternative are shown on Figures 12 through 20. Table 8 lists each directly-impacted wetland in the project area, amount affected by each alternative, general wetland type (as discussed in this report) and its potential functions. Results are further summarized by alternative on Graph 1.

The relative value of any one function over another is difficult to ascertain. As discussed in Section 3.2, an evaluation of vegetation type, hydrological input and output, wildlife information, topographic setting, and numerous other variables were evaluated to determine the presence of each function at the potentially impacted areas. Within the project area, some functions were estimated as being performed at a higher capacity among all mapped wetland types than are other functions.

The Juneau Creek Alternative would impact the most wetlands (Table 7), and as such, would impact the most wetland functions; followed by the G South Alternative and the Cooper Creek Alternative, respectively (Graph 1).

Table 8: Cut and fill areas in wetlands and ponds; wetland functions

Impacted Wetland ID (See Figures 11-20)	Affecting Alternative	Wetland Type	Approximate acres Impacted	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
1	C, G, J	Emergent	0.19		x	x	x	x						
2	C, G, J	Forested	0.02		x			x	x	x				
3	C, G, J	Emergent	0.55	x	x	x		x	x					
4	C, G, J	Deciduous Shrub Thicket	0.10		x	x	x	x						
5	C, G, J	Deciduous Shrub Thicket	0.004		x			x						
6	C, G, J	Deciduous Shrub Thicket	0.02		x			x						
7	C, G, J	Deciduous Shrub Thicket	0.10		x			x						
8	C, G	Pond	0.12	x		x		x	x	x				
	J		0.10											
9	C, G	Deciduous Shrub Thicket	0.69			x	x	x	x	x	x			
	J		0.63											
10	C, G	Pond	1.06	x		x		x	x	x	x		x	x
	J		1.05											

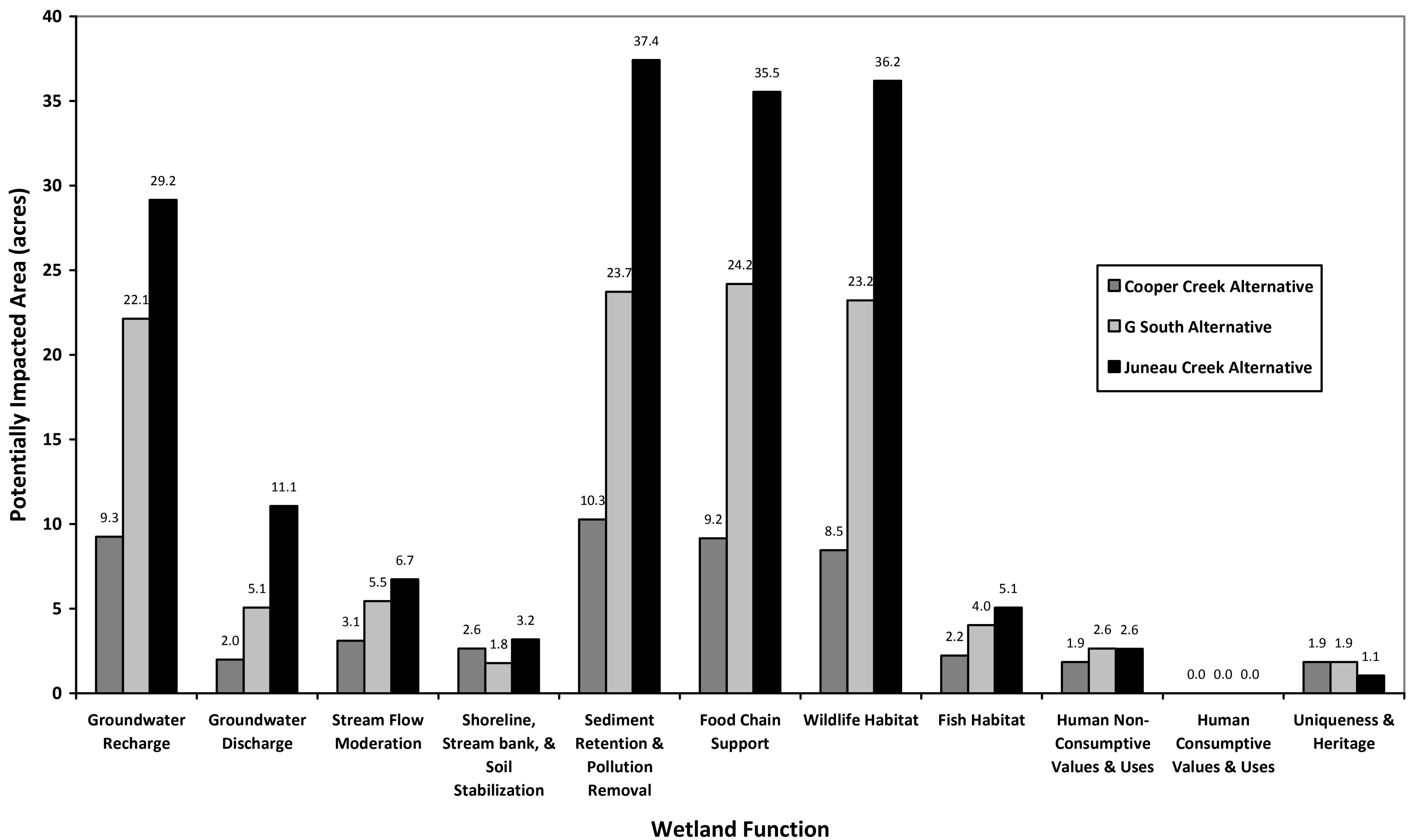
Impacted Wetland ID (See Figures 11-20)	Affecting Alternative	Wetland Type	Approximate acres Impacted	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
11	C, G	Emergent	0.07	x	x	x		x	x	x				
	J		0.04											
12	C, G	Deciduous Shrub Thicket	0.20		x			x			x			
	J		0.50											
13	C, G	Deciduous Shrub Thicket	0.06		x			x			x			
	J		0.24											
14	C. G	Deciduous Shrub Thicket	0.17		x			x			x			
	J		0.44											
15	C, G	Deciduous Shrub Thicket	0.02		x	x	x	x	x	x	x			
16	C, G	Pond	0.38	x		x		x	x	x	x		x	x
17	C, G	Emergent	0.13	x	x	x		x	x	x				
18	C, G	Pond	0.21	x	x	x		x	x	x			x	x
19	C, G	Deciduous Shrub Thicket	0.14	x	x	x		x	x	x				
20	C, G	Pond	0.20	x				x	x	x	x		x	x
21	C, G	Pond	0.23	x				x	x					
22	C, G	Emergent	0.16	x				x	x					
23	C, G	Pond	0.04	x				x	x					
24	C	Shrub Bog	0.25	x				x		x				

Impacted Wetland ID (See Figures 11-20)	Affecting Alternative	Wetland Type	Approximate acres Impacted	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
25	C	Shrub Bog	2.19	x			x	x	x	x				
26	C	Forested	2.27	x				x	x	x				
27	C	Shrub Bog	1.25	x				x	x	x				
28	C, G	Deciduous Shrub Thicket	0.02			x	x	x		x	x			
	J		0.15											
29	J	Deciduous Shrub Thicket	0.05		x	x	x	x	x	x				
30	J	Deciduous Shrub Thicket	0.26	x										
31	J	Deciduous Shrub Thicket	0.51		x	x	x	x	x	x	x			
32	J	Deciduous Shrub Thicket	1.03		x	x	x	x	x	x	x			
33	J	Deciduous Shrub Thicket	0.52		x	x	x	x	x	x	x			
34	J	Shrub Bog	0.76	x	x	x		x	x	x				
35	J	Shrub Bog	1.05	x	x	x		x		x				
36	J	Emergent	5.60	x				x	x	x				
37	J	Forested	1.14		x			x	x	x			x	
38	J	Forested	0.44		x				x	x			x	
39	J	Forested	3.36		x			x	x	x				
40	G	Forested	16.27	x				x	x	x				
	J		19.27											
41	J	Shrub Bog	0.47	x					x	x				

Impacted Wetland ID (See Figures 11-20)	Affecting Alternative	Wetland Type	Approximate acres Impacted	Groundwater Recharge	Groundwater Discharge	Stream Flow Moderation	Shoreline, Stream bank, and Soil Stabilization	Sediment Retention and Pollution Removal	Food Chain Support	Wildlife Habitat	Fish Habitat	Human Consumptive Values and Uses	Human Non-Consumptive Values and Uses	Uniqueness and Heritage
42	G	Shrub Bog	0.77	x	x	x	x	x	x	x				
43	G	Deciduous Shrub Thicket	1.23		x				x	x	x			
44	G	Forested	0.08		x				x	x				
45	G	Emergent	0.02	x				x	x	x				
46	G	Shrub Bog	0.79	x				x	x	x			x	

Alternative abbreviations are as follows: C = Cooper Creek, G = G South, and J = Juneau Creek.

Graph 1: Comparison of Potentially Impacted Wetland Functions by Project Alternatives



6.0 SUMMARY OF TEMPORARY CONSTRUCTION-RELATED WETLAND IMPACTS

Construction of any build alternative will result in temporary impacts to wetlands. All waste and borrow sites will be located in uplands and therefore no permanent impacts to wetlands are anticipated from these types of activities. While engineers have minimized construction-related impacts to wetlands, temporary impacts to wetlands along the cut and fill edges and from staging areas are unavoidable. For the purpose of impact evaluation, land 10 feet beyond the designed cut and fill limits has been assumed to be impacted by construction activities. Staging areas are required for material stockpiling and equipment operation adjacent to proposed bridge locations. In both the staging areas and the 10-foot buffer the contractors will be required to operate machinery and equipment on geotextile mats when in wetland areas. This management practice will aid in minimizing permanent disturbance to wetlands in the project area.

Temporary fill in wetlands would be required for wetlands that exist in the proposed staging areas. In areas where temporary fill is required, ADOT&PF would require the construction contractor to place the fill on geotextile mats or other suitable materials of sufficient thickness to facilitate the removal of the fill and the materials to the maximum extent practicable when they are no longer needed for construction. Although some organic soil compaction would occur due to the weight of the equipment placed on the geotextile mats, no natural earthen material would be removed from under the geotextile mat when the temporary fill was removed. ADOT&PF would stabilize the wetlands against erosion once construction equipment and protective mats were removed by reseeding and revegetating the disturbed areas as necessary. Best management practices (BMPs), described in Section 7.3, would also be implemented during construction. The contractor would be required to provide silt fencing, prepare and follow a stormwater pollution prevention plan, and adhere to all practices to minimize impacts to wetlands determined by the USACE and ADOT&PF.

