16 Wetlands

16.1 Wetland Setting

Wetlands are dynamic depressional, or slightly sloping ecosystems that are saturated with water for a significant period during the growing season (Warner and Rubec 1997). They include both the wet basin and transitional areas surrounding the basin and upland vegetation (Huel 2000). Wetland ecosystems are important in performing a wide range of ecological, hydrological, biochemical, and habitat functions (Milko 1998; Hanson et al. 2008) and are valued by society (Lynch-Stewart & Associates 2000; Mitsch and Gosselink 2000b).

Wetlands are present throughout the KSM Project (the Project) area and will be directly affected by development of the Tailing Management Facility (TMF) and other Project components. Wetland values were incorporated into the KSM environmental assessment because a preliminary effects screening identified a strong likelihood of the Project adversely affecting wetlands, and First Nations and government regulators (Environment Canada) identified them as important components of a comprehensive assessment. Seabridge committed to following the spirit of the federal policy on wetland conservation (Environment Canada 1991). This assessment and the supporting wetland baseline study (Appendix 16-A) and compensation plan (Appendix 16-B), and wetland management plan (Chapter 26.19) were drafted to reflect the values of parties interested in wetland ecosystems.

Six Broad Ecosystem Units (BEC) units occur within the region of the Project, including both coastal and interior units (Table 16.1-1). Four of the six BEC units are forested, while two are alpine/parkland units. The two alpine BEC units, Boreal Altai Fescue Alpine undifferentiated parkland (BAFAunp) and Coastal Mountain-heather Alpine undifferentiated parkland (CMAunp), together contribute to more than 40% of the study areas.

Wetland ecosystems accounted for approximately 522.2 ha representing less than 3% of the land base within the local baseline study area (BSA), as defined in Section 16.1.1.1. This figure is less than the published 5.6% estimated wetland land base in British Columbia (BC MOE 2011). Large portions of the local BSA consist of rocks, ice, or large dynamic river floodplain systems, environments which tend to preclude the formation of many wetland ecosystems. The average size of a wetland ecosystem within the proposed infrastructure areas is 2.3 ha with the largest wetland area estimated at approximately 85.4 ha.

Baseline studies of the physical, chemical, and biological characteristics of wetlands within the local BSA were conducted in 2008 and 2009 (Appendix 16-A); baseline data for the Treaty Creek access road (TCAR) was collected in 2011 and 2012, and is presented in Appendix 17-B. Field surveys and provincial inventory data were used to classify and map wetlands within the local BSA.

16.1.1 Methodology Overview

The following section provides an overview of the study area, methods, and data used for the characterization of wetlands in the local BSA.

Table 16.1-1. BEC Units in the Regional Baseline Study Area

BEC Unit Name	Description	BEC Unit Label	RSA Extent (ha)	RSA Extent (%)
Boreal Altai Fescue Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	BAFAunp	87,995	26
Coastal Mountain-heather Alpine - Undifferentiated Parkland Subzone	Alpine/Parkland	CMAunp	65,036	19
Coastal Western Hemlock - Wet Maritime Subzone	Low elevation forest (coastal)	CWHwm	17,835	5
Engelmann Spruce – Subalpine Fir Wet Very Cold Subzone	Subalpine forest (interior)	ESSFwv	81,443	24
Interior Cedar Hemlock - Very Wet Cold Subzone	Low elevation forest (interior)	ICHvc	47,404	14
Mountain Hemlock - Leeward Moist Maritime Variant*	Subalpine forest (coastal)	MHmm2	38,294	11
Total			**338,008**	**100**

*** The official ecological classification of the Mountain Hemlock BEC unit in the vicinity of the KSM Project is currently incomplete; subzones and/or variants are not yet recognized or documented for this area. However, data collected by field personnel during the 2008 to 2012 baseline field studies, and consultation with the research ecologist at the Ministry of Forests, Lands, and Natural Resource Operations office in Smithers, resulted in reclassification of the KSM Project location from MHun (undifferentiated) to the Mountain Hemlock leeward moist maritime (MHmm2) BEC unit.**

16.1.1.1 Local Baseline Study Area

The local BSA (Figure 16.1-1) is composed of two parts and is 20,018 ha in total. The two sections of the local BSA are: 1) the Mine Site infrastructure and Coulter Creek access road (CCAR; west side); and 2) the TMF and the TCAR (east side). The local BSA for the 2008 to 2009 study was established using the terrestrial ecosystem mapping (TEM) study area. This area provided a broad zone within the mine development area and allowed sufficient detail to be collected from individual wetland sites. The study area was updated in 2011 to reflect changes to the proposed access routes; namely selection of the TCAR over the Teigen Creek access road.

The local BSA is different from the regional and local study areas (used for the impact assessment) discussed in this chapter; however, the local BSA is important to mention because it detailed wetland information was collected within this area.

16.1.1.2 Wetland Ecosystem Survey

A total of 111 wetland surveys were conducted in September 2008 and July 2009. Additional sites were mapped from ecosystem mapping data (Appendix 17-A) and Terrain Resource Information Management (TRIM) data in 2011. Survey methodology followed *Field Description of Wetland and Related Ecosystems in the Field* (MacKenzie 1999) and *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004). Data collected during the field surveys were used to classify wetland ecosystems and determine wetland extent and function. A total of 227 wetlands covering 522.2 ha were identified in the local BSA.

PROJECT # 868-016-27 GIS No. KSM-22-022 January 18, 2013

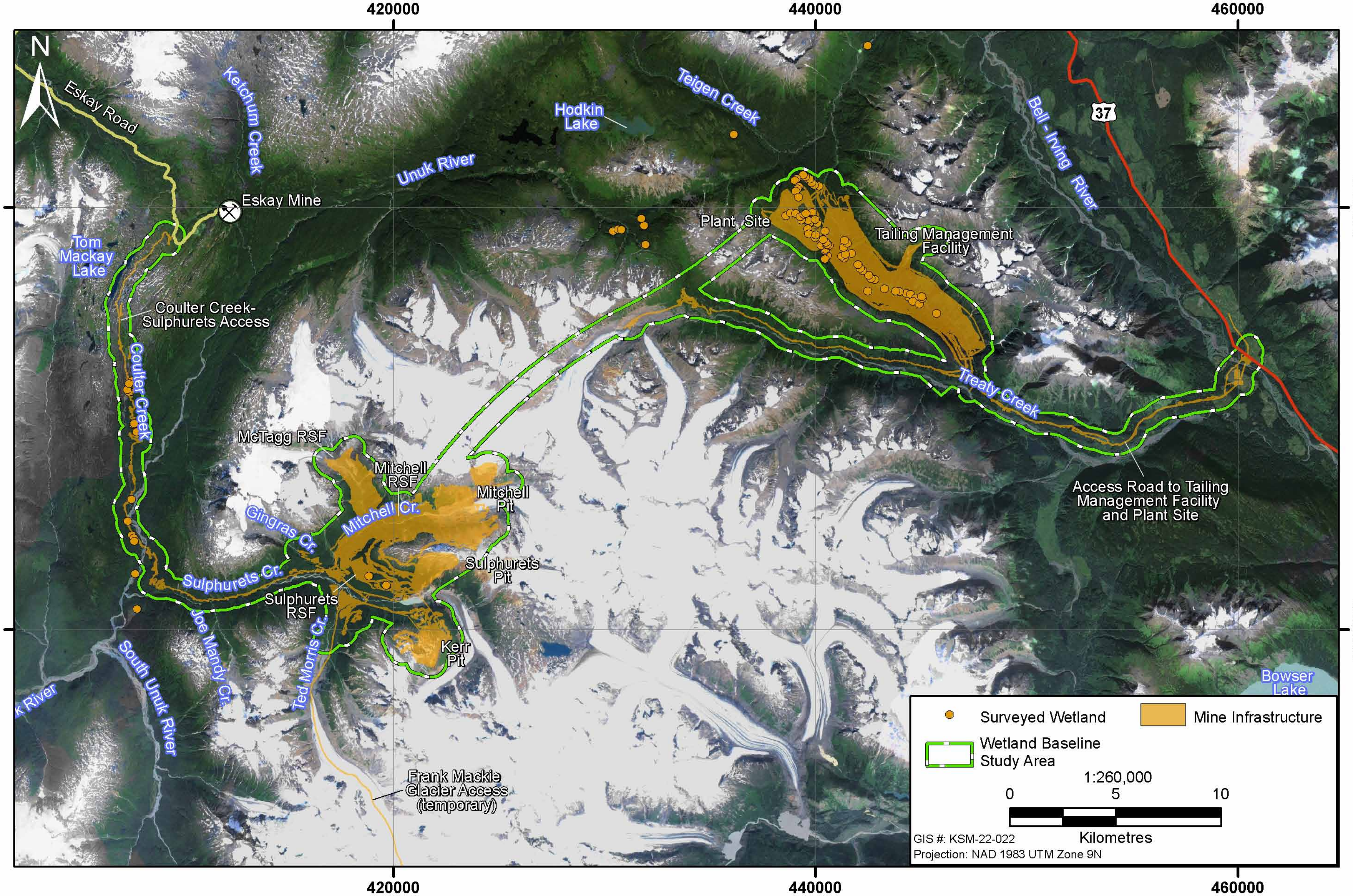


Figure 16.1-1

SEABRIDGE GOLD
KSM PROJECT

KSM Wetland Local Baseline Study Area and Mapped Wetland Sites

Rescan
Engineers & Scientists

Figure 16.1-1

The following data were recorded at each survey site:

- hydrodynamic index, a measure of vertical/lateral water flow through a wetland;
- water presence above or below the ground and its availability through surface or groundwater pathways;
- the sketched boundaries of the wetland;
- soil pit information including hydric soil indicators, rooting depth, and depth to water;
- measurements of soil water and surface water pH and conductivity;
- peat development, state of decomposition, and texture; and
- plant species and relative percent cover with a focus on wetland association indicator species.

16.1.1.3 Wetland Classification and Mapping Wetland Extent

Wetland classification is a process whereby ecologically important factors are interpreted so that commonalities among wetlands can be identified. The classification process in BC integrates several classification models into a single hierarchical framework (MacKenzie and Moran 2004). The "Class" concept, as described in the Canadian Wetland Classification System (Warner and Rubec 1997), is used as the broad description of a site. The "Site Association" concept is used as a more precise description of individual sites, often characterized by vegetation associations. Each of the five wetland classes—bog, fen, marsh, swamp, and shallow open water—is composed of site associations, which are defined as sites capable of supporting a similar community at climax (MacKenzie and Moran 2004; Table 16.1-2).

The classification is used to determine rare and sensitive ecosystems and aids in describing wetland function. Wetlands are listed provincially by the BC Conservation Data Centre (BC CDC; BC MOE 2007) as either:

- **red-listed:** any ecological community that is extirpated, endangered, or threatened in British Columbia; or
- **blue-listed**: any ecological community considered to be of special concern (formerly vulnerable) in British Columbia.

The presence of a listed wetland was determined by comparing the wetland associations identified during the field surveys to a list of ecosystems identified by the BC CDC as being within similar biogeoclimatic ecosystem classification (BEC) subzones within the regional Forest District (Skeena Stikine Forest District). Wetland associations matching those from the BC CDC list were then classified as red- or blue-listed.

Wetland extent was delineated from ortho-images using Terrestrial Resource Information Management (TRIM) data and data from field surveys. A geographic information system (GIS) product was developed to improve wetland spatial information because TRIM does not map marshes smaller than 1.0 ha or swamps smaller than 2.0 ha, and it does not encompass all wetland classes. While TRIM data are useful for identifying large swamp, marsh, and open water wetlands, they do not contain sufficient information to evaluate the effects of the Project.

Table 16.1-2. Description of Wetland Classes

Wetland Class	Description
Bogs	• Shrubby or treed, nutrient-poor peatlands • pH less than 5.5 • Ericaceous shrubs and hummock-forming Sphagnum species • Highly acidic and oxygen-poor soil conditions • Form basins where peat accumulation has raised the wetland surface above groundwater flow
Fens	• Peatlands where groundwater inflow maintains relatively high mineral content within the rooting zone • pH usually above 5 • Non-ericaceous shrubs, sedges, grasses, reeds, and brown mosses • Develop in basins, lake margins, river floodplains, and seepage slopes, where the water table is usually at or just below the peat surface for most of the growing season
Marshes	• Shallowly flooded mineral wetland dominated by emergent grass-like vegetation • A fluctuating water table is typical in marshes • Exposure of the substrate in late season or during dry years is common • Nutrient availability is high
Swamps	• Shallowly flooded mineral wetland dominated by tall woody vegetation (trees and tall shrubs) • A fluctuating water table is typical in marshes • Exposure of the substrate in late season or during dry years is common • Nutrient availability is high
Open Water	• Open water areas < 2 m deep • > 10% cover by emergent, submergent, or floating leaved aquatic vegetation

16.1.1.4 Wetland Function

Wetland function is defined as a process or series of processes that a wetland performs. These include wetland ability to regulate water levels and attenuate flow, to filter water and improve water quality, and to provide aquatic and terrestrial habitat for wetland-dependent or wetland-associated species. Wetland function is separated into four primary categories: hydrological, biochemical, ecological, and habitat (Milko 1998; Table 16.1-3).

Table 16.1-3. Wetland Function and Associated Fieldwork Component

Wetland Function	Description	Supporting Data
Hydrological	Contribution of the wetland to the quantity of surface water and groundwater	• Ecosystem Survey (hydrodynamics) • Static Hydrology Survey
Biogeochemical	Contribution of the wetland to the quality of surface water and groundwater	• Ecosystem Survey (soil water pH and conductivity measurements) • Wetland Classification (wetland class)

(continued)

Table 16.1-3. Wetland Function and Associated Fieldwork Component (completed)

Wetland Function	Description	Supporting Data
Habitat	Relative abundance of terrestrial and aquatic habitat and connectivity to surrounding ecosystem	• Ecosystem Survey (wildlife observations) • Wetland Classification (wetland class)
Ecological	Role of the wetland in the surrounding ecosystem	• Ecosystem Survey (wetland size and distribution) • Wetland Classification (wetland complexes, rare or unique wetlands)

Wetland functions include a series of complex interactions between various wetland components such as water, soil, and vegetation. Table 16.1-3 shows which aspects of wetland functions are described by field data.

The principle wetland functions for each wetland class were determined by integrating data collected in support of the functional component of the baseline study, individual wetland class and landscape position, and scientific literature, principally Hanson et al. (2008). To describe wetland hydrological function within the TMF, wetland hydrology studies were conducted in the summers of 2008 and 2009 at three representative wetlands. The purpose of the wetland hydrology monitoring program was to observe water table fluctuations throughout the year in different wetland locations. The wetland hydrology study consisted of static and continuous water level measurements taken from monitoring wells at three wetlands within the study area (Figures 16.1-2 and 16.1-3).

16.1.2 Results Overview

16.1.2.1 Wetland Classification

Four of the five wetland classes—fen, marsh, swamp, and shallow open water—were observed in the study area. They were classified to wetland association following MacKenzie and Moran (2004). Bog communities were not encountered during wetland field studies. A total of 18 wetland associations, including a number of TRIM wetlands, shallow open water features, an unclassified fen, and a sedge-willow swamp, were identified (Table 16.1-4). Some of the most common wetland associations observed were:

- Water sedge – Peat-moss fen (Wf03, Plate 16.1-1);
- Barclay’s willow – Water sedge – Glow moss fen (Wf04, Plate 16.1-2); and
- Narrow-leaved cotton-grass – Marsh-marigold fen (Wf12, Plate 16.1-3).

PROJECT # 868-016-27 GIS No. KSM-022-023a October 23, 2012

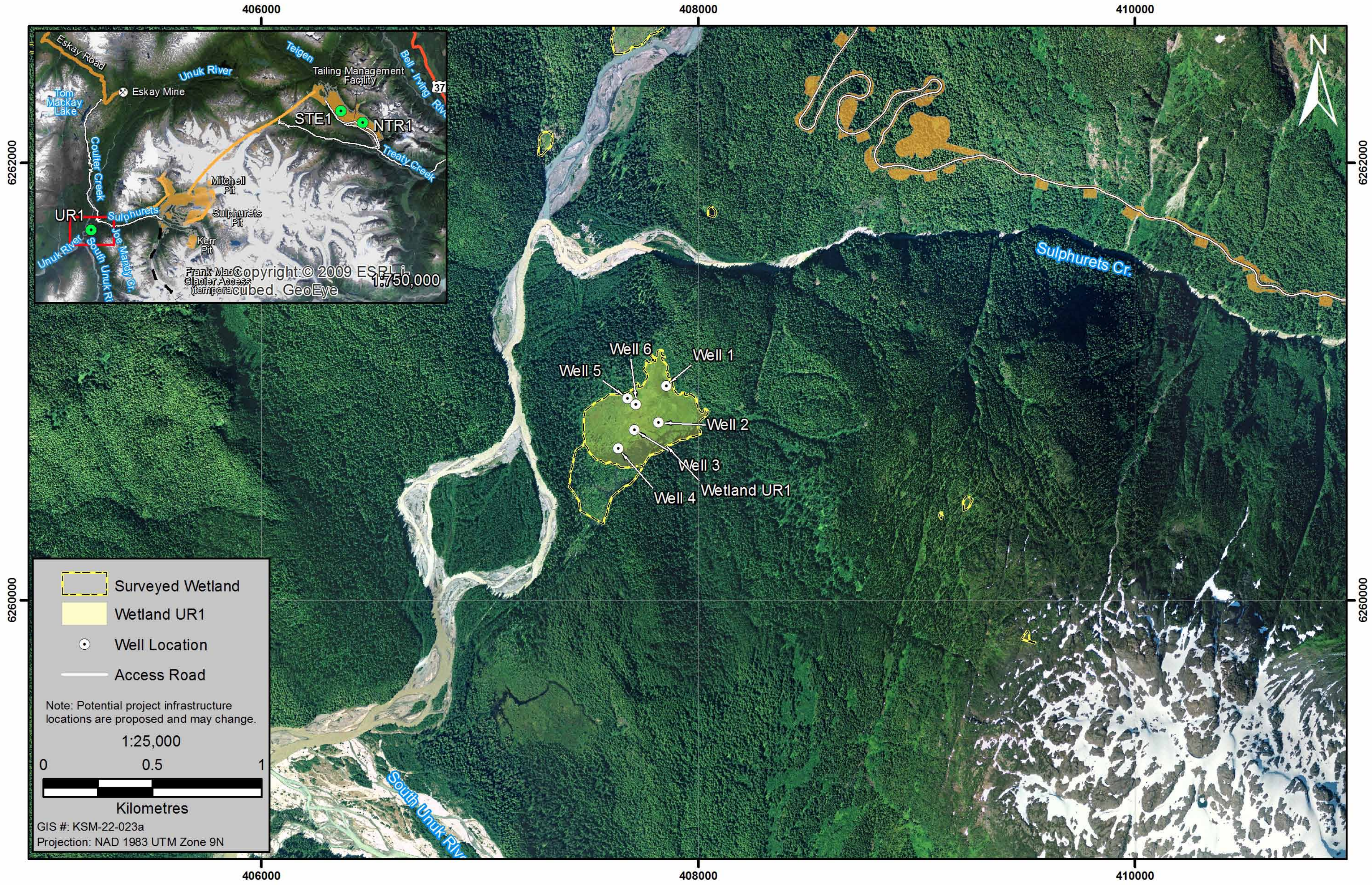


Figure 16.1-2

Wetland UR1 Location

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

Figure 16.1-2

PROJECT # 868-016-27 GIS No. KSM-022-023b October 23, 2012

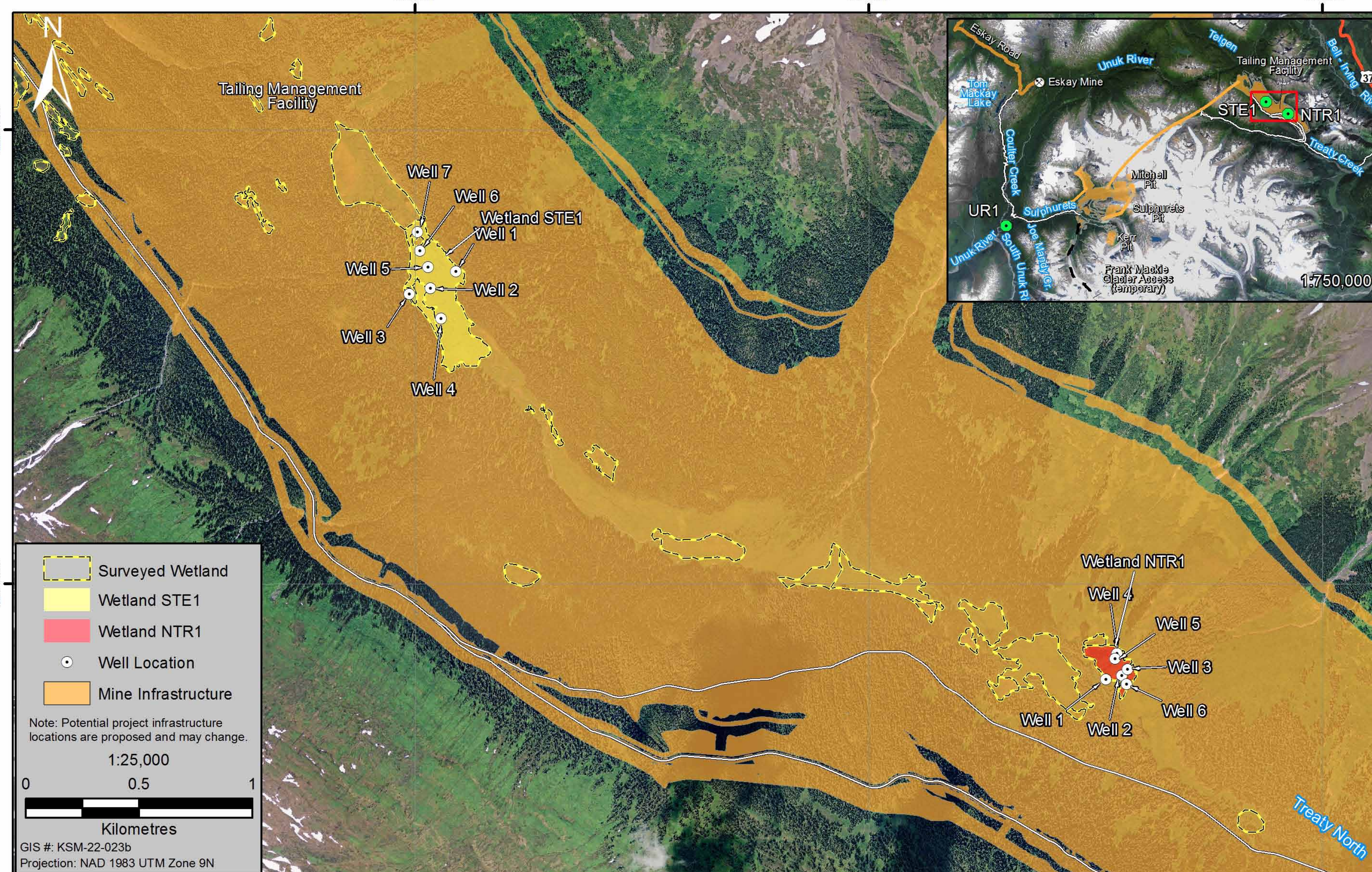


Figure 16.1-3

Wetlands STE1 and NTR1 Locations

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

Figure 16.1-3

Table 16.1-4. Wetland Associations Observed in the KSM Project Wetland Study

Wetland Class and Association[1]	Total Wetland Observations (Decile[2] 1)	Total Wetland Observations (Decile[2] 2)	Total Wetland Observations (Decile[2] 3)
Fen			
Unclassified	1	-	-
Wf03	18	3	-
Wf04	8	18	2
Wf08	1	-	-
Wf12	20	1	-
Wf13	5	-	-
Wf50	11	-	-
Marsh			
Wm01	2	-	-
TRIM Marsh	20	-	-
Swamp			
Ws06	4	1	-
Ws08	1	-	-
Ws09	6	-	-
Ws54	1	-	-
Willow - Sedge	2	-	-
TRIM Swamp	14	-	-
Shallow Open Water			
Open Water	2	13	-
Yellow Pond Lily	0	2	1
TRIM Open Water	111		
Total	**227[3]**	**38**	**3**

[1] Wetland association codes were adapted from MacKenzie and Moran (2004). The letter portion indicates the wetland class (Wf=Fen, Ws= Swamp, Wb=bog, and Wm=marsh) and the numeric portion identifies which vegetation community was identified in accordance with MacKenzie and Moran (2004).
[2] A decile is the percentage of a wetland ecosystem that a given community is observed to occupy. For instance a marsh wetland may have two deciles: the primary marsh community (decile 1), and the associated open water component (decile 2). Together these make up the wetland but for the purpose of classification and inventory have been recorded separately.
[3] Total number of wetlands identified in the study area.

16.1.2.2 Wetland Extent

Wetlands cover 522.3 ha (2.6%) of the 20,018 ha local BSA (Section 16.1.1.1). The average size of a wetland within the local BSA is 2.3 ha. Overall, TRIM swamps account for the majority of the wetland area (Table 16.1-5). Of the classified wetlands, fens cover the largest area at 70.6 ha with the greatest proportion belonging to the Wf03 and Wf04 associations. The spatial distribution of wetlands is presented in Figures 16.1-4a-d to 16.1-5a-b and is detailed in Appendix 16-A.

Plate 16.1-1. Peat-moss (Wf03) fen at Site KS50 (North Cell – TMF).

Plate 16.1-2. Barclay's willow – Water sedge – Glow moss (Wf04) fen at Site KS42 (South Cell – TMF).

Plate 16.1-3. Narrow-leaved cotton-grass – Marsh-marigold (Wf12) fen at Site KS72 (Plant Site Area).

Table 16.1-5. Area of Wetland Classes and Associations in the KSM Wetland Local Baseline Study Area

Wetland Class and Association[1]	Wetland Area (ha; Decile[2] 1)	Wetland Area (ha; Decile[2] 2)	Wetland Area (ha; Decile[2] 3)	Total (ha)
Unclassified	0.2	-	-	0.2
Wf03	18.5	1.2	-	19.7
Wf04	12.9	8.8	0.4	22.1
Wf08	0.9	-	-	0.9
Wf12	8.9	0.3	-	9.2
Wf13	10.6	-	-	10.6
Wf50	7.9	-	-	7.9
Total Fen Class	**59.9**	**10.3**	**0.4**	**70.6**
Wm01	1.6	-	-	1.6
TRIM Marsh	34.0	-	-	34
Total Marsh Class	**35.6**	**-**	**-**	**35.6**
Ws06	13.6	0.4	-	14.0
Ws08	0.6	-	-	0.6
Ws09	1.7	-	-	1.7
Ws54	0.2	-	-	0.2

(continued)

Table 16.1-5. Area of Wetland Classes and Associations in the KSM Wetland Local Baseline Study Area (completed)

Wetland Class and Association[1]	Wetland Area (ha; Decile[2] 1)	Wetland Area (ha; Decile[2] 2)	Wetland Area (ha; Decile[2] 3)	Total (ha)
Willow - Sedge	1.9	-	-	1.9
TRIM Swamp	355.9	-	-	355.9
Total Swamp Class	**373.9**	**0.4**	**-**	**374.3**
Open Water	2.4	3.1	-	5.5
Yellow Pond Lily	-	0.1	0.1	0.2
TRIM Open Water	36.1	-	-	36.1
Total Shallow Open Water Class	**38.5**	**3.2**	**0.1**	**41.8**
Grand Total	**507.9**	**13.9**	**0.5**	**522.3**

[1] Wetland association codes were adapted from MacKenzie and Moran (2004). The letter portion indicates the wetland class (Wf=Fen, Ws= Swamp, Wb=bog, and Wm=marsh) and the numeric portion identifies which vegetation community was identified in accordance with MacKenzie and Moran (2004).
[2] A decile is the percentage of a wetland ecosystem that a given community is observed to occupy. For instance a marsh wetland may have two deciles: the primary marsh community (decile 1), and the associated open water component (decile 2).

16.1.2.3 Wetland Function

The functions of each wetland were not identified; however, wetland functions were identified for wetland classes and associations following Hanson et al. (2008). Additionally, data from specific aspects of the wetland ecosystem survey and a study of wetland hydrology at select sites were used to complete the descriptions of wetland function. The following is a description of wetland functions identified for each observed wetland class (Table 16.1-6.)

Table 16.1-6. Summary of Primary Wetland Function within the Local Baseline Study Area

Wetland Class	Wetland Functions			
	Hydrological Functions	Biochemical Functions	Ecological Functions	Habitat Functions
Fen	Groundwater recharge, potential downstream flood mitigation	Carbon storage, nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	Large mammal foraging habitat, migratory bird habitat, bat foraging habitat (open areas)
Marsh	Downstream flood mitigation	Nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	General wildlife habitat, large mammal foraging habitat, bat foraging habitat (open areas)
Swamp	Water retention, downstream flood mitigation	Carbon storage, nutrient cycling, water quality improvements	Wetland complexes and habitat diversity	General wildlife habitat, large mammal foraging and thermoregulation habitat, fish habitat (riparian swamps), bat roosting areas where large trees are present
Shallow Open Water	Extended water storage within the landscape	Water quality improvements	Wetland complexes and habitat diversity	General wildlife utilization, fish habitat, migratory bird habitat, bat foraging habitat (open areas)

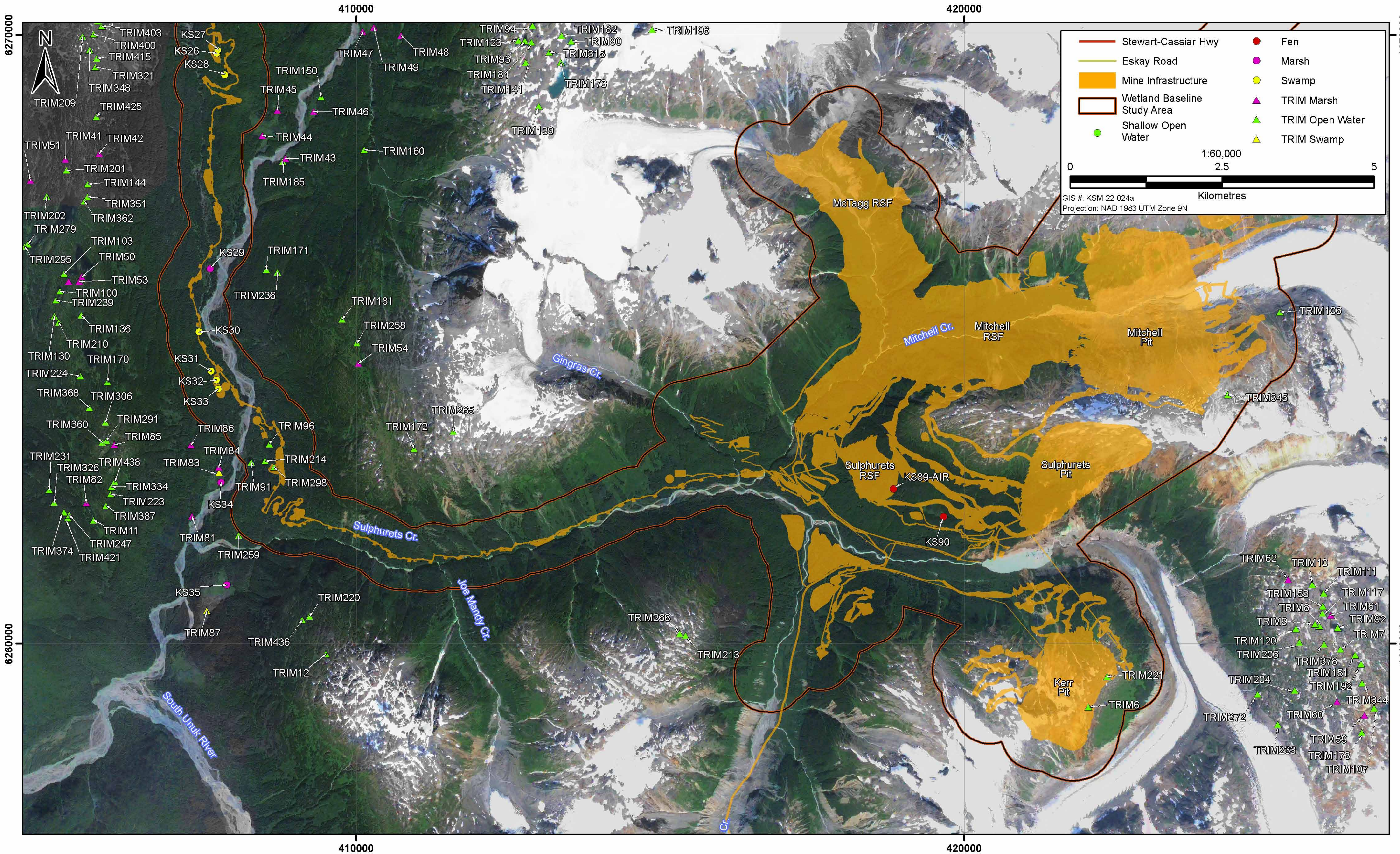


Figure 16.1-4a

Wetland Distribution in the KSM Wetland Local Baseline Study Area - Mine Site, Map 1