Table 9: Temporary impacts to wetlands and ponds

Approximate Temporary Disturbance Area (acres)					
Temporary Disturbance Type	**Affected Wetland Type**	**No Build**	**Cooper Creek**	**G South**	**Juneau Creek**
Disturbance of areas within 10 feet of cut/fill prism	Forested	0	0.3	2.0	2.8
	Deciduous shrub thickets	0	0.3	0.5	0.7
	Shrub bogs	0	0.7	0.3	0.3
	Emergent	0	0.3	0.3	1.0
	Ponds	0	0.6	0.6	0.3
Staging areas	Forested	0	0	0	2.7
	Deciduous shrub thickets	0	0	0.3	0
	Shrub bogs	0	0	0	0.1
	Emergent	0	0	0	4.0
	Ponds	0	0	0	0.0
Total temporary disturbance		0	2.2	4.0	11.9
Approximate Amount of Temporary Fill (cubic yards)					
		No Build	**Cooper Creek**	**G South**	**Juneau Creek**
Location of temporary fill	Wetlands	0	0	1,450	32,910
	Ponds	0	0	0	0
	Total temporary fill in wetlands and ponds	0	0	1,450	32,910

7.0 REFERENCES

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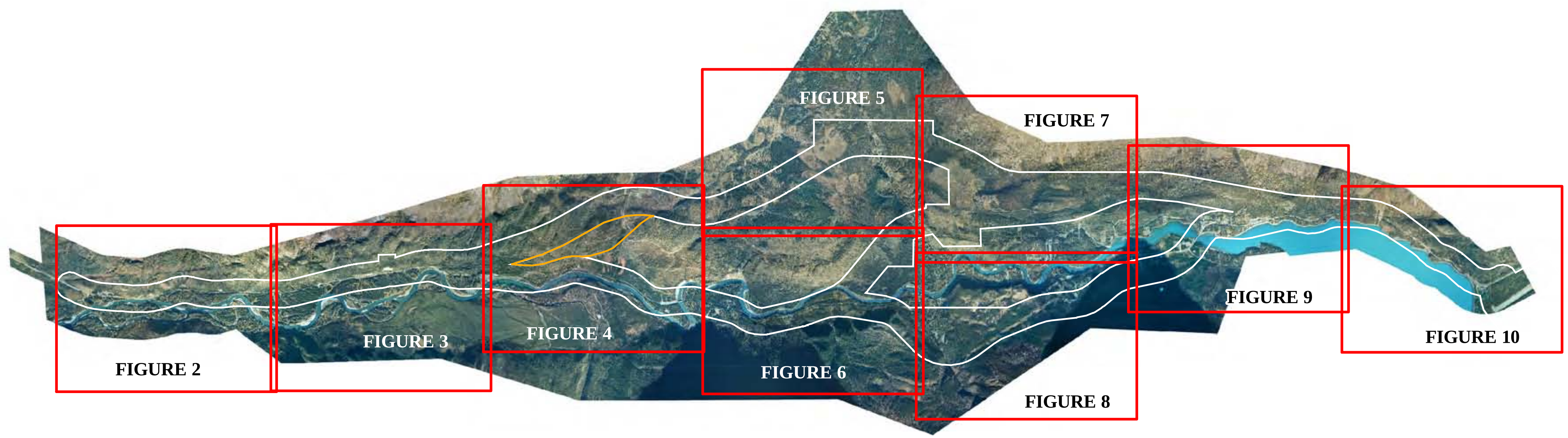
Appendix 1 – Sample Functional Assessment Data Form

Project: **Date:** **Time:** **Investigators:**	**Site #:** **WLD form?** Y N **General location:** **General wetland type:**
HGM class: Depression w/o outlet Depression w/ outlet Slope (groundwater discharge) Flat (precip dominant) Lacustrine fringe Riverine Tidal fringe	**NWI class:** Growth form cover %: Trees: Moss: Shrubs: Bare ground: Herbs: Open water %:
Water source: Inflowing channel – perennial/seasonal Dispersed overland runoff– perennial/seasonal Stream overflow Groundwater discharge – springs, seeps Water flow through soils Precipitation only Any evidence of water table fluctuation? Y N # in:	**How water leaves the site:** Groundwater infiltration substrate? Channelized outflow Dispersed flow into adjacent stream Dispersed overland flow Evapotranspiration only
Wetland located in which portion of watershed? Upper 1/3 Middle 1/3 Lower 1/3 **Approx. wetland size:** (from aerial photos) **Landform:**	**Location with respect to slopes:** Hill top Slope %: Upper slope Mid slope Toe of slope On broad flat Vertical: convex or concave? Horizontal: convex or concave?
Evidence of periodic flood events: Observed during site visit Y N Drift lines Y N Bent vegetation Y N Sediment deposition Y N Scour Y N Sediment layers in soil Y N	**Evidence of erosive force:** Presence of creek or open water subject to wave Y N Visible scour (exposed soil, roots, steep banks) Y N Veg'n pushed by ice Y N Does vegetation have roots that would bind soil against scour? (fine or many roots) Y N
Microrelief Pronounced – 18" Well developed - 6-18" Poorly developed - <6 in None	**Human Disturbance** Any human disturbance? Y N Type? Disturbance in watershed? Y N Upstream Disturbance? Y N Downstream Disturbance? Y N
Veg growth form interspersion High (small groupings, diverse and interspersed Moderate (broken irregular rings) Low (large patches, concentric rings)	**Describe veg/open water interspersion** 0-25% of water or veg Interspersion: 26-75% of water and veg max 100% of water or veg min mod
Wildlife Animal Sign? Y N Type of Sign (Tracks, trails, browse, scat, hair, nest, burrow, all, observation, other) Species List	**Size of open water bodies** Longest dimension Average dimension Any streams running through wetland? Y N Fish in stream? Y N Anadromous? Resident? Does wetland provide structure to stream? Woody debris? Overhanging vegetation? Does water flow from wetland to fish stream? Y N
Human Uses Potential human uses of wetland? Type of use? Unique features that suggest human use (berries, ducks, etc…)Anything unique about this wetland?	Is this wetland type extensive in the region? Y N (e.g., <5% of wetlands are of this type)

Sterling Highway Project MP 45 to 60
Index Map for Wetland Delineation Figures



Sterling Highway Project MP 45 to 60

Wetlands Technical Evaluation Memorandum

Legend

Figure # and Extent

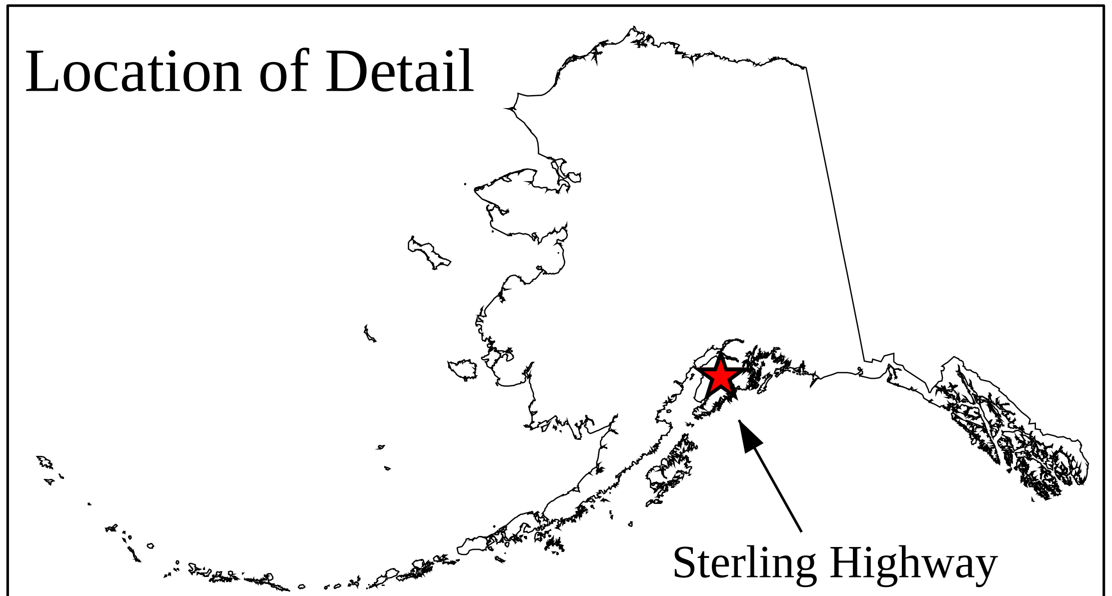
Wetland Mapping Limits

2009 Add-on Mapping Limits

N

Miles
0 0.5 1 1.5

Location of Detail



Sterling Highway
MP 45 to 60
Project Area
(Cooper Landing, Alaska)

FIGURE 1

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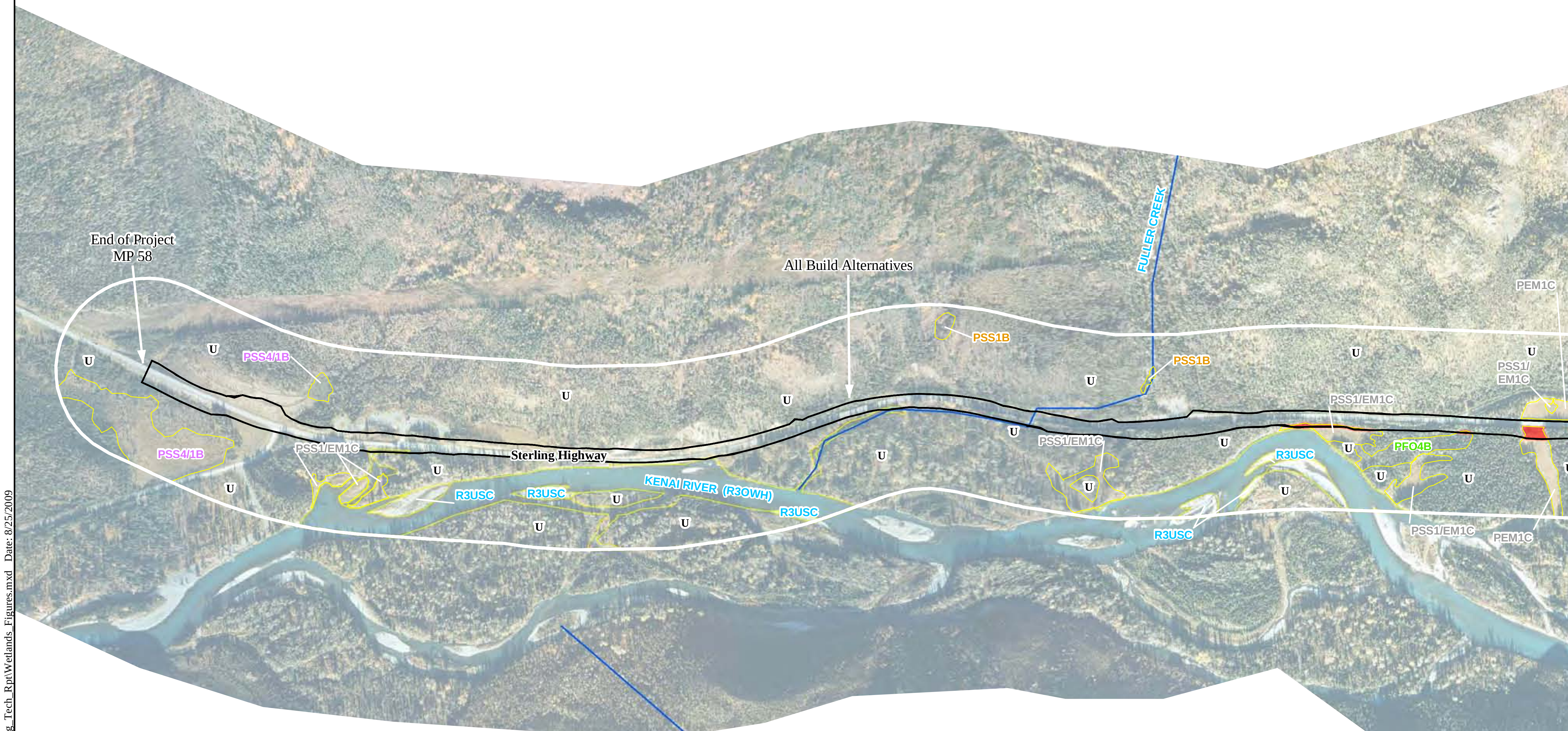
Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts



Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands

PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets

PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs

PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands

PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters

L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands

U

0 750 1,500
Feet
N

FIGURE 2 OF 20

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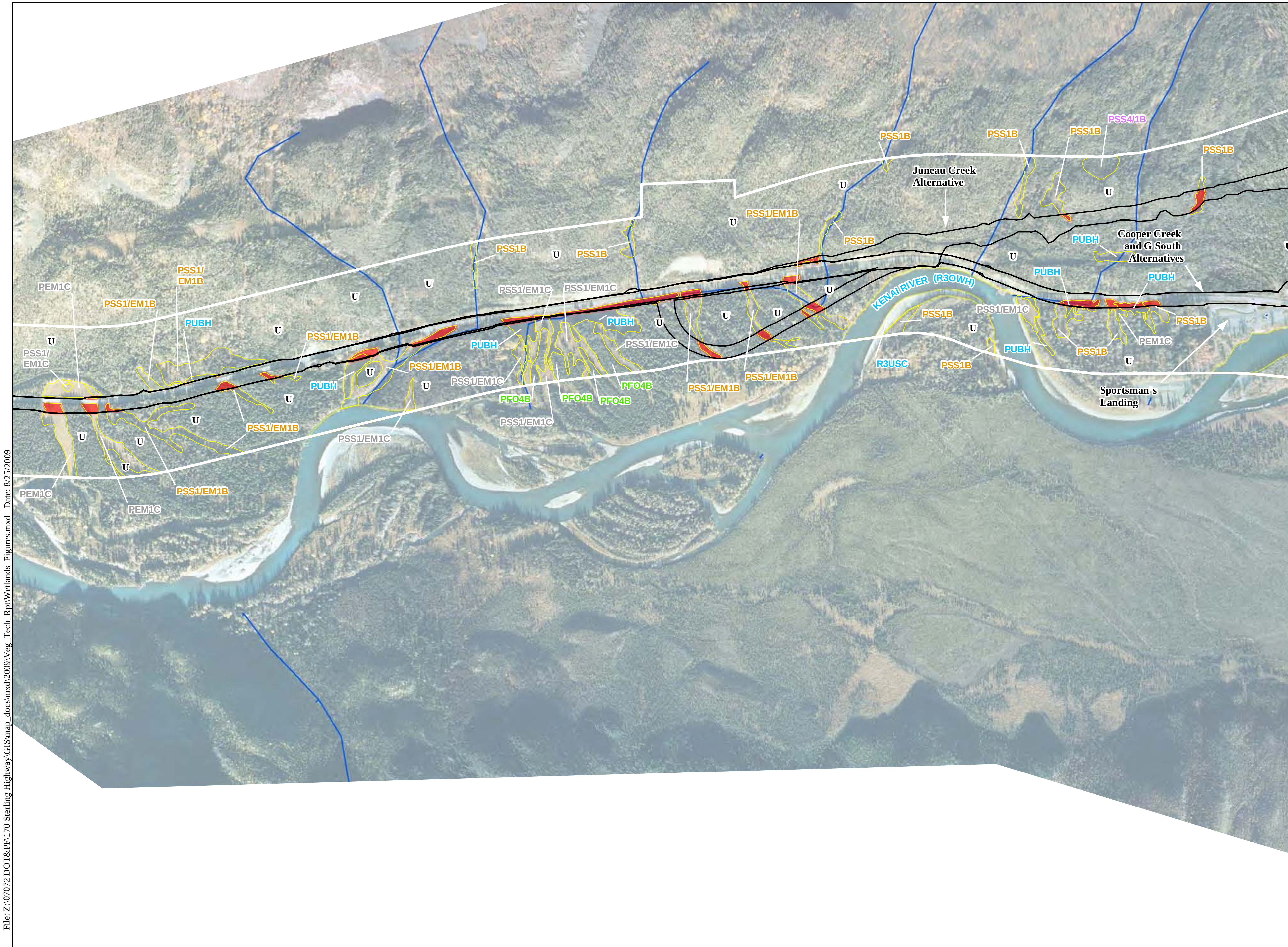
Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts



Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 3 OF 20

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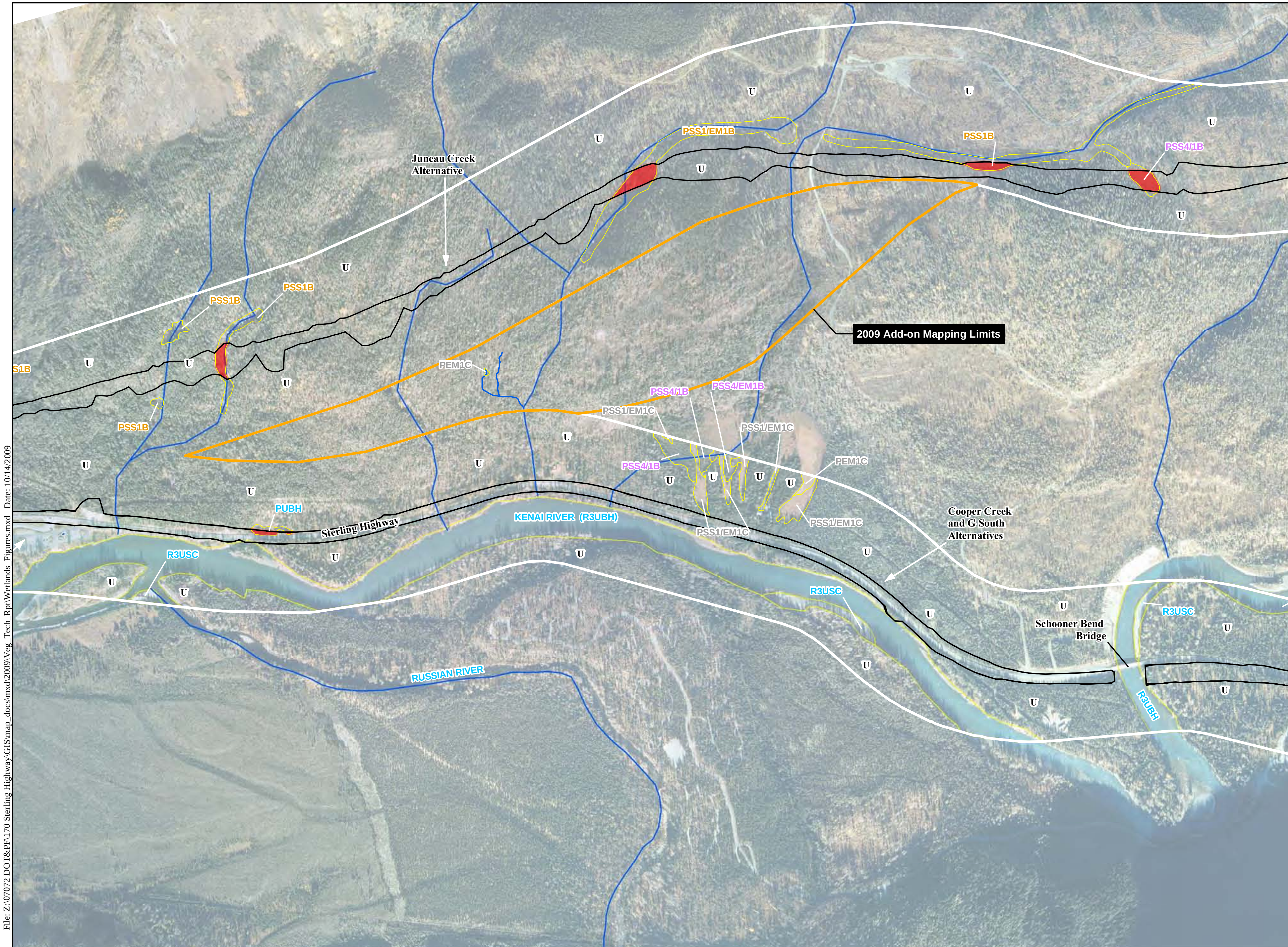
Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts



Legend

- Project Alternatives (Cut/Fill)
- Wetland Mapping Limits
- Wetland/Upland and Wetland Type Boundaries
- Potential Wetland Impacts
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 4 OF 20

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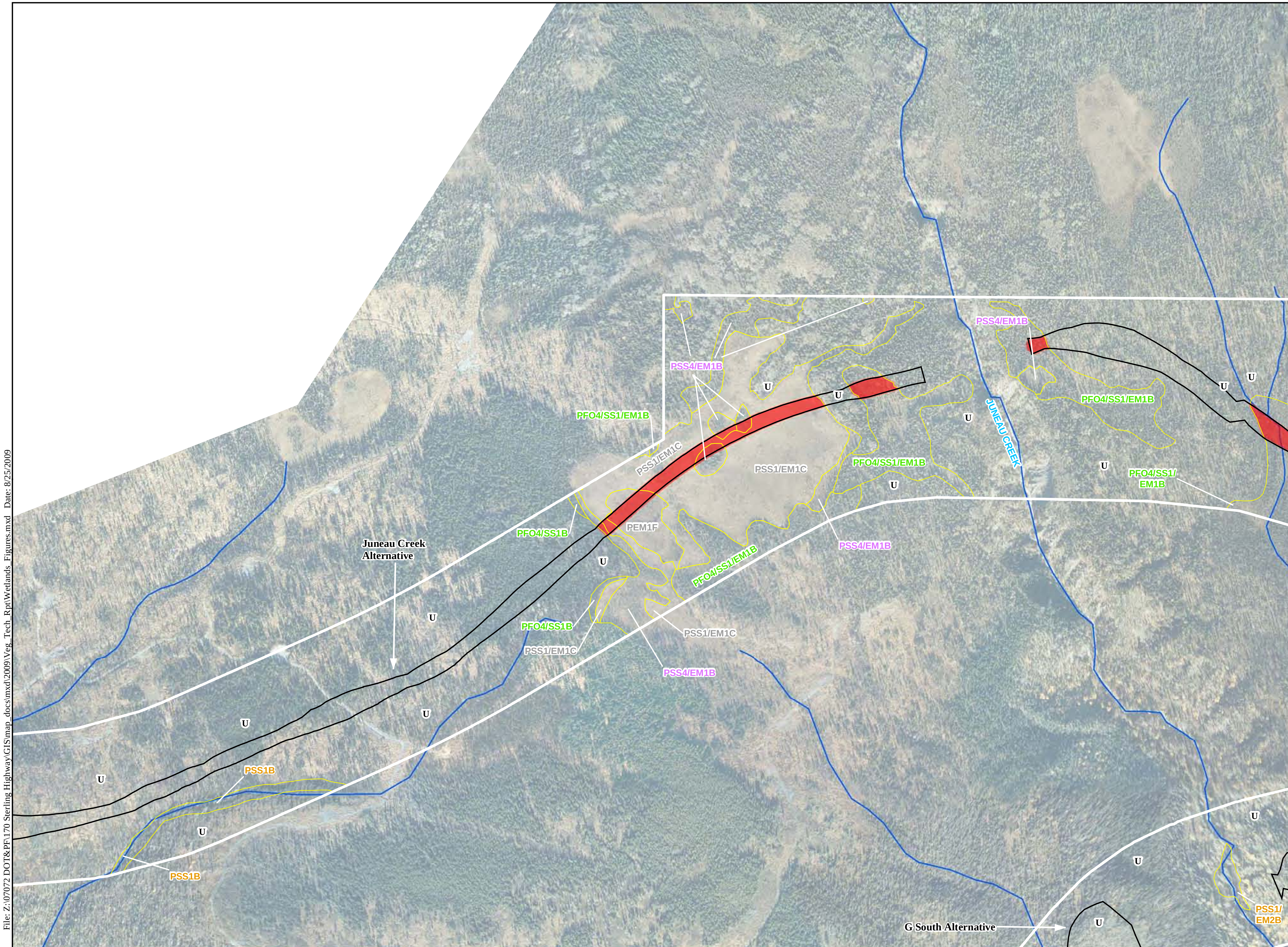
Sterling Highway Project MP 45 to 60 Wetland Delineation and Potential Wetland Impacts



Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 5 OF 20

Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 6 OF 20

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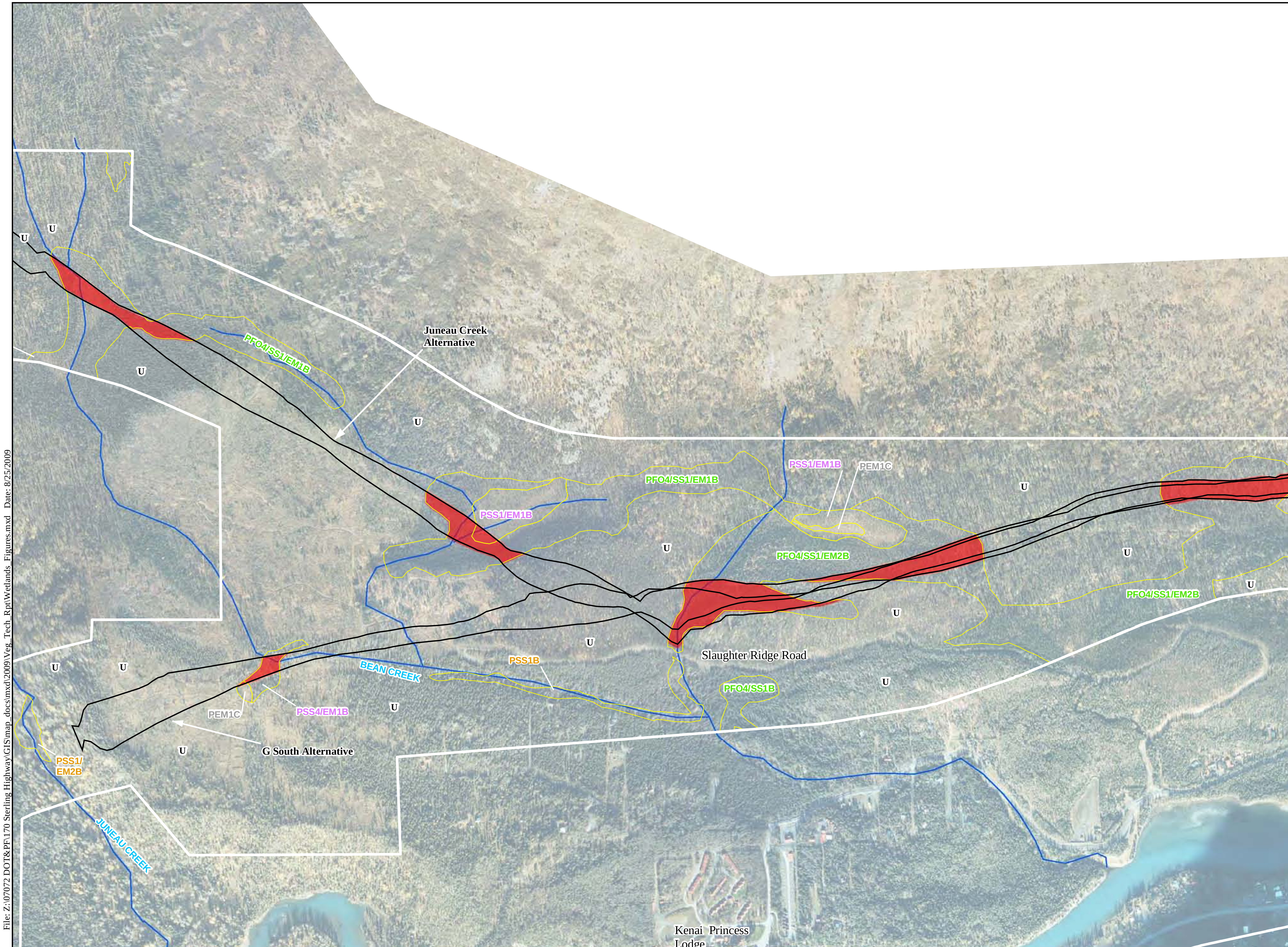

Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and
NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 7 OF 20

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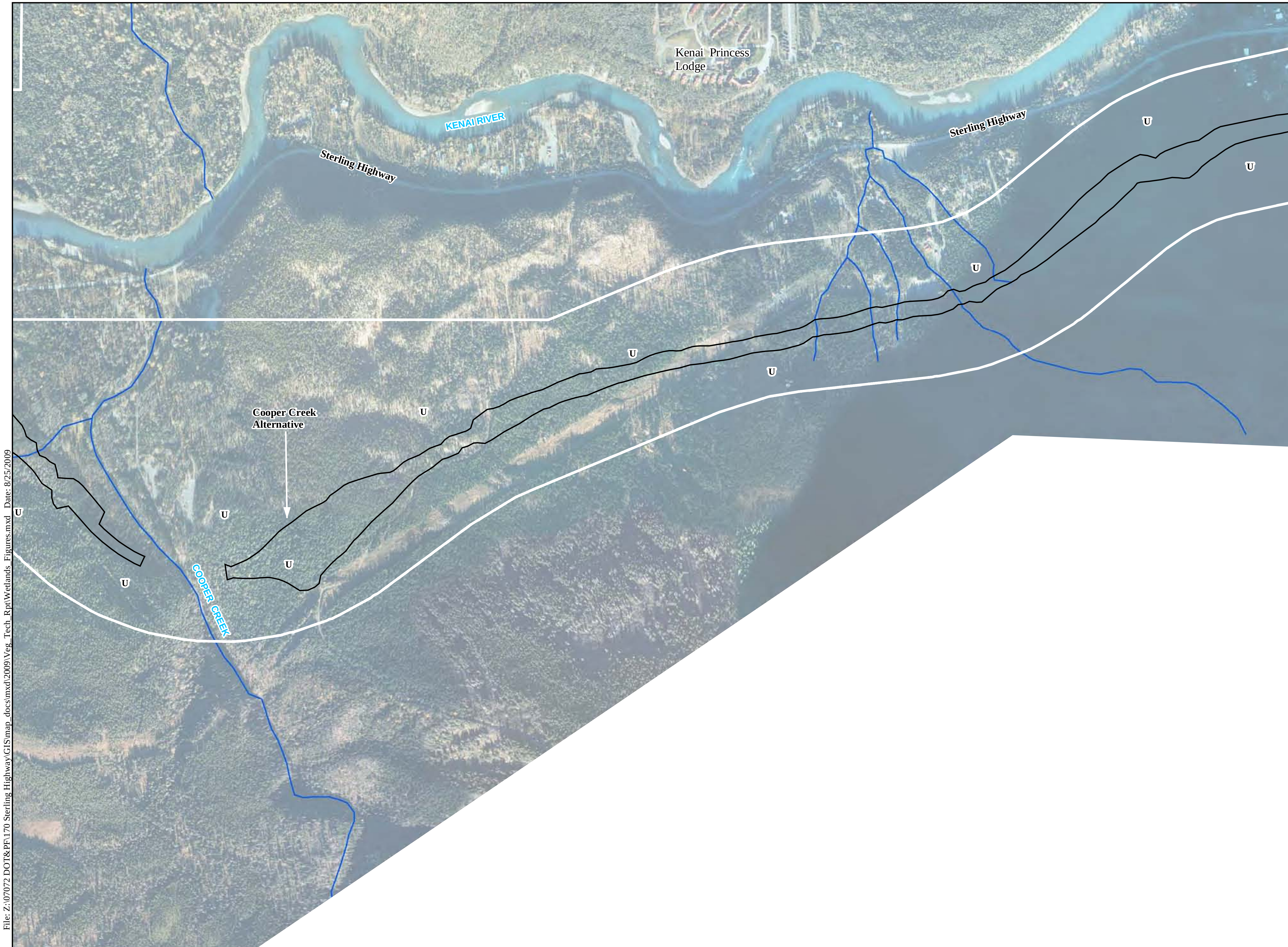

Sterling Highway Project MP 45 to 60 Wetland Delineation and Potential Wetland Impacts