Rescan Engineers & Scientists

SEABRIDGE GOLD
KSM PROJECT

PROJECT # 868-016-27 GIS No. KSM-22-024b January 18, 2013

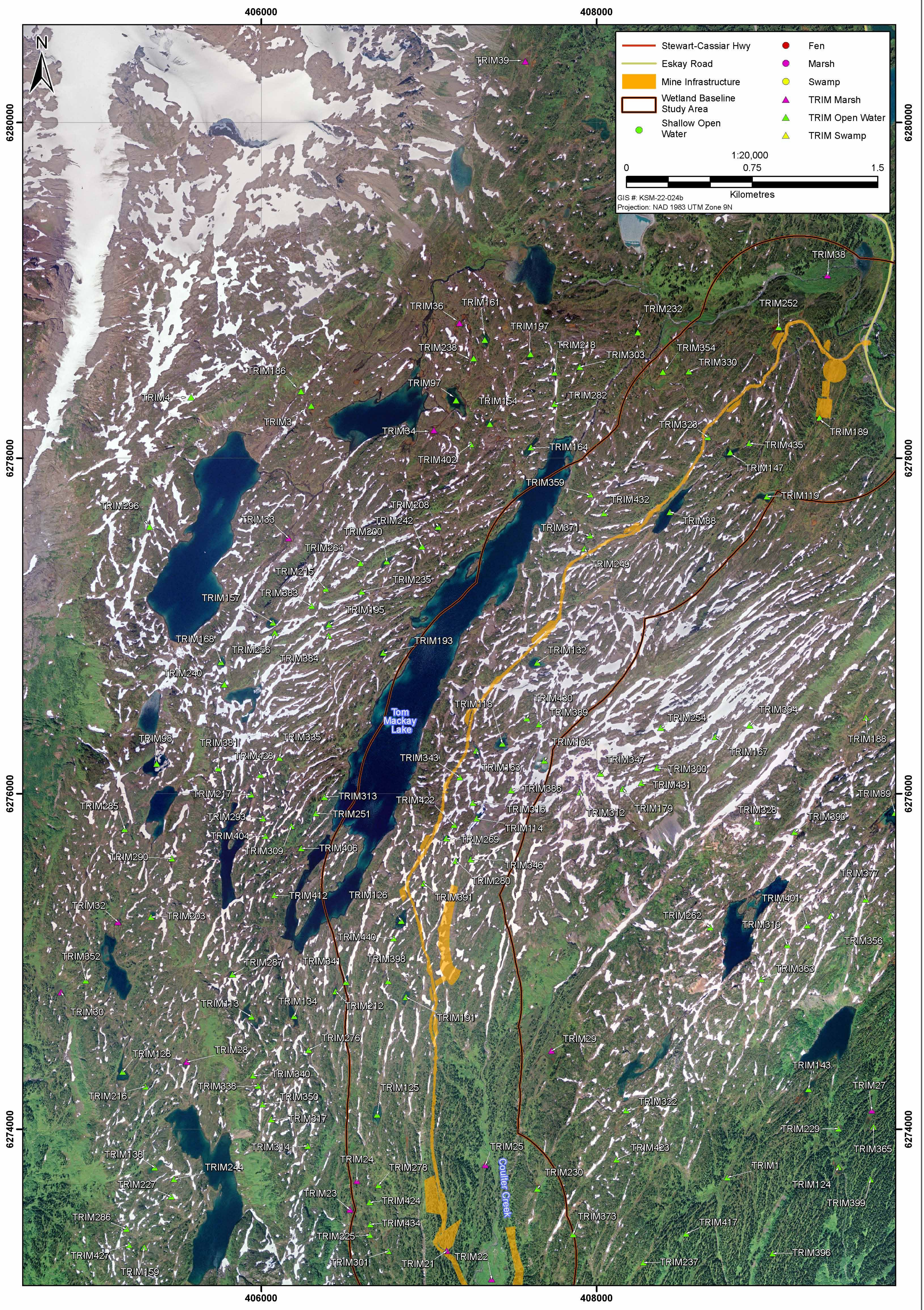


Figure 16.1-4b

Figure 16.1-4b

Wetland Distribution in the KSM Wetland Local Baseline Study Area - Mine Site, Map 2

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

PROJECT # 868-016-27 GIS No. KSM-22-024c January 18, 2013

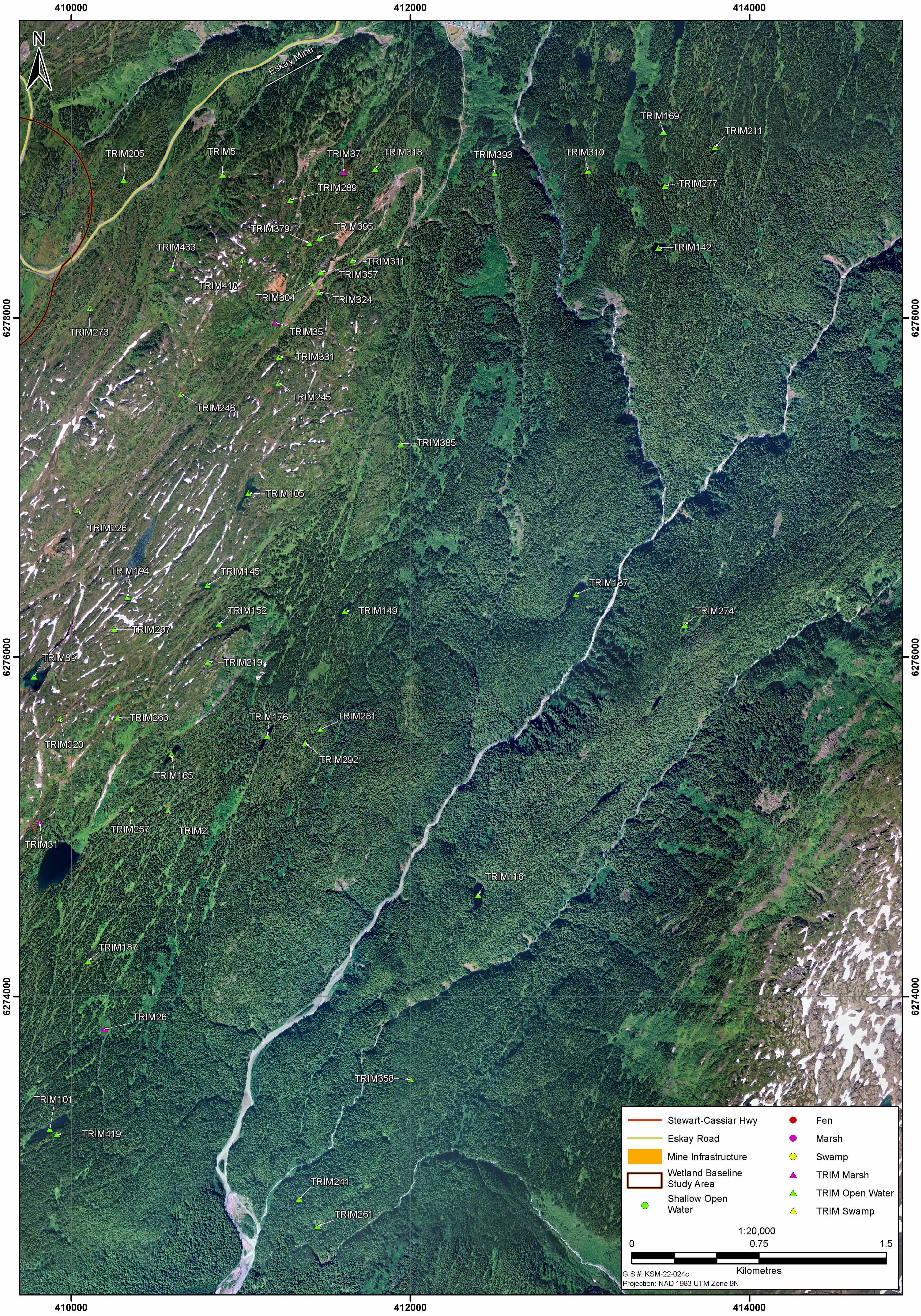


Figure 16.1-4c

SEABRIDGE GOLD
KSM PROJECT

Wetland Distribution in the KSM Wetland Local Baseline Study Area - Mine Site, Map 3

Figure 16.1-4c

Rescan
Engineers & Scientists

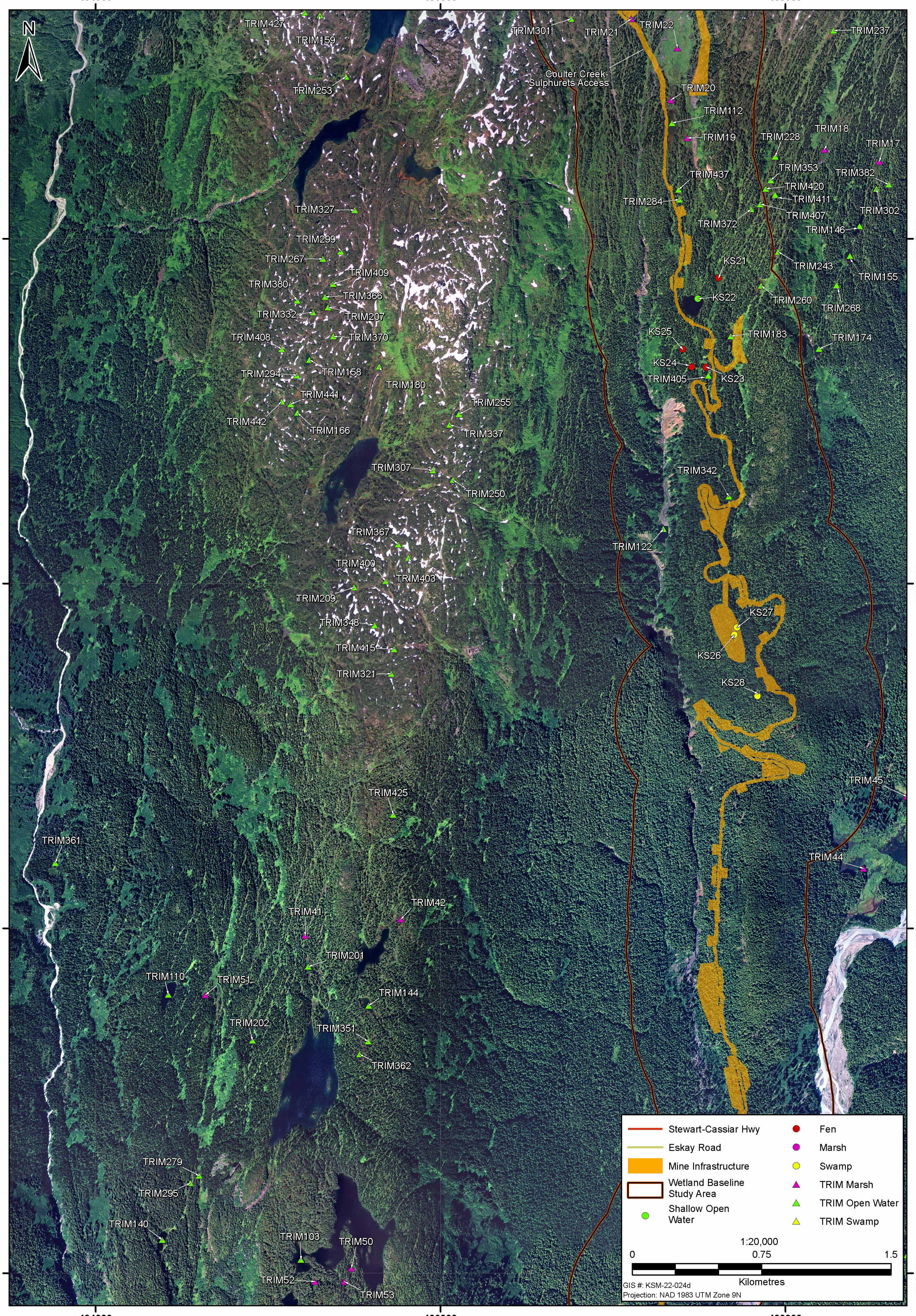


Figure 16.1-4d

SEABRIDGE GOLD
KSM PROJECT

Wetland Distribution in the KSM Wetland Local Baseline Study Area - Mine Site, Map 4

Rescan
Engineers & Scientists

PROJECT # 868-016-27 GIS No. KSM-22-024e_T January 18, 2013

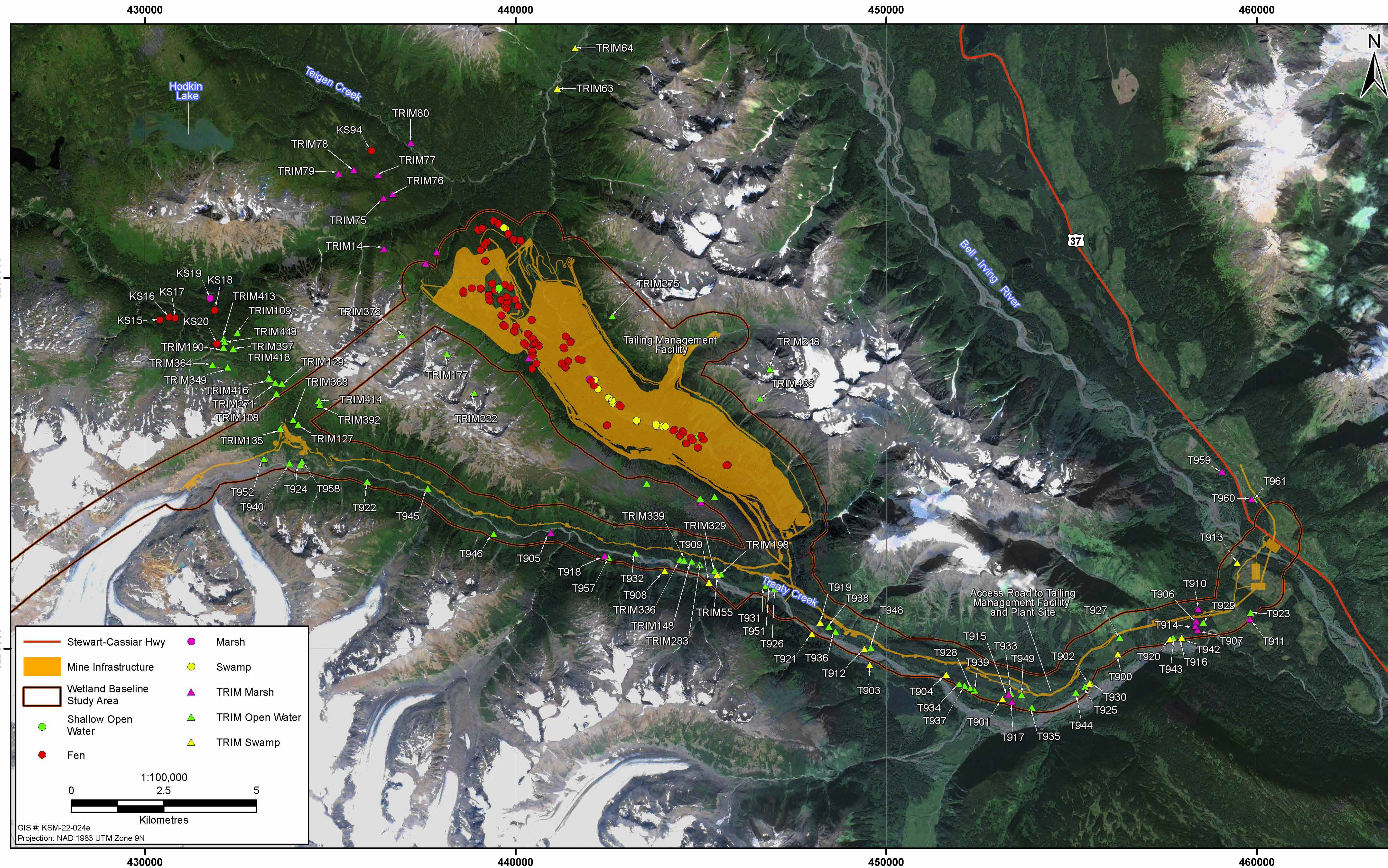


Figure 16.1-5a

Rescan Engineers & Scientists

Wetland Distribution in the KSM Wetland Local Baseline Study Area - PTMA Site, Map 1

SEABRIDGE GOLD
KSM PROJECT

PROJECT # 868-016-27 GIS No. KSM-22-024f_T January 18, 2013

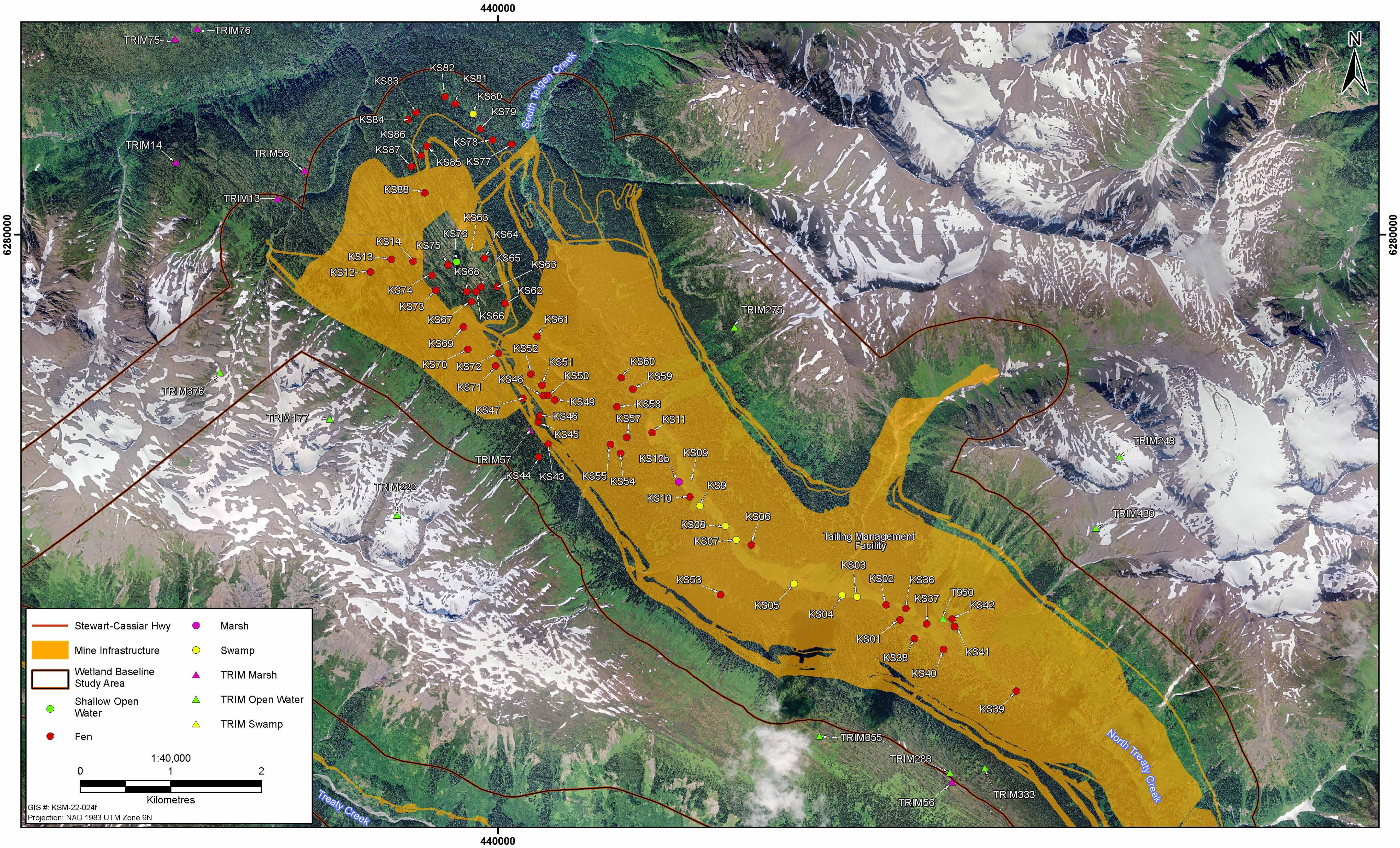


Figure 16.1-5b

Rescan Engineers & Scientists

Wetland Distribution in the KSM Wetland Local Baseline Study Area - PTMA Site, Map 2

SEABRIDGE GOLD
KSM PROJECT

16.1.2.3.1 Fen Wetland Functions

Fen Hydrological Functions

The hydrological functions of fens are moderate to low (Hanson et al. 2008). For example, fens can provide some mitigation of local flooding but the value of this function is largely related to downstream flows and the potential impacts of changes to these flows. The remoteness of the KSM Project precludes a substantial benefit from flood mitigation function, as downstream infrastructure is limited. However, these wetlands could likely provide some mitigation for stream bed scouring, sediment loading, and temperature mitigation for cold-water species.

Fens provide a groundwater recharge capacity; however, the capacity is highly dependent on basin size, location in the watershed, substrate, and local groundwater gradients (Hanson et al. 2008). Smaller wetlands have a greater perimeter to volume ratio than larger wetlands and have been demonstrated to better support groundwater recharge (Weller 1994). The majority of fens observed within the local BSA were relatively small. Approximately 89% of all fen wetlands mapped were less than 2 ha (Table 16.1-7). Thus, it is likely that fen wetlands in the study area provide important groundwater recharge functions.

Table 16.1-7. Distribution of Fen Wetland Size

	< 0.1 ha	0.1–0.25 ha	0.25–0.5 ha	0.5–2 ha	2–5 ha	5–10 ha
Count	1	13	19	24	3	4
% Count	1.6	20.3	29.7	37.5	4.7	6.3
Area	0.08	2.3	7. 1	24.1	7.2	30.5
% Area	0.1	3.2	9.9	33.8	10.1	42.8

Fen Biochemical Functions

The biochemical functions of fens are potentially high (Hanson et al. 2008). This potential is difficult to quantify because biochemical functions are influenced by a myriad of site-specific factors such as ambient temperature, local geology, base water chemistry, vegetation species, aspect, slope, drainage, etc. (Almas and Singh 2001; Brunham and Bendell 2010). It is generally accepted that fen ecosystems can improve water quality; actively facilitate nutrient storage, transformation, and transport; and store carbon (Mitsch and Gosselink 2000b).

Fens, like other wetland classes, facilitate the nitrification/de-nitrification process (Reilly 1991; Gilliam 1994). Fens can be considered both carbon sinks and carbon sources depending on the wetland condition. This is determined by the stability of the ecosystem, and whether the system is developing (active peat accumulation and vegetation deposition), flooded (such as during extreme precipitation events), drained (through anthropomorphic disturbance), or in decline (drying out through natural successional processes).

Fen Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity, complexity, and rarity within the landscape.

Collectively, fen wetlands are among the most floristically diverse of all wetland classes (Bedford and Godwin 2003). A search of rare or threatened wetlands revealed that the majority of potentially red- or blue-listed wetland ecosystems potentially occurring in the local BSA were fen communities. The fact that fen communities were present underscores the importance of the ecological function of these wetland ecosystems. Additionally, wetland mapping reveals that more than 50% of the fens in the local BSA exist in complex with another wetland class. This increases the habitat diversity and complexity, which further supports the importance of ecological function and contributes to habitat function.

Fen Habitat Functions

The habitat function of fens is related to their biological productivity (Hanson et al. 2008). The biological productivity of the fen can be attributed to a number of factors, including surrounding landscape type and use, stand age, complexity of landscape patterns, availability of specific habitat types for specific species within the area, uniqueness of habitat types available at various scales, and adjacency to a particular habitat with another habitat, to identify only a few. In early spring open sedge areas provide forage opportunities for grizzly bear and black bear (Plate 16.1-4). Treeless wetland areas adjacent to mature trees provide forage habitat for bat species throughout the growing season when insects are abundant (Plate 16.1-4). In spring and summer, emergent and submergent vegetation in open water areas provide moose browse (Plate 16.1-5). In addition, a number of migratory bird species and signs of use were observed in fens within the local BSA, particularly where fens were in complex with shallow open water (Plate 16.1-6).

Plate 16.1-4. KS49 (North Cell – TMF) – Open fen areas with high sedge components provide early spring forage for grizzly bear and black bear. These open areas surrounded by mature trees also provide aerial forage opportunities for many bat species.

Plate 16.1-5. KS64 (Plant Site Area) — A small subalpine shallow open water wetland in complex with a surrounding fen wetland. Note the aquatic vegetation, which can provide forage opportunities for moose.

Plate 16.1-6. KS20 (Upper Unuk River) — Migratory bird sign observed within this fen complex.

16.1.2.3.2 Marsh Wetland Functions

Marsh Hydrological Functions

The hydrological function of marshes is high when compared to other wetland classes and is strongly connected to the wetland sub-form (Hanson et al. 2008). The hydrological function of marshes typically includes water flow moderation, groundwater recharge, and shoreline erosion protection. Marshes adjacent to surface water features, such as lakes, rivers, and creeks, receive a portion of their water during high water events. Marsh wetlands in these positions are extremely valuable at stormwater retention; however, that value is directly related to downstream reaches and potential infrastructure located in these areas. The remoteness of the KSM Project precludes a substantial benefit from this function, as downstream infrastructure is limited. Marsh wetlands do provide some mitigation for stream bed scouring, sediment loading, and temperature mitigation for cold-water species utilizing these areas.

Marsh Biochemical Functions

The biochemical function of marsh wetlands is high compared to other wetland classes and upland areas but varies depending on local physical processes, interaction between root/bacteria assemblages, substrate, and oxidation (Hanson et al. 2008). Biochemical functionality can range among wetland complexes and temporally within a single wetland, depending on season and the processes indicated above.

Marshes, like other wetland classes, facilitate the nitrification/de-nitrification process (Reilly 1991; Gilliam 1994) and are thus major contributors to the nitrogen cycle in the environment.

Phosphorus absorption is facilitated through the deposition of suspended solids or dissolved phosphorus within wetlands. Floodplain marsh complexes tend to be important sites for phosphorus removal from the water column and improving water quality (Walbridge and Struthers 1993).

Marsh wetlands can reduce sulphate to sulphide, which can be released to the atmosphere as hydrogen, methyl, and dimethyl sulphides or is bound to wetland sediments such as complexes of phosphates and metal ions (Mitsch and Gosselink 2000b). These sulphides, when released to the atmosphere, can produce condensation nuclei and affect regional climates, while produced complex metal phosphates remove metals from free water within the water table.

Marshes filter suspended solids in the water column when they come into contact with wetland vegetation. Live and dead vegetation, leaves and stems, slow down the velocity of the water, allowing suspended solids to settle and thus removing potential pollutants from the water column (Johnston 1991).

Marshes can be considered both carbon sinks and carbon sources depending on the wetland condition. This is determined by the stability of the ecosystem, developmental stage of the ecosystem, flooded (such as extended flooding during extreme precipitation events), drained (through anthropomorphic disturbance), or in decline (drying out through natural successional processes).

All wetland soils contain some concentration of metals. Metals may exist in wetland soils or vegetation and enter wetlands through surface water, groundwater flow, and aerial deposition.

Wetlands can remove metals from surface and groundwater by binding metals to iron and aluminum ions via adsorption to clay surfaces or through carbonates precipitating as inorganic compounds. They can also form complexes with organic soils (Gambrell 1994). Marsh wetlands remove more metals from slow flowing water since there is more time for chemical processes to occur before the water moves out of the wetland.

Marsh Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity, complexity, and rarity within the landscape. No listed marsh types were identified as potentially occurring in the local BSA. Marshes were not commonly observed as complexes with other wetland types. Due to the limited contributions of marsh communities to ecosystem complexity, ecological function is not considered a primary function of these wetland classes within the local BSA.

Marsh Habitat Functions

In general the habitat function of marsh wetlands is generally high but variable (Hanson et al. 2008). Marshes are the most heavily used wetland class for most wetland-using wildlife species. They are typically eutrophic and support large standing crops of palatable vegetation, plankton, and aquatic invertebrates. They are the favoured wetland class for most waterfowl, amphibians, and semi-aquatic mammals because they provide good cover, open water, and food (MacKenzie and Moran 2004). Marsh and open water complexes provide opportunities for beaver habitation, which was observed within the local BSA (Plate 16.1-7).

Plate 16.1-7. KS29 (Coulter Creek access road) – Beaver lodge observed within this marsh wetland complex.

16.1.2.3.3 Swamp Wetland Functions

Swamp Hydrological Functions

The hydrological function of swamp wetlands is dependent on the wetland sub-form; it is low for mid-slope or tidal swamp wetlands, but generally high for riparian swamps (Hanson et al. 2008). Treed and shrubby riparian swamp wetlands slow the velocity of runoff and have the capacity to store water for extended periods. This function was directly observed in the TMF. Water from previous precipitation events was observed slowly discharging into local watercourses from adjacent swamp wetlands (Plate 16.1-8).

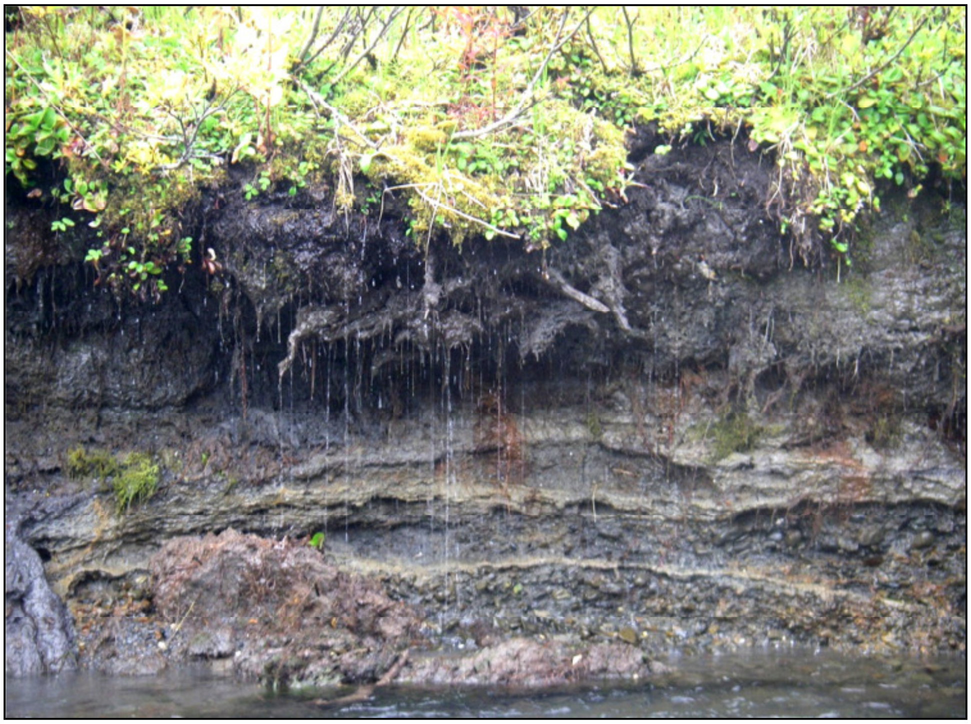


Plate 16.1-8. KS09 (North Cell – TMF) Water infiltrating into a stream from an adjacent swamp complex, maintaining downstream hydrology.

Swamp Biochemical Functions

The biochemical functions of swamps can be similar to marsh wetlands; variable, but generally quite high compared to other wetland classes and upland ecosystems with the variability arising from local physical processes, interaction between root/bacteria assemblages, substrate, and oxidation (Hanson et al. 2008). Swamps within the BSA likely provide numerous biochemical functions such as nutrient and organic export and carbon storage and sequestration. Swamps, like other wetland classes, facilitate the nitrification/de-nitrification process (Reilly 1991; Gilliam 1994).

Phosphorus absorption is facilitated through the deposition of suspended solids or dissolved phosphorus within wetlands. This is likely to occur in riparian-associated swamp complexes (Walbridge and Struthers 1993).

Swamps are both carbon sinks and sources depending on the wetland condition and stability. The high accumulation of organic matter and slow decomposition rates of vegetation that can occur in forested swamps enable these swamps to sequester carbon at a relatively higher rate than many other wetland classes.

Riparian swamps have the capability to filter suspended solids in the water column as these solids come into contact with wetland vegetation. Live and dead vegetation, leaves and stems, slow down the velocity of the water, allowing settling of suspended solids and removal of potential pollutants from the water column (Johnston 1991).

Swamp Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity, complexity, and rarity within the landscape. No listed swamp types were identified as potentially occurring in the local BSA; however, swamp habitats were observed. Swamps were generally observed in complex wetland ecosystems with other wetland classes and vegetation associations. Based on this complexity the ecological function of swamp wetlands is as a component of wetland complexes and is considered relatively high when in complex as compared to single-class wetland ecosystems.

Swamp Habitat Functions

Some habitat functions of swamps are closely related to their vertical structure, as the vertical structure in swamps supports more diverse avifaunal assemblages than any other wetland class (MacKenzie and Moran 2004). In addition, forested swamps typically have an open canopy that appears to be favoured by many bird and bat species(MacKenzie and Moran 2004; Lausen 2006). The habitat functions of swamp wetlands within the local BSA is considered moderate to high due to the existing habitat diversity and structure within the local BSA. Black spruce–skunk cabbage complexes provide spring forage for grizzly and black bears (Plate 16.1-9). In winter, spring, and summer months, willow swamp complexes can provide moose with thermoregulation sites as well as browse opportunities (Plate 16.1-10).

16.1.2.3.4 Shallow Open Water Wetland Functions

Shallow Open Water Hydrological Functions

The hydrological functions of shallow open water wetlands are high, especially as they relate to water storage (Hanson et al. 2008). The majority of the area's wetlands were small shallow open water wetlands, which were misidentified by TRIM as open water lakes (not wetlands). Although these sites are mapped as lakes, these small (less than 2 ha) open water features within the local BSA are typically associated with or a part of wetland habitats, particularly in the alpine and subalpine areas. The primary hydrological function of these wetlands is water storage within the landscape. Water is held in these shallow open water wetlands for prolonged periods, extending into the drier summer months and providing a source of freshwater to adjacent ecosystems and wildlife during these periods.

Plate 16.1-9. KS27B (Coulter Creek access road) — Black spruce–skunk cabbage swamp. Skunk cabbage provides early forage for grizzly bear and black bear species.

Plate 16.1-10. KS35 (Sulphurets Creek at Unuk River) — Willow swamp complex surrounding larger open fen complex. Example of areas that provides thermoregulation and forage opportunities for large mammals such as moose.

Shallow Open Water Biochemical Functions

Biochemical function performance is dependent on nutrient/sediment loading rates, flow through rates and volumes, retention time, wetland capacity, volume to surface area ratios, and productivity. Due to the relatively small size and location of these wetlands, these shallow open water wetlands do provide some capacity to remove sediments by allowing them to settle out in their slower moving waters.

Shallow Open Water Ecological Functions

The ecological function of wetlands, exclusive of wetland class, is best described in terms of ecosystem sensitivity, complexity, and rarity within the landscape. No listed shallow open water types were identified as potentially occurring in the local BSA. Shallow open waters were generally observed in complex wetland ecosystems with other wetland classes and vegetation associations (Plate 16.1-11). The ecological function of the shallow open water wetlands within the local BSA is as a component of wetland complexes and is considered relatively high when compared to single-class wetland ecosystems.

Plate 16.1-11. KS22 (Coulter Creek access road) — Subalpine shallow open water wetland providing water for surrounding ecosystems and wildlife as well as open water habitat for waterfowl.

Shallow Open Water Habitat Functions

The habitat function of shallow open water wetlands is highly variable (Hanson et al. 2008); however, these sites offer exclusively aquatic habitat. As such, if present, their level of function is dependent on the availability of such habitat within the landscape and the presence of locally valued species that may utilize such habitat. Wetlands in the local BSA provide important open water habitat for migratory birds, mammals, and ungulates such as moose.