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 8 OF 20

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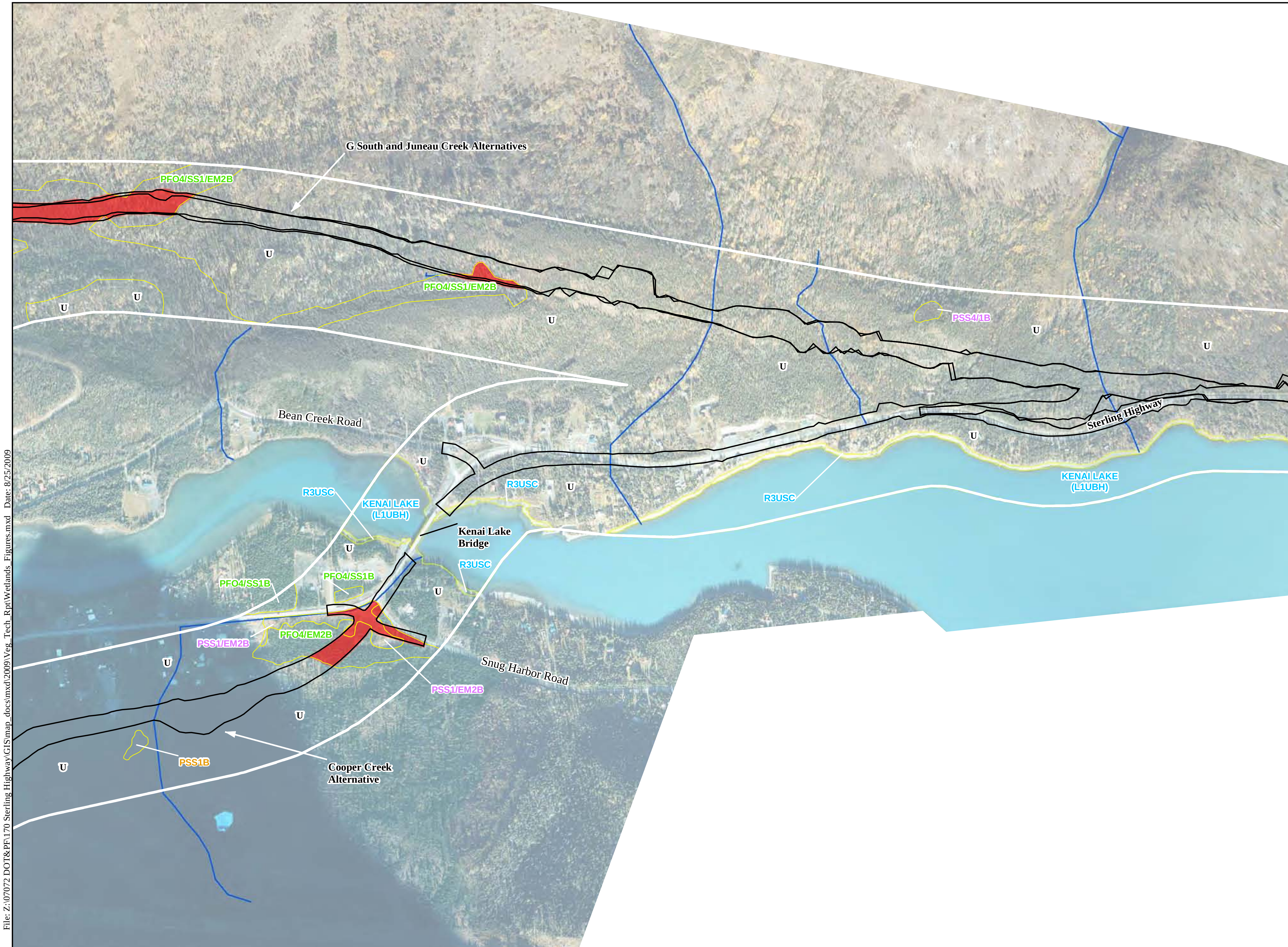
Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts



Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

Non-Wetlands
U

0 750 1,500
Feet
N

FIGURE 9 OF 10

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Sterling Highway Project
MP 45 to 60
Wetland Delineation and Potential Wetland Impacts

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams (R3UBH or R4SBC)

Major Wetland Types and
NWI Mapping Codes

Note: color of NWI label indicates wetland category

Forested Wetlands
PFO4B
PFO4/EM2B
PFO4/SS1/EM1B
PFO4/SS1/EM2B
PFO4/SS1B

Deciduous Shrub Thickets
PSS1A
PSS1B
PSS1/EM1B
PSS1/EM2B

Shrub Bogs
PSS1/4B
PSS1/EM1B
PSS1/EM2B
PSS4/1B
PSS4/EM1B
PSS4/EM2B

Emergent Wetlands
PEM1C
PEM1F
PSS1/EM1C

Other Jurisdictional Waters
L1UBH
PUBH
R3OWH
R3UBH
R3USC
R4SBC

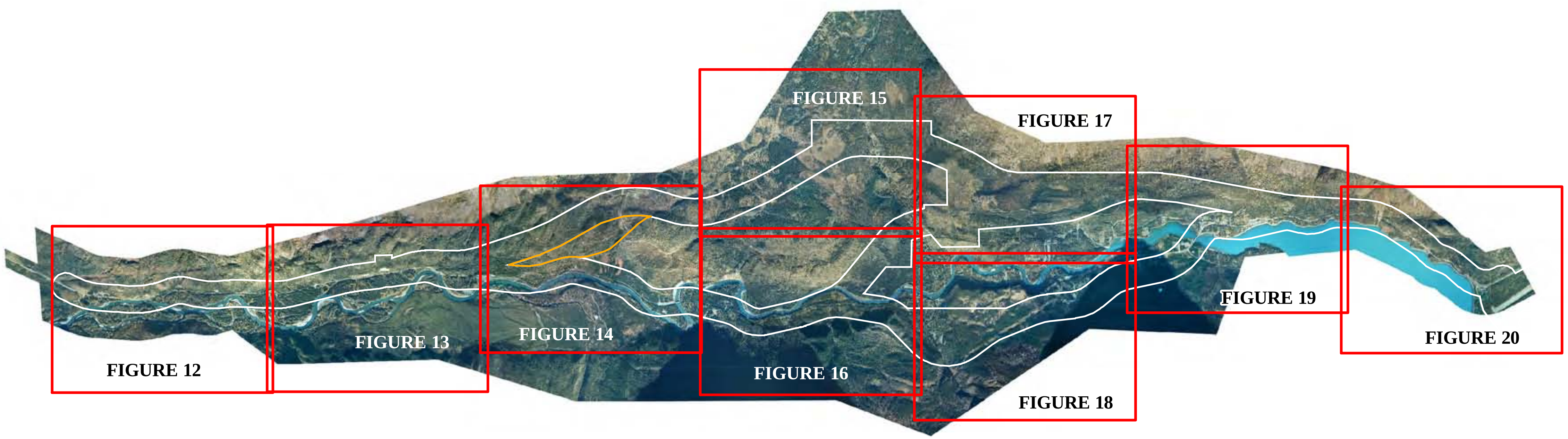
Non-Wetlands
U

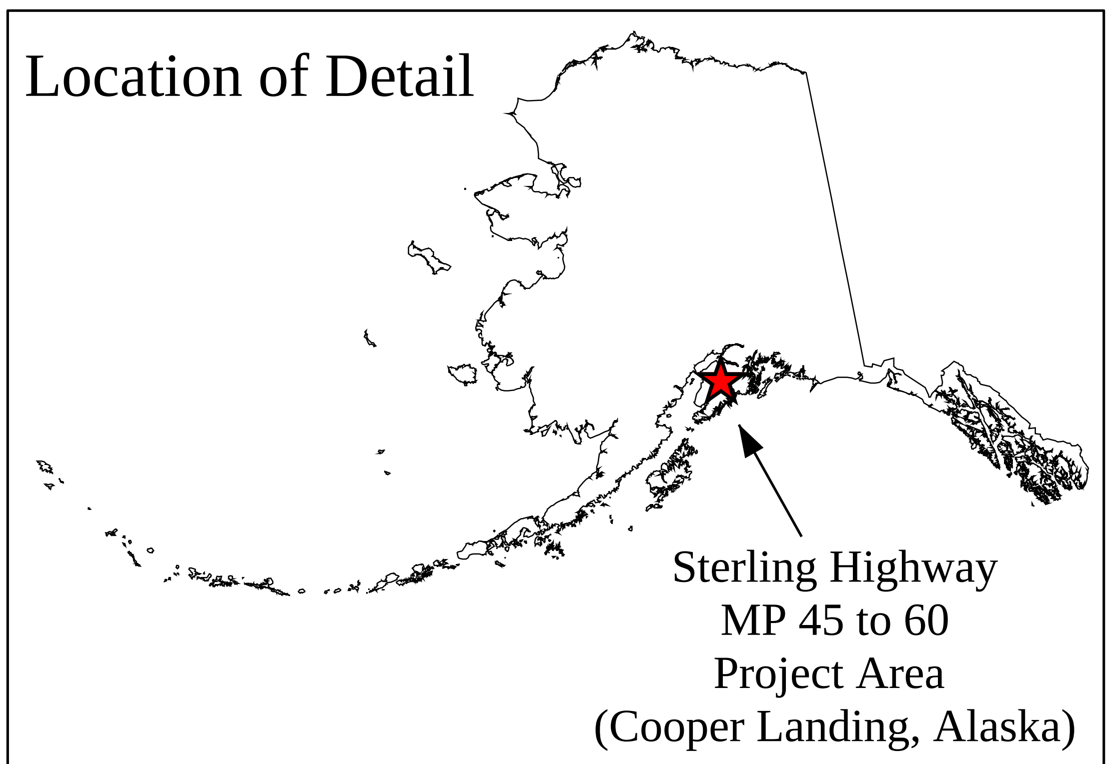
0 750 1,500
Feet
N

FIGURE 10 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Wetlands_Figures.mxd Date: 8/25/2009

Sterling Highway Project MP 45 to 60
Index Map for Wetland Functions and Values Figures