16.2 Historical Activities

The inclusion of wetlands as a specific component in environmental assessments is a relatively new requirement and, as such, detailed information relating to the total area of wetlands affected by historical developments in BC or northern BC is not available. No effects on wetlands were observed within the local BSA during wetland surveys indicating wetland resources are pristine.

Within the larger regional BSA, effects on wetlands by past developments have been documented to some extent, and wetland loss has been raised as an issue of concern at community meetings throughout northwest BC. For example, there are a number of large wetlands in the Snowbank Creek area between Bell II and Bob Quinn that were affected by the construction of Highway 37. This has resulted in a loss of wetland extent under the road allowance area, and a loss or alteration of wetland function as evidenced by a large number of amphibians dying due to road maintenance; in 1998, a number of western toads died as a result of being trapped in seal-coating oil (Pojar, pers. comm.).

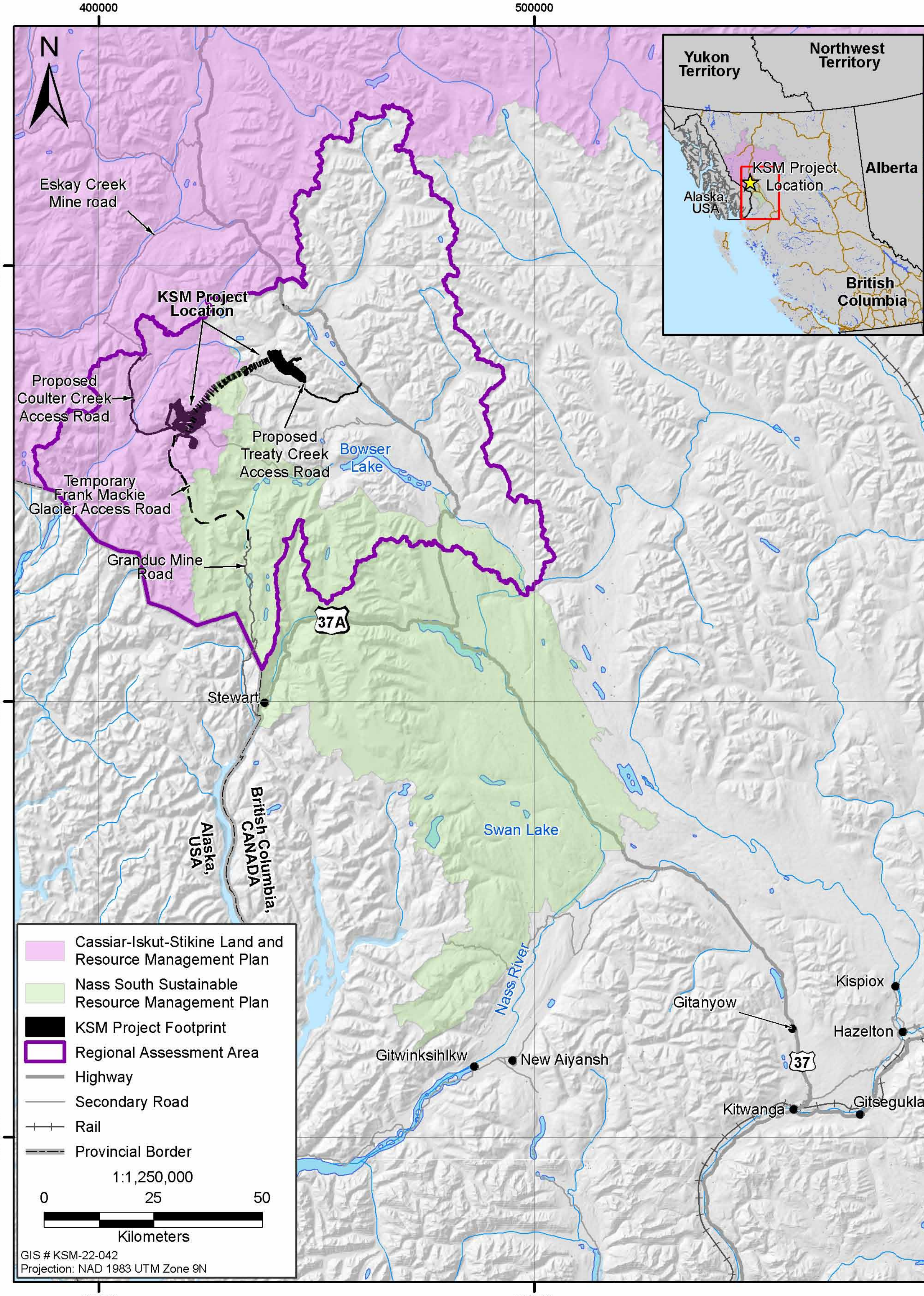
Past forestry activities, mining, and infrastructure development such as the construction and operation of the Van Dyke camp have also contributed to a loss of wetland extent and function. However, the specifics of such losses are not quantifiable given the myriad of site-specific variables that govern wetland function at the site and watershed levels.

16.3 Land Use Planning Objectives

Components of the Project lie within the Cassiar Iskut-Stikine Land and Resource Management Plan (CIS LRMP; BC ILMB 2000) and the Nass South Sustainable Resource Management Plan (Nass South SRMP; BC MFLNRO 2012; Figure 16.3 1). Although various parts of the Project sit within these large-area-plan boundaries, the TMF and TCAR are east of both plans.

Relevant sections of these plans were reviewed as they relate to wetlands. The management provisions for wetlands within the CIS LRMP include:

- Access Management;
- Aquatic Ecosystem and Riparian Habitat;
- Endangered Plants and Animals;
- Landscape Connectivity;
- Wildlife;
- Settlement, Agriculture, and Range; and
- Specific Areas:
  - Iskut-Stikine confluence;
  - Hottah-Tucho Lakes;
  - Iskut Lakes;
  - Middle Iskut Zone;
  - Lower Iskut Zone; and
  - Unuk River Zone.



SEABRIDGE GOLD
KSM PROJECT

Cassiar Iskut-Stikine Land and Resource Management Plan and the Nass South Sustainable Resource Management Plan Boundaries in relation to the KSM Project

Figure 16.3-1

Rescan
Engineers & Scientists

The majority of these management areas include general directives for avoiding or minimizing development pressures on wetland ecosystems. Examples of these directives are:

- avoid high biodiversity values, critical habitat features including floodplains, riparian habitats, wetlands, wetland complexes, and lake outlets during road layout and exploration access;
- maintain a visual buffer around wetlands with nesting and overwintering sites, where applicable; and
- minimize effects to areas with high biodiversity values including riparian habitats, wetlands, lake outlets, and floodplains.

The CIS LRMP identifies specific zones where wetland management, beyond the general directives, is considered necessary. Wetlands within the Unuk River Zone are identified as critical patch habitats for grizzly bears. The CIS LRMP also states that the best management practices from the *Riparian Management Area Guidebook* (BC MOE and MOF 1995) should be followed (BC ILMB 2000).

The management provisions for wetlands within the Nass South SRMP include (BC MFLNRO 2012):

- maintain water quality, quantity, peak and low flows within the range of natural variability in rivers, streams, lakes, and wetlands to protect the hydrological integrity of their watersheds (water quality includes temperature, turbidity, and chemistry);
- limit the potential for soil erosion within the first 10 m of the riparian area past the edge of a wetland or that is hydrologically connected to a wetland; and
- maintain ecological functioning of streams, rivers, wetland complexes and lakes, including those that do not support populations of fish.

16.4 Spatial and Temporal Boundaries

16.4.1 Spatial Boundaries

The local and regional study areas (LSA and RSA) are presented in Figure 16.4-1 and are defined below. This assessment addresses Project effects on wetlands associated with proposed infrastructure. The loss of wetland extent is a local effect; unless the wetland is regionally significant (listed as being of special concern or within a region subject to significant pressures on wetlands). The loss of wetlands are assessed at the local scale as there are no regionally significant wetlands in the vicinity of the Project.

The Project footprint, including proposed infrastructure, comprises 4,195 ha. The LSA includes the maximum extent of the proposed Project infrastructure surrounded by a 100 m buffer and covers approximately 10,021 ha (Figure 16.4-1). The buffer width of 100 m is derived from the spatial extent of notable changes to wetland function might be expected in response to various Project effects, such as dust/metal deposition or the extent of hydrologic effects of surface development, ditching, and runoff.

PROJECT # 868-016 GIS No. KSM-22-025 January 26, 2013

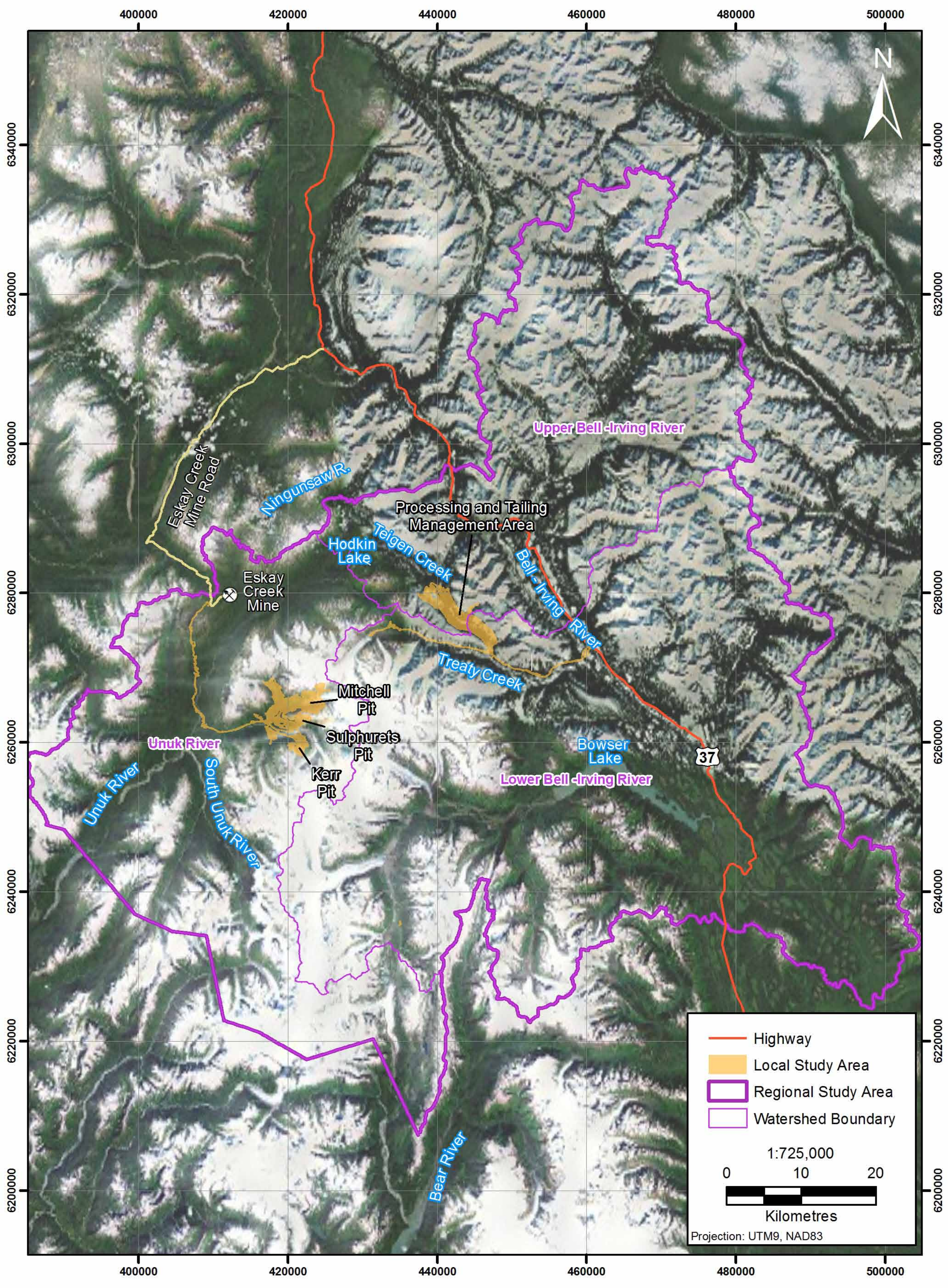


Figure 16.4-1

KSM Project Local Study Area and Regional Study Area

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

Assessment of the zone beyond 100 m around the directly disturbed area of the Project footprint is difficult because depending on the choice of methods, timescales, and measured impacts (e.g., on hydrology, microclimate, or global process [carbon storage]). The above comments do not imply that the negative effects on wetlands are limited to 100-m buffers. It is expected, however, that the most acute effects, capable of influencing the quantity of wetland resources, will largely be limited to these buffers. For the above reasons the 100-m buffer around the maximum extent of disturbance was chosen as the LSA for the assessment.

The RSA is approximately 729,784 ha, including three adjacent watersheds. It was used to assess the potential cumulative environmental effects of the Project (Figure 16.4-1).

16.4.2 Temporal Boundaries

The temporal boundaries include the following four phases:

- construction: 5 years;
- operation: 51.5 year life of mine;
- closure: 3 years, including Project decommissioning and reclamation; and
- post-closure: 250 years, including ongoing reclamation, maintenance, and monitoring.

The temporal boundaries of the assessment form the context for the spatial boundaries in that the maximum extent of disturbance over the four phases provides the maximum extent of disturbance. The footprint analysis for the wetland effects assessment was conducted for each of the four phases using a single footprint.

16.5 Valued Components

Due to the value placed on wetlands by local communities, Aboriginal groups and governments, wetlands were selected for specific study within the LSA. Wetland extent and function were selected as valued components (VCs) because they represent aspects of wetlands that are measurable, valued by society, and respond differently to environmental effects. These components involve spatial distribution, type, total area, and wetland process. Wetland extent is valued because a loss of wetland extent translates into a loss of wetland function. Wetland function is valued because the processes performed by wetlands have the greatest potential interaction with other VCs, such as habitat for critical wildlife species and biochemical alterations to water quality.

Wetlands are regarded as important ecosystems within BC, Canada, and internationally because they provide critical habitat for fish, birds, and other wildlife (Environment Canada 1991; Milko 1998; Hanson et al. 2008; The Ramsar Convention on Wetlands 2010; BC MOE 2011). Most wildlife in BC use wetland habitat at some point in their life cycle, and many red- and blue-listed species are wetland-dependent (BC MOE 2011).

VCs were identified by integrating a number of important information sources including Nisga'a Nation and First Nations considerations, federal policy, scientific literature, and professional expertise (Table 16.5-1). Wetlands contribute to the economic, social, and cultural well-being of

Nisga'a Nation citizens because they contain or support culturally significant species such as some migratory waterfowl, fish and aquatic plants (SD 92 1996; NLG, Province of BC, and Government of Canada 1998; Annex 17-1 2008; 2009 Wildlife Baseline). For example, coho salmon, which are present in the Project area, use wetlands for rearing and overwintering (Appendix 15-C). Under the Nisga'a Final Agreement, Nisga'a Nation citizens have the right to harvest migratory birds, fish, and aquatic plants within the Nass Area (NLG, Province of BC, and Government of Canada 1998).

Table 16.5-1. Identification and Rationale for Wetland Valued Component Selection

Valued Component	Identified by*				Rationale for Inclusion
	F	G	P/S	O	
Wetland Extent	X	X	-	X	First Nations value wetlands and wetland-dependent species. Nisga'a Nation values wetlands and wetland-dependent species. There is a growing concern over the escalating rate of wetland losses in British Columbia (BC MOE 2011). Wetland extent often supports wetland function. Wetland extent is easily quantifiable and potential effects can be predicated directly though a footprint analysis.
Wetland Function	X	X	-	X	Wetlands support a variety of wildlife, birds, fish, amphibians, and edible plants that are economically and culturally important. Federal policy is of no-net-loss to wetland function.

*** F = First Nation and/or Nisga'a Nation; G = Government; P/S = Public/Stakeholder; O = Other.**

Skii km Lax Ha, Tahltan Nation, Gitanyow First Nation, and Gitxsan Nation have identified wetlands as culturally important or as ecosystems that support culturally important plants and animals (Daly 2005; Rescan 2009; THREAT 2009; Gitxsan Chiefs' Office 2010). Skii km Lax Ha have further identified wetlands as preferred trapping locations (Rescan 2009).

Two aspects of wetlands were studied: 1) wetland extent; and 2) wetland function. These areas were selected for study because:

- there is a growing concern over the escalating rate of wetland loss in BC (BC MOE 2011);
- federal wetland policy and environmental assessment guidelines request that wetland functions be included in environmental assessments (Environment Canada 1991; Milko 1998); and
- wetland functions are valued by society.

16.5.1 Valued Components Included in Assessment

Wetland extent and function were selected as VCs, because Project-related activities can cause a measurable change within either of these aspects of wetlands without necessarily affecting the other. For example, activities that change the vegetation species composition, such as the inadvertent introduction of an invasive wetland species, will result in changes to the ecological, habitat, and biochemical functions of a particular wetland but will not necessarily affect the extent of that wetland. Additionally, in areas dominated by numerous small isolated fens or bogs, activities that remove some of these wetlands affect wetland extent but may not affect specific functions provided by these wetlands within the region.

16.5.2 Valued Components Excluded from Assessment

No wetland-related VCs were excluded from further assessment.

16.6 Scoping of Potential Effects for Wetlands

Potential effects of the Project on wetlands follow one of two pathways: 1) Project component interaction with wetland extent and function resulting in a loss of extent and function; and 2) Project component interaction with one or more wetland functions resulting in a loss or alteration of one or more wetland function. These effects are quantified through a footprint analysis of the Project infrastructure using GIS analysis to identify areas within the LSA and are summarized in Table 16.6-1. Project areas absent from Table 16.6-1 were identified to not affect wetlands and thus are not considered further in the assessment; they are, however, included in the scoping table in Appendix 16-C.

Table 16.6-1. Potential Effects from the Project on Wetland Extent and Function

Project Region	Project Area	Loss of Wetland Extent and Function
Mine Site	Camp 3: Eskay	X
	Camp 7: Unuk North	X
	Coulter Creek access road	X
	Sulphurets laydown area	X
	Kerr Pit	X
Processing and Tailing Management Area	Treaty Ore Preparation Complex	X
	North Cell Tailing Management Facility	X
	Centre Cell Tailing Management Facility	X
	South Cell Tailing Management Facility	X
	Treaty Creek access road	X

X = interaction between component and effect.

Effects that follow the second pathway have the potential to result in an alteration of wetland function. These effects can also be identified through the footprint analysis; these effects are described as degraded or fragmented. Degraded and/or fragmented wetlands are identified where:

- part of a wetland is lost and the remaining piece is degraded;
- wetlands are not lost but wholly or partially within the LSA; and
- wetlands are located in areas surrounded by development and no longer directly connected with other ecosystems.

A precautionary approach was used to identify potential effects on function. It was assumed that wetland function is at its maximum becausethe Project area is relatively undisturbed. An effect on wetland extent will therefore result in an effect on wetland function of the same magnitude. Effects on wetland functions can be described by assessing the classes of wetlands lost against a set of standardized wetland functions for each class (Hanson et al. 2008). Other effects of the Project on wetland functions can be identified by assessing proposed land uses adjacent to wetland communities (wetlands within the degraded and fragmented portions of the footprint). This type of interaction may result in:

- alterations to wetland biochemical function through sedimentation, dustfall, site runoff, and point source discharge;
- alterations to wetland ecological function through the introduction of invasive or non-native wetland plant species and loss of adjacent upland buffer areas;
- alterations to wetland hydrological function through ditching, culverting, watercourse crossing, and water flow alteration; and
- alterations to wetland habitat function through fragmentation, change of vegetation structure, change of water sources, noise impacts, artificial light sources, and litter/garbage.

A footprint analysis was used to identify which Project areas and components would interact with wetlands. This was done for the footprint representing maximum extent of disturbance. Where Project/wetland interactions were identified during the construction phase they were carried through to closure because wetlands, outside the TMF, will not be reclaimed. Reclamation within the TMF will include wetlands; however, this is not expected until years 63 to 68; as such, effects on wetlands are still identified through all Project phases. Although the effects analysis was done using the footprint for the maximum extent of disturbance, Project phases were used to identify when the effects were expected to start. The results of this scoping are included in Appendix 16-C.

16.6.1 Construction

Wetlands will be lost in the construction phase from the development of a variety of Project components within the following Project areas:

- Camp 3: Eskay Staging Camp;
- Camp 7: Unuk North Camp;
- CCAR;
- Sulphurets laydown area;
- Treaty Ore Preparation Complex (OPC);
- North Cell TMF;
- Centre Cell TMF; and
- TCAR.

All of these effects will be permanent and include a loss of wetland extent and function. Wetlands in these areas were counted as lost through all phases of the Project because:

- they remain within a Project component that will be utilized for the life of the Project; and
- they are located within a reclaimed Project component outside of the TMF, as wetlands outside of the TMF will not be reclaimed.

Wetlands will be degraded where they are within 100 m of any of these features; construction of these features will require site clearing and a change in soil compaction. This will cause changes to the way water enters shallow groundwater reserves, drains from a site, and allows for the development and maintenance of wetland ecosystems. Thus for wetlands within 100 m of these features, alterations to wetland hydrology, ecology, habitat, and biochemistry are expected.

Construction effects that will be assessed include the loss of wetland extent from the construction of the above component. The assessment will focus on the maximum extent of disturbance, which includes all spatially related effects from the four Project phases. Construction effects also include alteration to wetland function from construction, use, or maintenance of the features. Specific Project component/wetland interactions are identified in Table 16.6-1 and Appendix 16-C.

16.6.2 Operation

Wetlands in all of the Project areas identified in Section 16.6.1.1 (Table 16.6-1) will continue to be lost during operation. Some of the features identified in Section 16.6.1 (Table 16.6-1) will be continuously developed and will not reach their maximum extent until the latter stages of operation; primarily the TMF. Wetlands in the area of the Kerr Pit and TMF South Cell will be lost during operation. Effects in the operation phase are expected to be permanent and will include a loss of wetland extent and function. Wetlands in these areas were counted as lost through all phases of the Project because:

- they remain within a Project component that will be utilized for the life of the Project; and
- they are located within a reclaimed Project component outside of the TMF (because wetlands outside of the TMF will not be reclaimed).

Wetlands will be degraded where they are within 100 m of any Project component. They will also be affected by dust, noise, and light.

Operation effects that will be assessed include the loss of wetland extent from continued development of the Project. The assessment will focus on the maximum extent of disturbance, which includes all spatially related effects from all Project phases. Operation effects also include alteration to wetland function from continued development, use, or maintenance of Project components. Specific Project component/wetland interactions are identified in Table 16.6-1 and Appendix 16-C.

16.6.3 Closure

It is not expected that any new Project components or areas will result in a loss of wetland extent in the closure phase. Indeed, some of the previously identified Project components and areas will be reclaimed to wetland ecosystems. Project areas containing reclaimed wetlands include:

- TMF North Cell;
- TMF Centre Cell; and
- TMF South Cell.

Although these areas will be reclaimed to contain wetlands, the communities will be created rather than enhanced; therefore, functioning wetlands are not expected within the closure phase.

Details of the closure plan including wetland reclamation are discussed in Chapter 27. It is expected that approximately 275 ha of shallow open water, marsh, and swamp (sedge-willow) wetland complex will be created in the TMF.

16.6.4 Post-closure

It is not expected that any new Project components or areas will result in a loss of wetland extent in the post-closure phase. Reclamation of wetlands in the TMF will be completed during the closure phase and it is expected that within the post-closure phase water quality will be sufficient as to pose no significant risk to wildlife. Habitat functions associated with marsh, swamp, and shallow open water wetlands will begin and will continue to develop and wetland vegetation moves along its successional trajectory. However, it may take 15 to 20 years for vegetation to reach an equilibrium state (Mitsch and Wilson 1996). Additionally it can take decades for organic sediments to develop to the state that they contribute to nutrient cycling (Johnson and Smardon 2011).

16.7 Potential for Residual Effects for Wetlands

16.7.1 Loss of Wetland Extent and Wetland Function

The direct loss of wetlands was identified where the Project footprint and wetlands mapped at baseline occupy the same space. These effects occur as the project is built and are generally related to construction activities. These interactions are summarized in Table 16.6-1 for each Project area. The loss of each wetland was recorded and the total area of all lost wetlands, wetland classes, and wetland associations were summarized. The loss of wetland function was identified at sites classified as lost because a loss of a wetland translates into a loss of function; however, the lost function will be specific to the type of wetland present. Lost wetland functions were identified by contrasting the lost wetland classes against a set of criteria equating wetland class and function (Hanson et al. 2008).

It is expected that 59.4 ha of wetlands will be lost as a result of the Project (Table 16.7-1).

Table 16.7-1. Area of Wetland Loss (Maximum Extent of Disturbance)

Wetland Class	Lost (ha)	Number of Wetlands Lost	Total Present in the Local BSA (ha)	Percent of Class Lost in the Local BSA
Fen	39.4	64	70.6	56%
Marsh	0.4	6	35.6	1%
Swamp	19.0	17	374.3	5%
Open Water	0.5	7	41.8	1%
Total	59.3	94	522.3	12%

The total loss of wetland extent is relatively minor given the number and total area of wetlands within the local BSA. It is expected that direct Project effects will result in a loss of 59.3 ha of wetlands identified in the LSA. Although this effect appears small it becomes magnified when examining the effect of wetland loss on specific wetland classes and associations from specific Project features (Table 16.7-2). For instance, the majority of the total wetland loss is due to the losses in two classes: fen and swamp and the majority of loss to these two classes is a result of the TMF. Therefore, although the loss over the Project area is not substantial, the loss of fen and swamp wetlands in the TMF is. The loss of fen and swamp within the TMF accounts for 82% of all lost wetland extent.

Table 16.7-2. Area of Lost Wetland Class and Associated Mine Infrastructure – Maximum Disturbance

Project Area	Fen (ha)	Marsh (ha)	Swamp (ha)	Open Water (ha)	Total (ha)
PTMA					
TCAR	0.8				0.8
CCAR	0.1	0.2	0.3	0.1	0.7
Construction camps					
Camp 3: Eskay Staging Camp				0.1	0.1
Camp 7: Unuk North Camp			0.2		0.2
TMF					
North Cell	9.3	0.2	9.9		19.3
South Cell	4.7		5.1		9.9
Centre Cell	16.0		3.5	0.1	19.6
Treaty OPC	8.3				8.3
Mine Site					
Sulphurets laydown area	0.2				0.2
Kerr Pit				0.2	0.2
Total (ha)	**39.4**	**0.4**	**19.0**	**0.5**	**59.3**

The spatial and class distribution of affected wetlands is important when considering mitigation measures and the loss of function associated with wetland classes. Some mine features such as road alignments, watercourse crossings, and building sites are more amenable to mitigation whereas others, such as the TMF, are not. This is because avoidance and minimization can be used to mitigate effects associated with road alignments, watercourse crossings, and building sites. Effects from tailing facilities are confined to specific areas because of their engineering requirements.

The loss of wetland function will occur in all areas where there is a loss of wetland extent, for the simple reason that wetlands provide wetland function; in essence, function is dependent on extent (Mitsch and Gosselink 2000a). The magnitude of the loss of function associated with individual wetlands is difficult to quantify because functions are best described at the watershed scale. For instance, the loss of a single, small, high-elevation fen wetland may not have any effect on an area's groundwater recharge rate (hydrological function) but the loss of all small, high-elevation fens may significantly reduce groundwater recharge in a given area. In addition, the loss of a single, small, high-elevation fen may equate to lost habitat function for a local population of amphibians in much the same way the loss of all small, high-elevation fens equates to lost habitat function within a region. Therefore, changes in level and types of function are best determined at the watershed scale. Thus, to be conservative in the approach of assigning effects of the Project on wetland function, it was assumed that: 1) the Project is located in a pristine area (Section 16.2) where wetlands are functioning at their maximum capacity; and 2) the magnitude of the loss of extent is applicable in describing the magnitude of loss of function. The majority of lost wetland extent for the KSM Project is fen and swamp; therefore, the majority of lost functions are those carried out by fen and swamps (Table 16.1-6).

The hydrological functions of fens are quite variable. Fens have been documented as modulating water flow (flood protection), providing groundwater recharge, protecting against erosion, and regulating climate change through evapotranspiration (Hanson et al. 2008). A loss of 56% of the local area of fen wetlands will translate into a loss of approximately 56% of the hydrological function of fens.

The hydrological functions of swamps are related to their landscape positions and the soil and vegetation composition. For example, swamps associated with discharge areas (slope and tidal swamps) have poor hydrological function whereas riparian swamps have high function (Hanson et al. 2008). The swamps lost within the TMF are riparian, and are associated with South Teigen and North Treaty creeks. Swamps, particularly at the upper portions of the watershed, have important flood control and water storage capabilities (Plate 16.1-8). A loss of swamp wetlands will translate into a loss of these hydrological functions.

The biochemical function of fens is generally quite high and applies to all types of fens. Fens improve water quality by acting as filters for water entering surface or groundwater systems (Hanson et al. 2008). Fens also cycle nutrients as soluble, partially decomposed organic matter that is transported downgradient. Fens store carbon and play an important role in the global carbon cycle because of their peat soil development and relatively low rates of decomposition. A loss of 56% of the local distribution of fen wetlands will translate into a loss of about 56% of the biochemical function of these wetlands.

The biochemical functions of swamps are variable, but there are some biochemical functions that generally relate to all types of swamps. Swamps have similar biochemical functions to fens but the processes that govern these functions and the value of these functions are different. For example, fens and swamps both cycle nutrients. However, where fens flush partially decomposed organic matter downgradient, swamps retain nutrients. Their biochemical function is much more dependent on root-bacteria assemblages, flow-through substrate, and heterogeneity of oxidation (Hanson et al. 2008). A loss of 5% of the local swamp wetlands will translate into a loss of about 5% of the biochemical function of these wetlands.

The ecological and habitat functions of fens and swamps are variable and generally depend on their landscape positions and species assemblages within the ecosystems. Ten potentially occurring listed wetland ecosystems were identified in the BAFAunp, CMAunp, CWHwm, ESSFwv, ICHvc, and MHun BEC zones within the Skeena Stikine Forest District; however, none of these listed wetland ecosystems were observed in the local baseline study area.

Wetland classes and associations occurring adjacent to each other are called a wetland complex, and can affect the local ecological functions. Wetland complexes account for 11% of the total wetland area. It is likely that the large TRIM wetlands are also complexes similar to the wetland complex in the TMF. The largest wetlands are TRIM swamps; these mapped units represent a number of ecological communities including non-wetland riparian forest and numerous flood associations. A loss of 56% of the local distribution of fens and a loss of 5% of the local distribution of swamps will translate into a loss of ecological and habitat functions within the area.

16.7.1.1 Mitigation for Loss of Extent and Function

Seabridge recognizes the value of wetland extent and will initiate mitigation following the wetland mitigation hierarchy (Cox and Grose 2000). The mitigation hierarchy includes:

- **Avoidance** – This refers to the elimination of adverse effects on wetland functions, by siting or design of a project.
- **Minimization -** This erefers to the reduction or control of adverse effects to wetland functions through project modification or implementation under special conditions.
- **Compensation** – This refers to the reduction or control of adverse effects to wetland functions through project modification or implementation under special conditions.

The following section describes the specific mitigation activities for each level of the mitigation hierarchy.

16.7.1.1.1 Avoidance

There are limited opportunities to avoid impacting wetland extent and function short of relocating proposed Project infrastructure. To mitigate the loss of wetland extent and function during construction, infrastructure will be sited such that it does not interact with wetlands, where possible. Avoidance was implemented in two Project areas:

- plant site; and
- TCAR.

In 2010, the Treaty OPC was designed such that it would have been responsible for the loss and degradation of 25.6 ha of wetlands. Project components within the plant site area were realigned in an effort to avoid wetland ecosystems such that the current plant site will affect (loss and degradation) 16.4 ha of wetlands (Figure 16.7-1).

In 2010, access to the TMF from Highway 37 was via the Teigen Creek Valley. This Project component would have affected 2.6 ha of wetlands directly and another 40 ha indirectly. Access to the TMF from Highway 37 has changed and the access road will be along Treaty Creek. Development of this road is expected to affect 22.6 ha of wetlands (loss of 0.8 ha and degradation of 21.8 ha).

Implementing these avoidance measures (realigning the plant site and moving the access road resulted in a net reduction of 29.2 ha of lost and degraded wetlands.

16.7.1.1.2 Minimization

The loss of wetland extent and function, as predicted through the Project footprint analysis, cannot be mitigated through the minimization of environmental effects because the footprint represents the extent of disturbance at the time of the assessment. Thus changes to the footprint would count as avoidance rather than minimization.

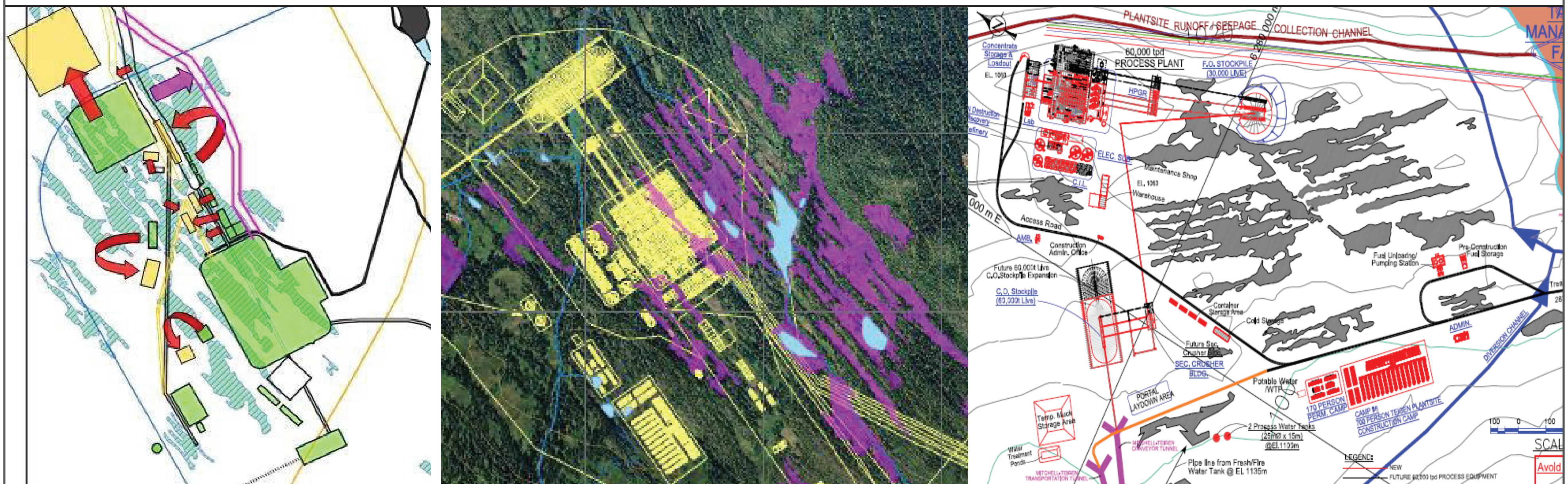
Additional losses of wetlands beyond those identified in the Project footprint analysis are possible where wetlands were identified as degraded (partially lost) or within the degraded area (100 m). Minimization for these types of effects can be accomplished by implementing environmental management plans.