Sterling Highway Project MP 45 to 60

Wetlands Technical Evaluation Memorandum

Legend

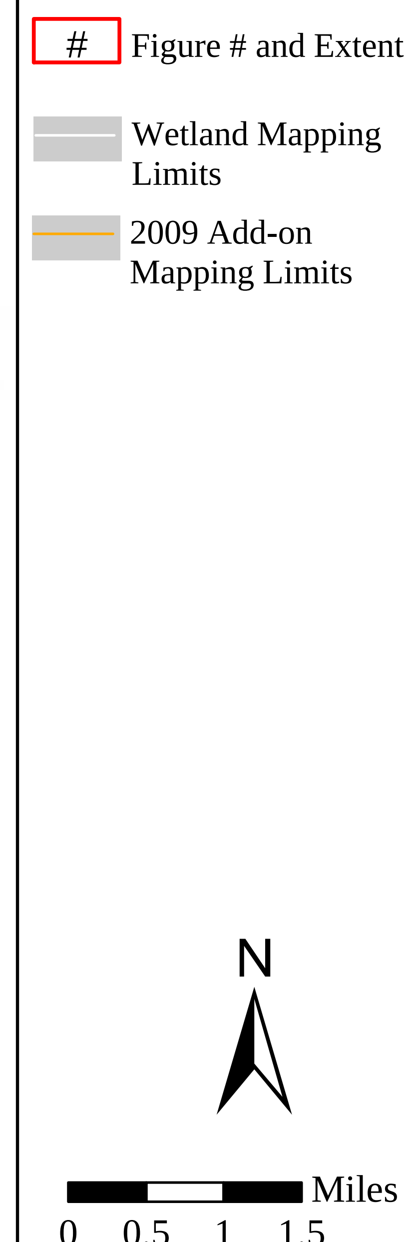
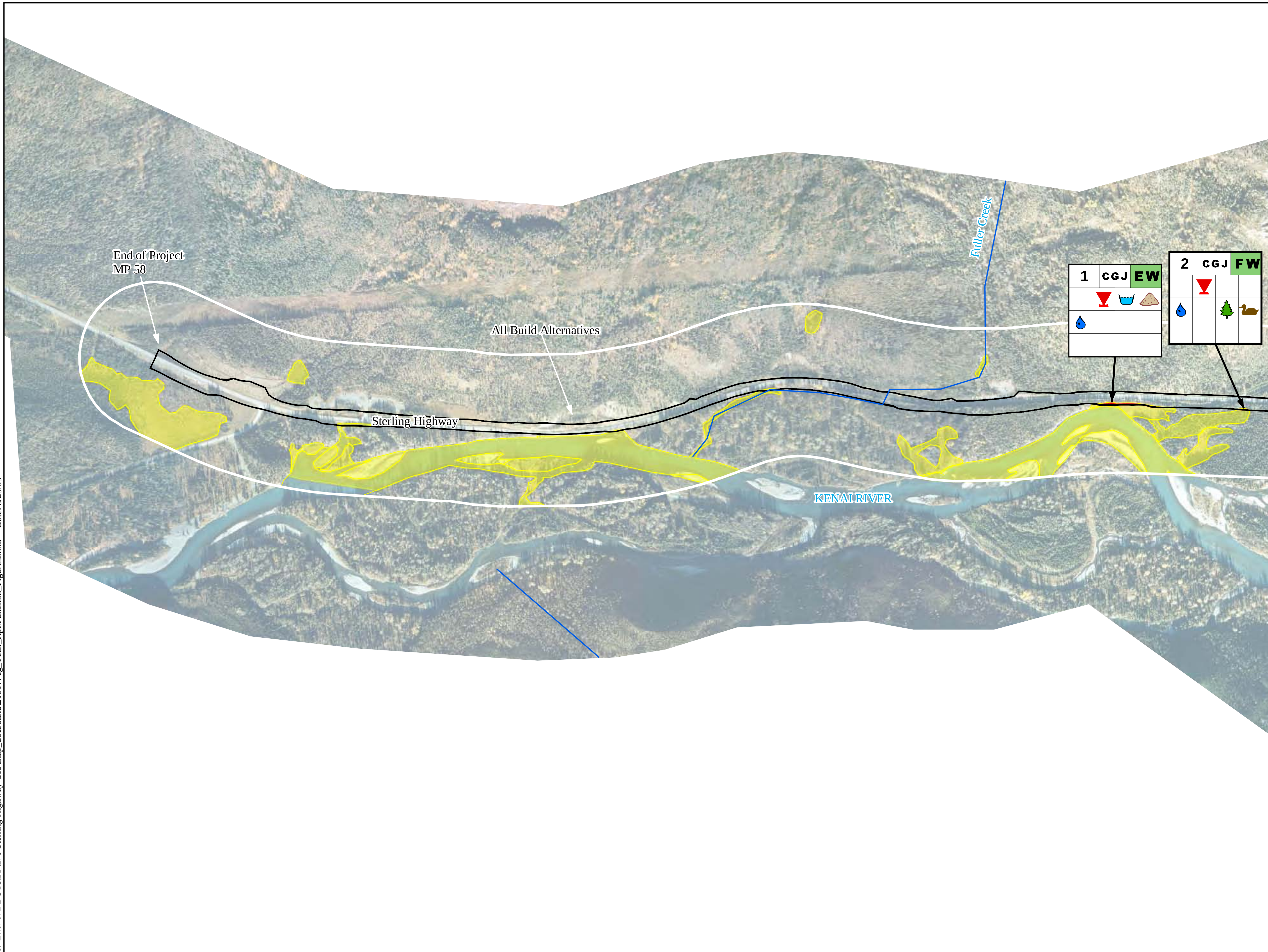


FIGURE 11

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Wetland_Tech_Rpt\2009 - Figure 11.mxd Date: 10-14-2009

Sterling Highway MP 45 - 60 Project
Wetland Functions and Values



Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
- Streams

SYMBOLS KEY

Wetland I.D.	Impacting Alternative	Wetland Type

Impacting Alternative

- C Cooper Creek Alternative
- G "G" South Alternative
- J Juneau Creek Alternative

Wetland Types

- FW Forested Wetland
- DST Deciduous Shrub Thicket
- SB Shrub Bog
- EW Emergent Wetland
- P Pond

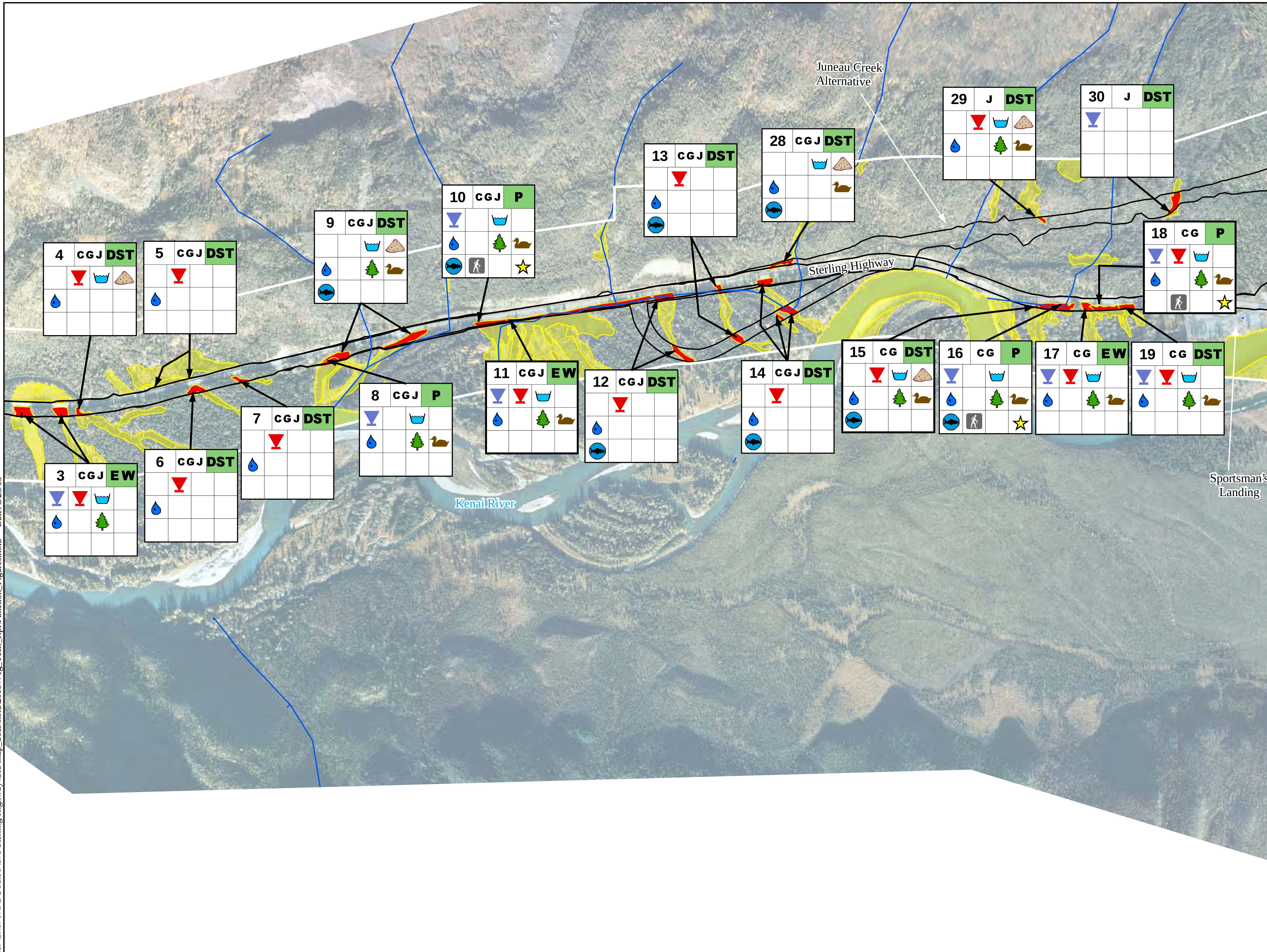
Wetland Functions

- Groundwater Recharge
- Groundwater Discharge
- Stream Flow Moderation
- Shoreline, Streambank, and Soil Stabilization
- Sediment Retention and Pollution Removal
- Food Chain Support
- Wildlife Habitat
- Fish Habitat
- Human Non-Consumptive Values
- Human Consumptive Values
- Uniqueness and Heritage

0 750 1,500
Feet
N

FIGURE 12 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09



Sterling Highway MP 45 - 60 Project Wetland Functions and Values

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
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- Fish Habitat
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- Human Consumptive Values
- Uniqueness and Heritage