16.7.1.1.3 Compensation

Appendix 16-B contains a wetland compensation plan to minimize adverse impacts on wetlands. The plan has been developed pursuant to the federal policy on wetland conservation. Wetland compensation will address the loss of wetland extent and the loss of wetland functions over time. Wetland function is difficult to quantify and directly compensate for because of the myriad of site-specific variables. As wetland function is generally related to the classes of wetland ecosystems present and the complexity of these ecosystems, compensation efforts will focus on developing ecosystems that are predicted to provide similar functions to those ecosystems that will be lost during development. This is known as “like for like” compensation. The wetland compensationplan focuses on the replacement of riparian swamp wetland complexes.

As the primary effects of the Project will be on riparian wetlands and associated fish habitat, it was determined that the most ecologically relevant, and practicable, compensation activities would be to develop functioning ecosystems supporting both fish and wetland compensation objectives. It was determined that macro site selection for wetland compensation would be directed by the development of the fish compensation plan. To add additional wetland area and value to the compensation plan, an investigation of degraded or otherwise impacted wetland ecosystems along Highway 37 from the Bob Quinn area through Smithers, BC, was conducted.

Mitigation Avoidance



2010 **2011** **2012**

SEABRIDGE GOLD
KSM PROJECT

Progression of Wetland Avoidance 2010 to 2012: Plant Site Area

Figure 16.7-1

Rescan™ Engineers & Scientists

Site selection for wetland compensation identified four preferred options: fish compensation sites at Teigen, Treaty, and Taft creeks and a Smithers-area wetland (Figure 16.7-2). These sites are reasonably accessible, located at fish habitat compensation sites, and are geographically and geologically capable of wetland restoration. Each compensation site will comprise a deep water (over 2 m deep) fish overwintering zone not to be counted in the wetland restoration area, a shallow open water wetland zone from 2 to 50 cm deep to be developed into shallow open water riparian marsh zone, and a variable depth swamp and sedge meadow zone. Each zone is targeted to provide different wetland functions (Table 16.7-3).

Table 16.7-3. Wetland Compensation Site Details

Compensation Project Name	Number of Open Water Features	Total Wetland Area (ha)	Distance from the TMF (km)	Wetland Functions and Values
Teigen Creek	11 ponds	11.9	7	Hydrological, Biochemical, Ecological, and Habitat
Treaty Creek	9 ponds	9.5	8	Hydrological, Biochemical, Ecological, and Habitat
Taft Creek	10 ponds	5.5	35	Hydrological, Biochemical, Ecological, and Habitat
Smithers-area Wetland	1-2 ponds	21	275	Hydrological, Biochemical, Ecological, Habitat, Recreation, Research, and Education
Total Area		**47.9**		

Values have been rounded to the nearest decimal place

Developing wetland compensation sites at the four preferred locations will, in conjunction with wetland creation in the TMF, mitigate effects at closure on wetland extent.

16.7.1.2 Potential for Residual Effects

Potential residual effects identified for the Project include lost wetland extent and function (Table 16.7-4).

The largest residual effect to wetlands and associated functions is loss within the Treaty OPC (8.3 ha) and the TMF (48.8 ha). The compensation plan will compensate for the loss of wetlands associated with the TMF. However, the loss of wetland extent was carried through as a residual effect because of the degree of loss. The loss of wetland function was also carried through as a residual effect because it is expected that mitigation efforts won’t maintain wetland function to a similar baseline level. Wetland functions can take years and, in some cases decades, to develop. Thus, functions from wetland compensation areas may not be mitigated at the same rate as wetland functions are affected.

16.7.1.3 Potential Residual Effects due to Loss of Wetland Extent and Function

The Project will have a potential effect on wetland extent and function in areas where the Project footprint directly overlays identified wetland habitat, where it significantly isolates wetland habitats from adjacent habitats, or segments/bisects existing wetland habitats. Relocating infrastructure outside of identified wetland habitats will reduce impacts by 29.2 ha.

PROJECT # 868-016 GIS No. KSM-22-043 December 7, 2012

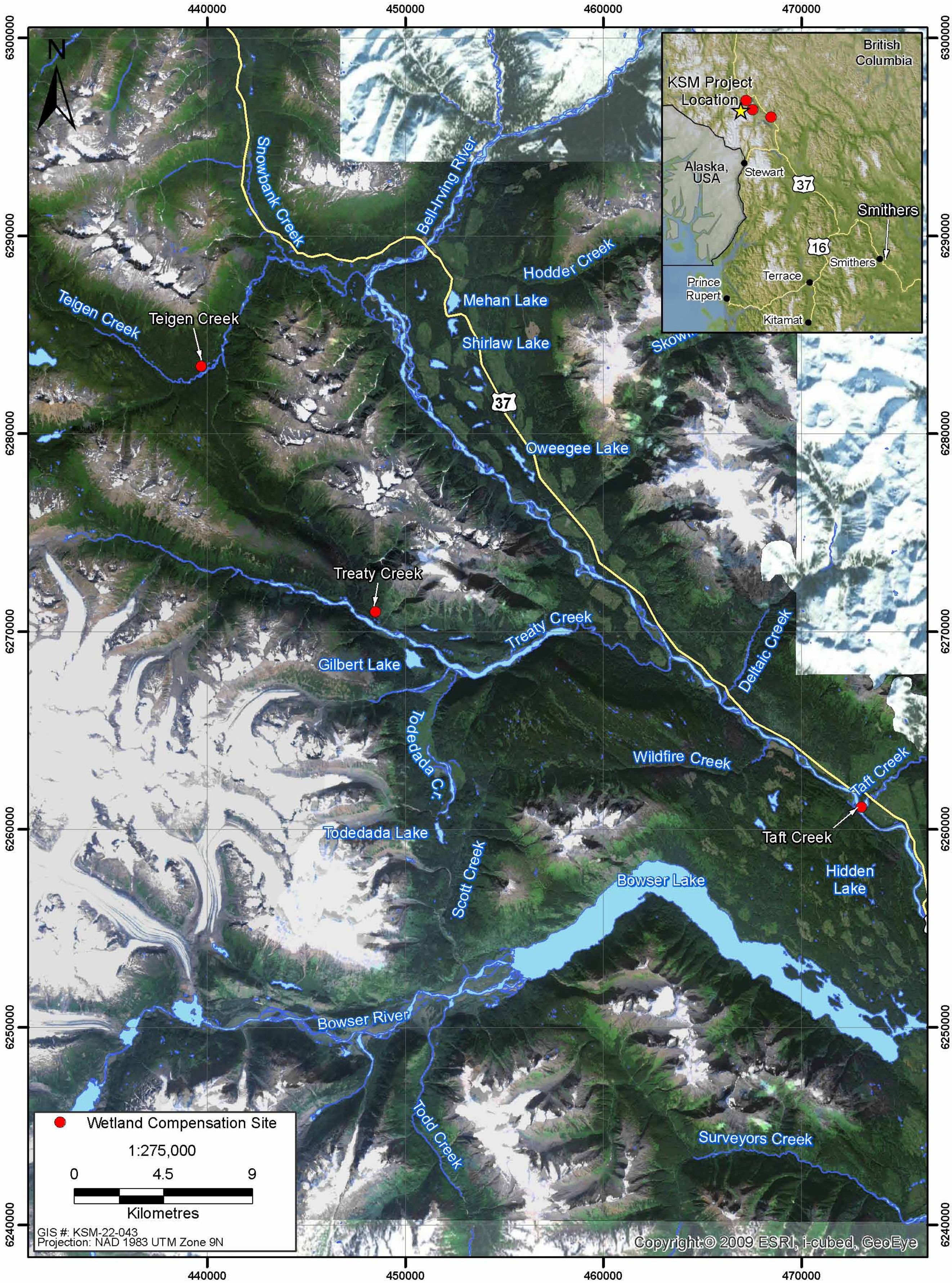


Figure 16.7-2

Preferred Wetland Compensation Sites

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

Table 16.7-4. Potential Residual Effects on Wetland Valued Components due to Direct Project Interaction

Valued Component	Timing Start	Project Area(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Wetland Extent	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Loss of Wetland Extent: 0.8 ha - Treaty Creek access road, 0.3 ha - Camp 3 and Camp 7, 8.3 ha - Treaty OPC, 48.8 ha - TMF, 0.2 ha - laydown area, 0.2 ha - Kerr Pit, and 0.7 ha - Coulter Creek access road	Avoidance and Compensation	Avoided wetlands by redesigning plant site area and changing access into the TMF; Proposing a wetland compensation plan pursuant to the federal policy on wetland conservation to compensate for lost extent	Yes	Loss of Wetland Extent
Hydrological Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Loss of Hydrological Function associated with a loss of wetland extent	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); implement buffer around wetlands; and follow Wetland Management Plan	Yes	Loss of Hydrological Function
Hydrological Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Alteration or Degradation to Hydrological Function: 1.0 ha - Camp 3, Camp 7, and Camp 8, 18.5 ha - Coulter Creek access road, 0.7 ha - Mitchell Pit, 0.6 ha - Mitchell-Treaty Saddle Area, 1.4 ha - TMF, 21.8 ha - Treaty Creek access road, and 8.1 ha - Treaty OPC.	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); implement buffer around wetlands; and follow Wetland Management Plan.	No	
Biochemical Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Loss of Biochemical Function associated with a loss of wetland extent	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); monitor point source and non-point source water contributions to wetlands; monitor vegetation cover in receiving wetlands; implement buffer around wetlands.	Yes	Loss of Biochemical Function
Biochemical Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Alteration or Degradation to Biochemical Function: 1.0 ha - Camp 3, Camp 7, and Camp 8, 18.5 ha - Coulter Creek access road, 0.7 ha - Mitchell Pit, 0.6 ha - Mitchell-Treaty Saddle Area, 1.4 ha - TMF, 21.8 ha - Treaty Creek access road, and 8.1 ha - Treaty OPC.	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); monitor point source and non-point source water contributions to wetlands; monitor vegetation cover in receiving wetlands; implement buffer around wetlands.	No	

(continued)

Table 16.7-4. Potential Residual Effects on Wetland Valued Components due to Direct Project Interaction (completed)

Valued Component	Timing Start	Project Area(s)	Description of Effect due to Component(s)	Type of Project Mitigation	Project Mitigation Description	Potential Residual Effect	Description of Residuals
Ecological Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Loss of Ecological Function associated with a loss of wetland extent	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; implement a buffer around wetlands; and follow the Wetland Management Plan.	Yes	Loss of Ecological Function
Ecological Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Alteration or Degradation to Ecological Function: 1.0 ha - Camp 3, Camp 7, and Camp 8, 18.5 ha - Coulter Creek access road, 0.7 ha - Mitchell Pit, 0.6 ha - Mitchell-Treaty Saddle Area, 1.4 ha - TMF, 21.8 ha – Treaty Creek access road, and 8.1 ha - Treaty OPC.	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; implement a buffer around wetlands; and follow the Wetland Management Plan.	No	
Habitat Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Loss of Habitat Function associated with a loss of wetland extent	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; Implement a buffer around wetlands; and follow the Wetland Management Plan.	Yes	Loss of Habitat Function
Habitat Function	Construction and Operation	• Camp 3: Eskay Staging Camp • Camp 7: North Unuk Camp • Treaty Creek access road • Treaty OPC • TMF (North Cell, Centre Cell, and South Cell) • Sulphurets laydown area • Kerr Pit • Coulter Creek access road	Alteration or Degradation to Habitat Function: 1.0 ha - Camp 3, Camp 7, and Camp 8, 18.5 ha - Coulter Creek access road, 0.7 ha - Mitchell Pit, 0.6 ha - Mitchell-Treaty Saddle Area, 1.4 ha - TMF, 21.8 ha - Treaty Creek access road, and 8.1 ha - Treaty OPC.	Alternative; Management Practices; Monitoring and Adaptive Management	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; Implement a buffer around wetlands; and follow the Wetland Management Plan	No	

With the implementation of mitigation measures, the residual effects will be limited to those wetland habitat areas directly impacted by proposed Project infrastructure areas. The construction and operation of the TMF, in particular, will result in residual effects and direct loss of wetland habitat .

16.7.2 Alteration or Degradation to Wetland Function

Alteration or degradation of wetland function has been identified at a number of sites based on the proximity of wetlands to the proposed development. Although wetlands within 100 m of any proposed development feature were deemed to be potentially degraded, it is quite likely that they will remain unaffected where they are not:

- hydrologically connected to the lost areas;
- subject to dust deposition;
- subject to the introduction of invasive wetland plant species; and
- fragmented.

Potentially degraded wetland functions were identified by contrasting wetland classes within the buffer area of the footprint against a set of criteria equating wetland class and wetland function (Hanson et al. 2008). Additionally, wetland ecological and habitat functions were determined degraded if they were identified as fragmented.

It is expected that 52.2 ha of wetlands will be degraded as a result of the maximum extent of disturbance (Table 16.7-5).

Table 16.7-5. Area of Wetlands Degraded from the Maximum Extent of Disturbance

Wetland Class	Degraded (ha)	Total Area Mapped (ha)	Percent of Class Degraded
Fen	12.0	70.6	17%
Marsh	10.1	35.6	28%
Swamp	21.8	374.3	6%
TRIM Open Water	8.3	41.8	20%
Total	**52.2**	**522.3**	**10%**

The effect of degradation on wetland function, based on wetland class, was also explored by Project area (Table 16.7-6) to determine activities that cause degradation such that mitigation measures can focus on those issues.

The wetland class with the largest degraded area is swamps (21.8 ha). The majority of this is expected along the TCAR. These riparian wetlands have important hydrological flood prevention/protection, biochemical (nutrient cycling), ecological (structural diversity), and habitat (moose winter range) functions. Vegetation clearing will affect vegetation community composition and structure, thus influencing all of these functions. For example, different plant species have different rates and capabilities when it comes to evapotranspiration. Alterations in the evapotranspiration capability of a wetland will alter how that ecological community functions to regulate water flow and buffer downstream areas from flooding during periods of high water.

Table 16.7-6. Area of Degraded Wetland Class and Associated Mine Infrastructure – Maximum Extent of Disturbance

Project Area	Fen (ha)	Marsh (ha)	Swamp (ha)	Open Water (ha)	Total (ha)
Camp 3: Eskay				0.2	0.2
Camp 7: Unuk North			0.2		0.2
Camp 8: Unuk South				0.6	0.6
Coulter Creek access road	1.5	9.5	1.3	6.2	18.5
Mitchell Pit	0.7				0.7
Mitchell-Treaty Saddle Area				0.6	0.6
South Cell Tailing Management Facility	1.4				1.4
Sulphurets laydown area	0.1				0.1
Treaty Creek access road	0.2	0.6	20.3	0.7	21.8
Treaty OPC	8.1				8.1
Total (ha)	**12.0**	**10.1**	**21.8**	**8.3**	**52.2**

A total of 8.1 ha of fen will be degraded by the Treaty OPC. Fens have important biochemical functions for protecting water quality, as they act as physical and chemical filter for water entering surface or groundwater systems. Total degradation to fens of 12.0 ha may result in changes in the fens ability to filter water. For example, if mitigation measures in the Erosion Control Plan are not followed then sediment deposition to fen wetlands is a possibility. This would effectively choke out vegetation, change the wetland ecology (ecological function), and alter their ability to filter water.

Potential effects on wetland function within the TMF and CCAR will be varied given the variety of wetland classes affected in these areas. Effects will include degradation of the biochemical and hydrological functions of wetlands at sites adjacent to roads (site roads within the TMF area and the CCAR) and at locations near maintenance activities (such as snow removal), both of which may contribute to sediment deposition in adjacent areas. There will also be a possibility that non-native (i.e., invasive) wetland vegetation will be introduced during road construction, and by vehicles travelling along roads during construction and operation.

16.7.2.1 Mitigation for Wetland Function Alteration or Degradation

Mitigation meaures for alteration or degration to wetland function were separated into measures specific to construction and measures specific to operations.

16.7.2.1.1 Construction

Implementing mitigation strategies will minimize degradation of wetland function. Avoiding wetland areas is the best way to limit potential effects (Section 16.7.1.1.1). Infrastructure will be sited such that it does not interact with wetlands provided that it does not have siting constraints that limit location options. At wetlands where avoidance is not an option given specific engineering or eventual operational requirements, Project effects on wetlands will be minimized by siting infrastructure away from hydrologically active areas such as groundwater springs, seepage slopes, channels, and deep-water zones. These mitigation measures will reduce the effects on wetland hydrological function.

Mitigation measures and related monitoring objectives are provided in the Wetland Management Plan (Section 26.19). Although monitoring is not a mitigation measure, the information collected during monitoring will inform future development of appropriate adaptive management strategies for wetland management. A summary of mitigation activities are described below.