0 750 1,500

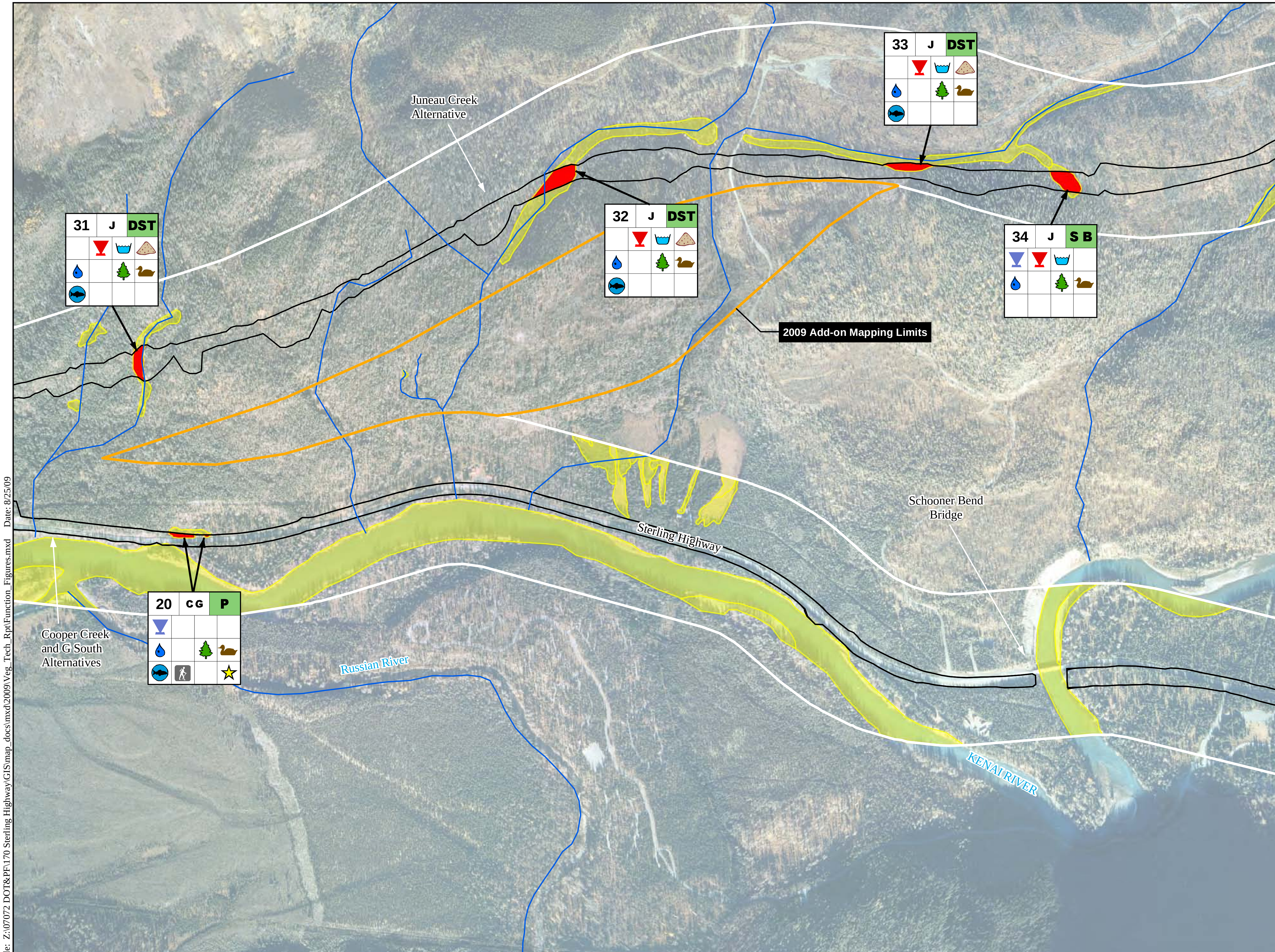
Feet

N

FIGURE 13 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09

Sterling Highway MP 45 - 60 Project
Wetland Functions and Values



Legend

- Project Alternatives (Cut/Fill)
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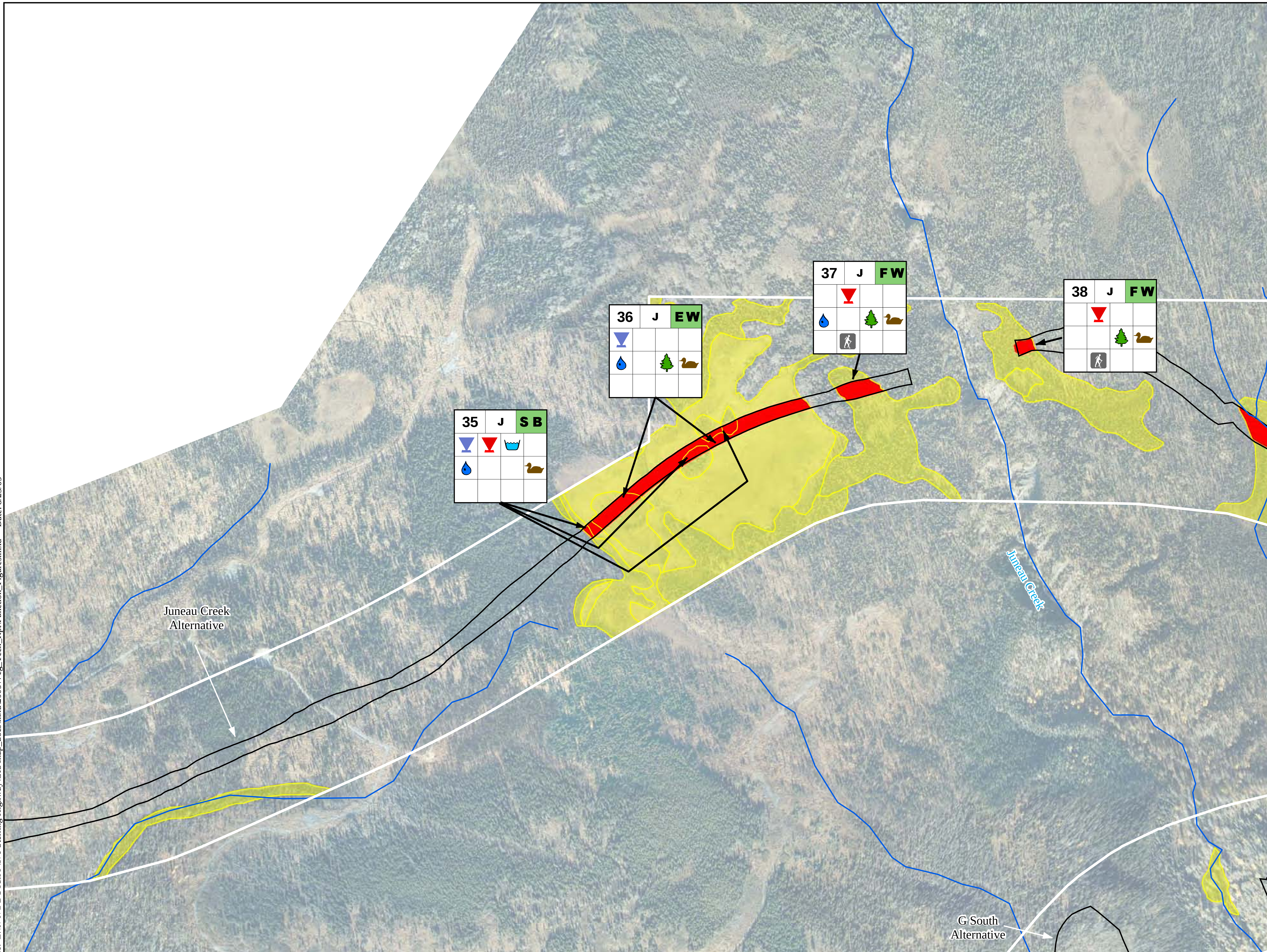
- Wildlife Habitat
- Fish Habitat
- Human Non-Consumptive Values
- Human Consumptive Values
- Uniqueness and Heritage

0 750 1,500
Feet
N

FIGURE 14 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09

Sterling Highway MP 45 - 60 Project
Wetland Functions and Values



Legend

- Project Alternatives (Cut/Fill)
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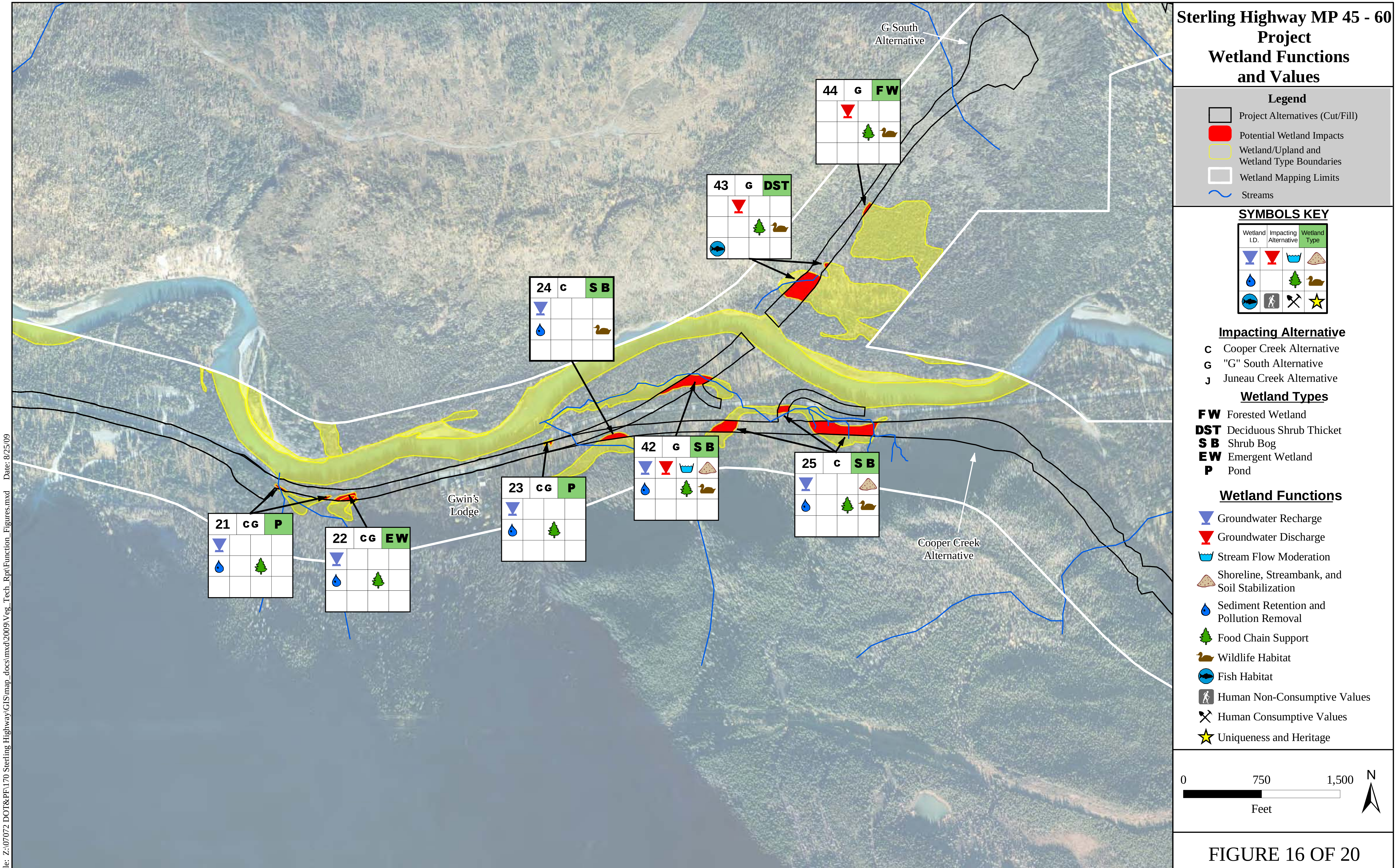
- Fish Habitat
- Human Non-Consumptive Values
- Human Consumptive Values
- Uniqueness and Heritage

0 750 1,500
Feet
N

FIGURE 15 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09


G South Alternative
44 G FW
43 G DST
24 C SB
42 G SB
25 C SB
23 CG P
21 CG P
22 CG EW
Gwin's Lodge
Cooper Creek Alternative
Sterling Highway MP 45 - 60 Project
Wetland Functions and Values
Legend
Project Alternatives (Cut/Fill)
Potential Wetland Impacts
Wetland/Upland and Wetland Type Boundaries
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Impacting Alternative
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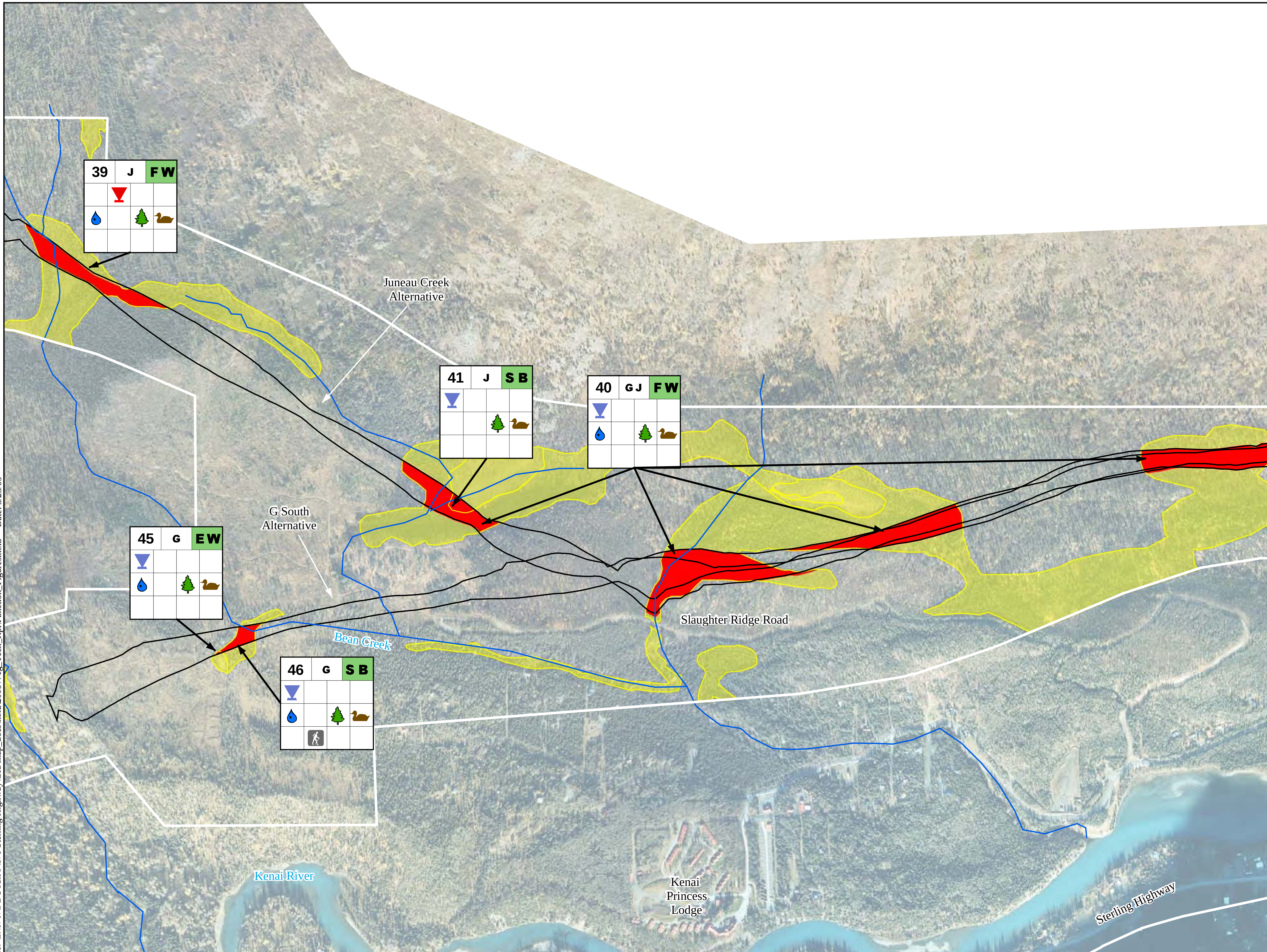
Sediment Retention and Pollution Removal
Food Chain Support
Wildlife Habitat
Fish Habitat
Human Non-Consumptive Values
Human Consumptive Values
Uniqueness and Heritage
0
750
1,500
Feet
N
FIGURE 16 OF 20
File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09



Sterling Highway MP 45 - 60 Project Wetland Functions and Values

Legend

- Project Alternatives (Cut/Fill)
- Potential Wetland Impacts
- Wetland/Upland and Wetland Type Boundaries
- Wetland Mapping Limits
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- Fish Habitat
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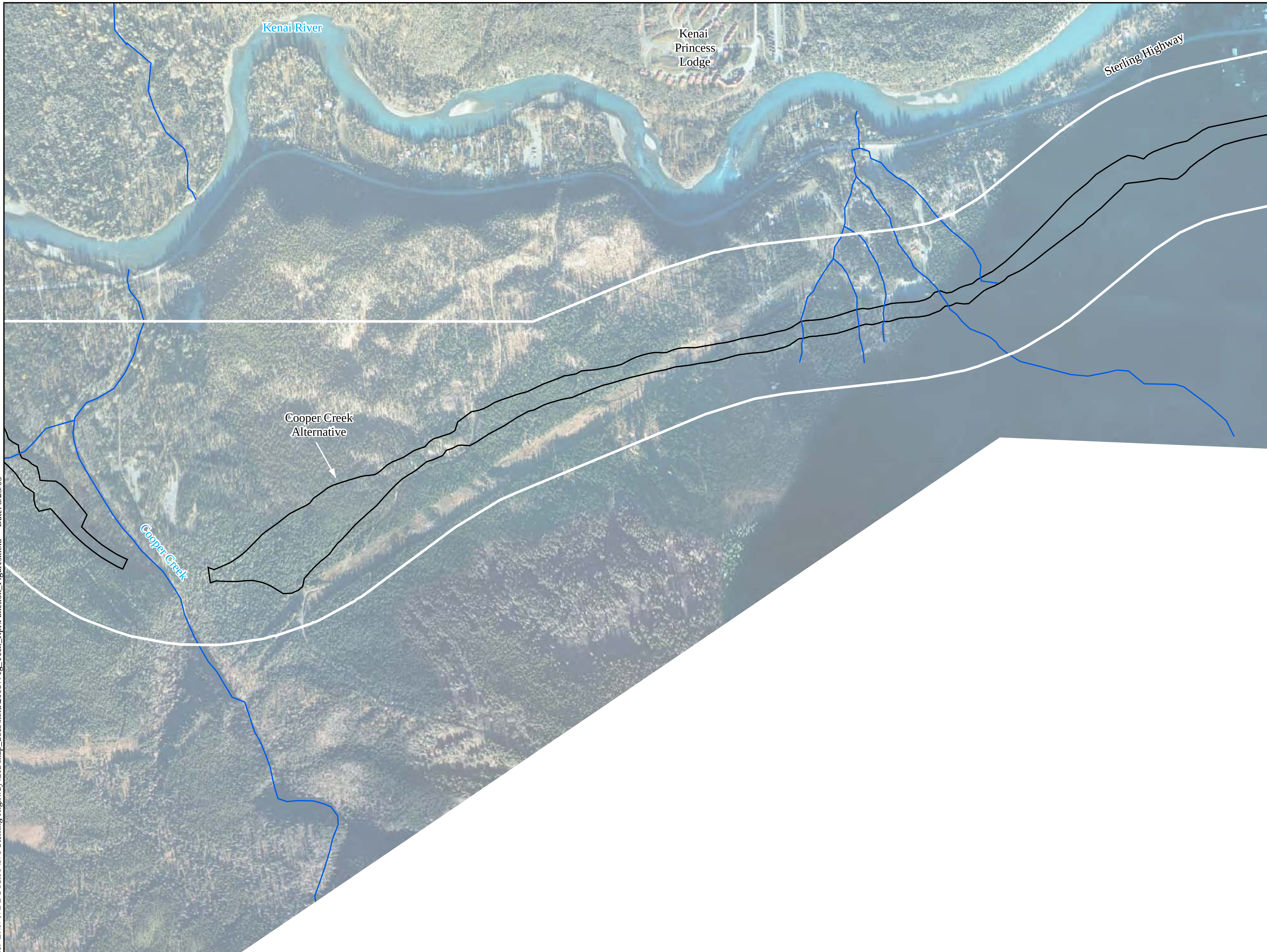
- Human Consumptive Values
- Uniqueness and Heritage

0 750 1,500
Feet
N

FIGURE 17 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09



Sterling Highway MP 45 - 60 Project Wetland Functions and Values

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- Human Consumptive Values
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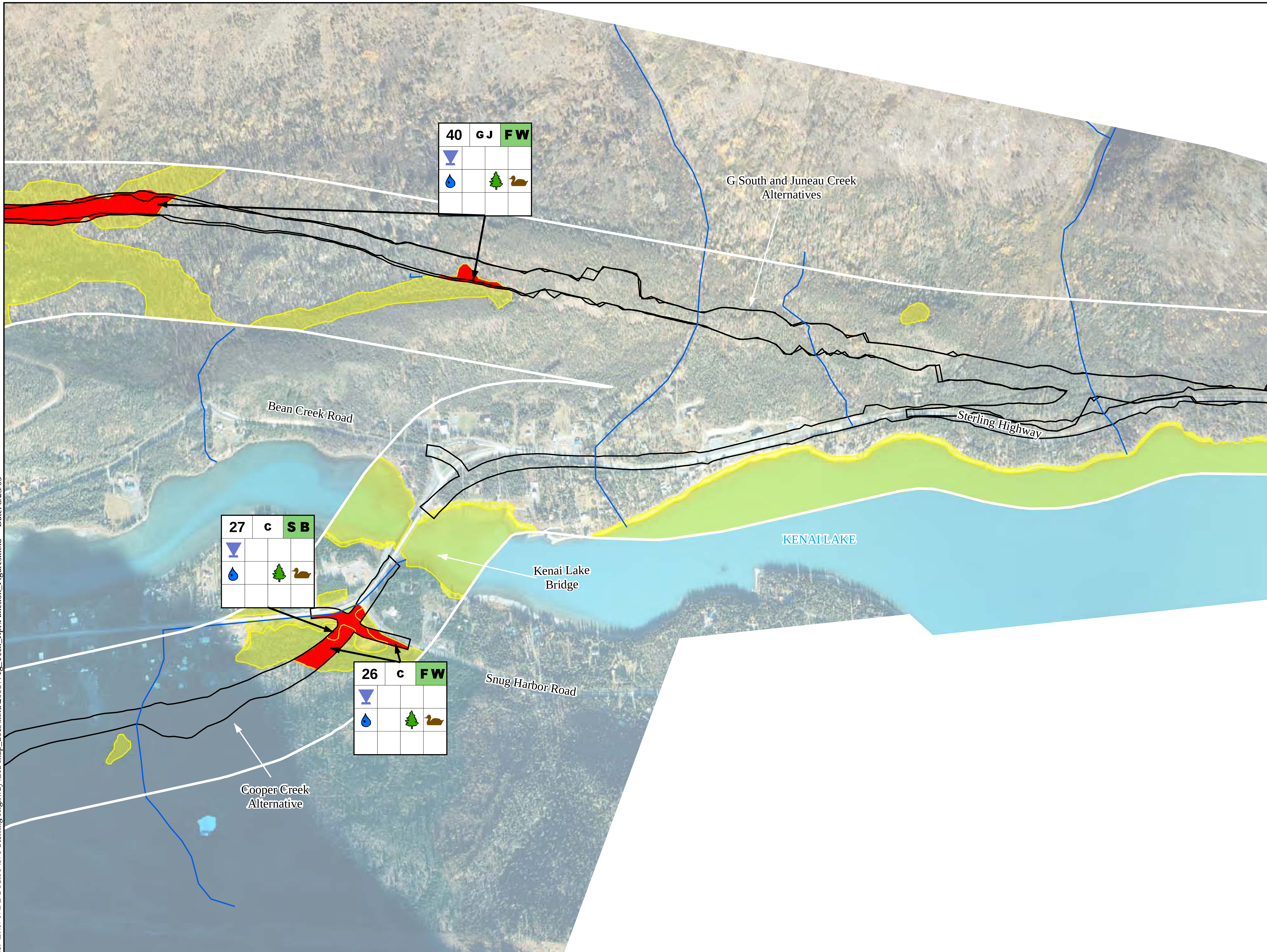
0 750 1,500
Feet
N

FIGURE 18 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09

Sterling Highway MP 45 - 60 Project
Wetland Functions and Values



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- Human Consumptive Values
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0 750 1,500
Feet
N

FIGURE 19 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09

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0 750 1,500
Feet
N

FIGURE 20 OF 20

File: Z:\07072 DOT&PF\170 Sterling Highway\GIS\map_docs\mxd\2009\Veg_Tech_Rpt\Function_Figures.mxd Date: 8/25/09