To mitigate alteration or degradation to wetland function, wetland extent must be maintained where possible. To support the maintenance of wetland extent, reserve and management area buffers will be established around all wetlands not identified as lost (Section 16.7.1). These buffers will be used to guide clearing activies for the construction phase and were selected following BC MOF and BC MOE (1995). The smallest reserve zone (10 m) proposed in the guidebook will be extended to all wetlands. This will provide adequate protection of the vegetation, soil, and hydrological constituents of wetlands, which will maintain their extent and function.

Wetland management zones will be extended beyond the 10 m reserve zone to a distance of:

- 20 m for any wetland less than 5 ha;
- 40 m for all wetland complexes; and
- 30 m for all wetlands greater the 5 ha (Table 16.7-7).

Table 16.7-7. Wetland Buffer Guidelines

Environmental Feature	Reserve Zone	Management Zone	Total Buffer
Small Wetlands (< 5 ha)	10 m	20 m	30 m
Large Wetlands (> 5 ha)	10 m	30 m	40 m
Wetland Complexes	10 m	40 m	50 m

Light activities, such as construction access, sediment, and erosion controls, and targeted vegetation clearing will be permitted within the wetland management zone; however, permanent features such as buildings and main roads will be located outside this zone wherever possible. An example of reserve and management zones around wetlands in the Treaty OPC is presented in Figure 16.7-3.

To maintain hydrological function mitigation measures include:

- installing effective sediment control and protection strategies prior to initiating construction or operation activities (i.e., silt fences, sumps, and proper ditching/culverts, etc.);
- regularly inspecting these devices and conducting maintenance or replacement when required;

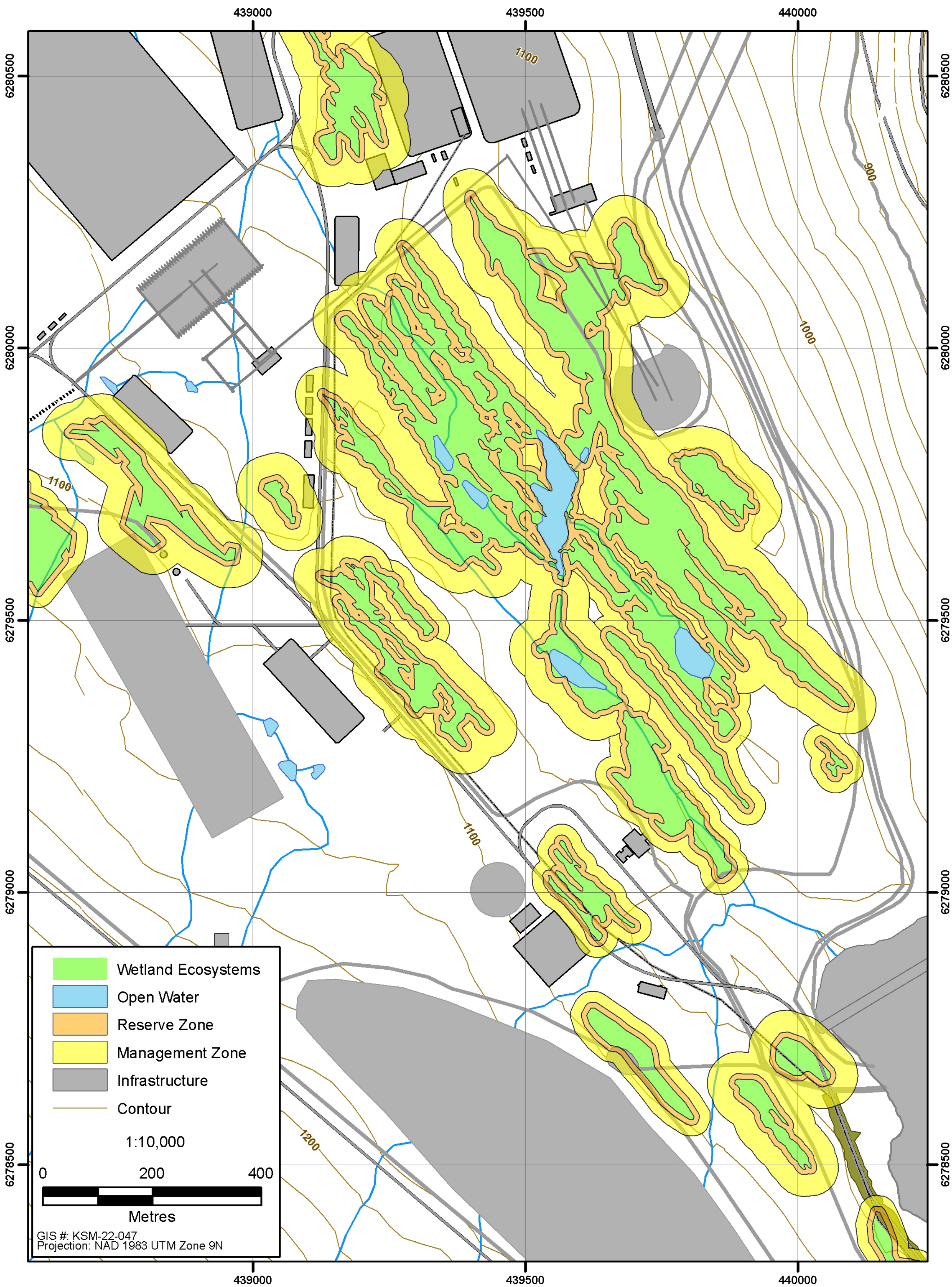


Figure 16.7-3

Reserve and Management Zones for Wetlands in the Treaty OPC

SEABRIDGE GOLD
KSM PROJECT

Rescan
Engineers & Scientists

- implementing erosion and slope protection measures on disturbed soils and covering all organic and mineral soil stockpiles (i.e., developing stockpiles away from surface water, skirting with silt fences, re-vegetation etc.);
- minimizing vegetation clearing;
- minimizing exposed soils;
- minimizing construction and operation activities during unfavourable weather conditions such as high precipitation events; and
- conducting site restoration as soon as possible to re-establish ground cover.

To mitigate the effects of development on the biochemical function of wetlands, the quality of any discharge will be thoroughly scrutinized through environmental monitoring.

Maintaining biochemical function will be addressed by following the recommendations of the Water Management Plan, Erosion Control Plan, and Spill Prevention and Emergency Response Plan. Tracking water sampling results, sampling frequencies, and threshold limits will ensure water quality is consistent and within appropriate water quality guidelines by allowing adaptive management strategies such as changing discharge locations, treatment, retention times, etc., to be implemented.

Spill prevention and emergency response is intended to prevent and mitigate the effects of deleterious substances discharged into wetlands. It also provides emergency response procedures should a spill occur. Spill prevention and emergency response measures include:

- storing, handling, and labelling fuels and other hazardous substances away from wetlands and water bodies;
- implementing equipment and servicing procedures such that servicing and maintenance occur in designated areas away from aquatic features;
- providing details on the location and nature of spill response equipment;
- developing spill response, reporting, and notification procedures; and
- developing containment, recovery, and cleanup procedures and providing training.

Hydrocarbon sampling will be required if a spill of petroleum hydrocarbons occurs within a wetland reserve zone, management zone, or water body directly connected to a wetland.

Wetland habitat function includes providing aquatic, semi-aquatic, and transition environments that are used by a variety of fish and wildlife. Thus following the Fish and Aquatic Habitat Management Plan and the Wildlife Management Plan will see the habitat function for wetland-dependent species is maintained.

Fish and aquatic habitat located in or associated with wetlands will be protected by strategies identified in the Fish and Aquatic Habitat Management Plans. Specific activities for managing aquatic habitat include:

- minimizing removal and disturbance of low-growing shrub, herb, or grass species;
- avoiding grubbing;
- directional falling of trees away from the water body; and
- preserving root structure and stability of topped trees.

Wildlife and wildlife habitat areas that are located within or are associated with wetlands are to be protected by strategies identified in the Wildlife Management Plan, Noise Management Plan, Domestic and Industrial Waste Management Plan, and the Traffic and Access Management Plan, which provide additional guidance for mitigation of effects. Specific activities for managing terrestrial and aquatic wildlife habitat include:

- minimizing riparian vegetation clearing;
- retaining wildlife trees;
- minimizing effects of construction related light and noise on wildlife; and
- avoiding construction activities, especially vegetation clearing, during sensitive periods.

If construction activities must take place within sensitive periods, appropriate pre-construction surveys will be conducted to ensure minimal risk to wildlife, birds, and amphibians. Sensitive periods, specific guidelines, and applicable legislation for species of concern are presented in the Wildlife Management Plan.

16.7.2.1.2 Operations

Once construction is completed and operations begin, the mitigation measures employed to maintain wetland function will be different. For example mitigation measures focusing on maintaining wetland extent will no longer be needed because once construction is complete no new areas will be disturbed. Thus, the use of reserve and management zones around wetlands can be suspended unless construction in previously undisterbed areas is needed. Specific mitigation measures from construction that carry though to operations include:

- maintaining and monitoring effective sediment control strategies;
- ensuring re-vegetation success of cleared areas;
- follow management plans, specifically:
    1. Wetland Management Plan;
    2. Water Management Plan;
    3. Erosion Control Plan;
    4. Spill Prevention and Emergency Response Plan;
    5. Fish and Aquatic Habitat Management Plan; and
    6. Wildlife Management Plan.
- storage, handling, and labeling of hazardous substances away from wetlands; and
- service equipment in designated areas.

Effective monitoring in wetlands proximate to development will also help mitigate operational effects. Although monitoring is not a mitigation measure it will identify continued pressures on wetland ecosystems. This will allow for targeted mitigation activities to be developed and employed if effects beyond those identified in this assessment are observed.

16.7.2.2 Potential for Residual Effects

Potential residual effects on wetland functions were identified and include:

- dustfall impacts on wetland vegetation having an adverse effect on vegetation, biochemistry, and hydrology;
- snow ploughing and salt addition to wetland areas during the winter, having an adverse effect on vegetation and function; and
- introduction of invasive species and herbicides and insecticides that may be used along roadway corridors.

Adverse effects of herbicide use, insecticide use, road salt use, and road ploughing on wetland functions will be mitigated through the implementation of Vegetation Clearing Management Plan and the Invasive Plant Management Plan. Dustfall impacts will be mitigated through Fugitive Dust Emissions Management Plan along all access corridors and work locations if required.

All potential effects on wetland function, associated mitigation measures, and identified residual effects are described in Table 16.7-4.

16.7.2.3 Potential Residual Effects due to Alteration or Degradation of Wetland Function

The Project will have an effect on wetland function, particularly those functions associated with fen and swamp wetlands. The footprint analysis determined that 52.1 ha of wetlands will be at risk of degradation. The majority of the potential degradation is within the Treaty Creek and Coulter Creek access roads. Mitigation measures such as avoidance, siting infrastructure adjacent to, rather than over, wetlands, instituting reserve and management buffers around wetlands, following site-wide water quality monitoring and adaptive management protocols, and implementing the Wetland Management Plan will mitigate the potential for residual effects on wetland function as a result of degradation/fragmentation.

16.8 Significance of Residual Effects for Wetlands

The residual effects of the Project on wetland extent and function that are carried through the assessment are the loss of wetland extent and function associated with the construction and operation of the following:

- Treaty Creek access road;
- Coulter Creek access road;
- construction camps;
- Camp 3: Eskay Staging Camp;

- Camp 7: Unuk North Camp;
- Tailing Management Facility;
- North Cell;
- South Cell;
- Centre Cell;
- Treaty OPC;
- Sulphurets laydown area; and
- Kerr Pit.

16.8.1 Residual Effect Descriptors for Wetlands

Residual effect descriptors are used to describe aspects of the potential residual effect. The descriptors and definitions used in this assessment are presented in Table 16.8-1.

The magnitude of the effect is determined through the footprint analysis. Thresholds of the percent of local loss were used to determine magnitude for effects on wetland extent (Table 16.8-2).

The geographic extent of the effects is aligned to the LSA and RSA. The local extent is the footprint +100 m (LSA), and the regional extent is the Unuk and Upper and Lower Bell-Irving watershed (RSA; Section 16.4.1).

The definitions of duration, context, and probability are included in Table 16.8-1.

16.8.2 Residual Effects Assessment for Wetland Extent and Function

Discussions about the residual effect for lost wetland function are presented in increasing magnitude. The residual effects assessment is summarized in Table 16.8-3.

16.8.2.1 Loss of Wetland Extent

There is a predicted residual effect on the loss of wetland extent. Loss of wetland extent will occur at many Project areas and throughout numerous Project activities. The loss of extent associated with Camp 3: Eskay Staging Camp, the Sulphurets laydown area, and the Kerr Pit is of negligible magnitude because the loss accounts for less than 1% of total wetland loss. The effect of loss of wetland extent is local because it will be confined to specific features/activities within the footprint. The duration of the effect is far-future because lost wetlands, outside of the TMF, will not be reclaimed. The frequency of the effect is sporadic because the total loss will occur throughout operation (51.5 years) due to the placement of infrastructure. The effect is irreversible as no wetlands on the Mine Site will be reclaimed to wetland. The context of the effect of the loss of wetland extent is neutral because wetlands can be persistent, particularly when their hydrological regime is maintained and they are not communities of special concern. Although there is a loss of wetlands at the local scale, the loss within the RSA is not expected to threaten the sustainability of wetlands in the region. The residual effect of loss of wetland extent within these areas is not significant (Table 16.8-3).

Table 16.8-1. Definitions of Significance Criteria for Wetlands Residual Effects

Timing	Magnitude	Geographic Extent (Physical/Biophysical)	Duration	Frequency	Reversibility	Context (Resiliency)	Likelihood of Effects: Probability	Likelihood of Effects: Confidence Level
When will the effect begin?	*How severe will the effect be?*	*How far will the effect reach?*	*How long will the effect last?*	*How often will the effect occur?*	*To what degree is the effect reversible?*	*How resilient is the receiving environment or population? Will it be able to adapt to or absorb the change?*	*How likely is the effect to occur?*	*How certain is this analysis? Consider potential for error, confidence intervals, unknown variables, etc.*
Construction Phase	**Negligible:** No or very little detectable change from baseline conditions. For loss of wetland extent and function this is < 1% of total loss.	**Local:** Effect is limited to within a 100 m buffer of the immediate Project footprint.	**Short-term:** Effect lasts approximately 1 year or less.	**One Time:** Effect is confined to one discrete period in time during the life of the Project.	**Reversible Short-term:** Effect can be reversed relatively quickly.	**High:** The receiving environment or population has a high natural resilience to imposed stresses, and can respond and adapt to the effect.	**High:** It is highly likely that this effect will occur.	**High**: > 80% confidence. There is a good understanding of the cause-effect relationship and all necessary data are available for the Project area. There is a low degree of uncertainty and variation from the predicted effect is expected to be low.
Operation Phase	**Low:** Differs from the average value for baseline conditions to a small degree. For loss of wetland extent and function this is 1% to 25% of total loss.	**Landscape**: Effect is limited to a broader area but still remains tied to the Project footprint.	**Medium-term:** Effect lasts from 1 to 5 years.	**Sporadic:** Effect occurs rarely and at sporadic intervals.	**Reversible Long-term:** Effect can be reversed over many years.	**Neutral:** The receiving environment or population has a neutral resilience to imposed stresses and may be able to respond and adapt to the effect.	**Medium:** This effect is likely, but may not occur.	**Intermediate**: 40 to 80% confidence. The cause-effect relationships are not fully understood, there are a number of unknown external variables, or data for the Project area are incomplete. There is a moderate degree of uncertainty; while results may vary, predictions are relatively confident.
Closure Phase	**Medium:** Differs substantially from the average value for baseline conditions and approaches the limits of natural variation. For loss of wetland extent and function this is > 25% to 70% of total loss.	**Regional:** Effect extends across the broader region (e.g., RSA, multiple watersheds, etc.).	**Long-term:** Effect lasts between 6 and 40 years.	**Regular:** Effect occurs on a regular basis and potentially beyond the life span of the Project.	**Irreversible:** Effect cannot be reversed.	**Low:** The receiving environment or population has a low resilience to imposed stresses, and will not easily adapt to the effect. This may be due to past human activity or ecological/social fragility, or a high level of existing stressors as baseline.	**Low:** This effect is unlikely but could occur.	**Low**: < 40% confidence. The cause-effect relationships are poorly understood, there are a number of unknown external variables, and data for the Project area are incomplete. High degree of uncertainty and final results may vary considerably.
Post-closure Phase	**High**: Differs substantially from baseline conditions, resulting in a detectable change beyond the range of natural variation. For loss of wetland extent and function this is > 75% of total loss.	**Beyond Regional:** Effect extends beyond the regional scale, and may extend across or beyond the province.	**Far Future:** Effect lasts more than 40 years.	**Continuous:** Effect occurs constantly during, and potentially beyond, the life of the Project.				

Table 16.8-2. Magnitude Thresholds for Percent Loss of Local Wetland Class

Magnitude of Effect	% Loss
Negligible	< 1%
Low	1-25%
Medium	25-75%
High	> 75%

Parts of the Project lie within one of two resource management plans: the CIS LRMP and the Nass South SRMP (BC ILMB 2000; BC MFLNRO 2012).

The CIS LRMP identifies wetlands within the Unuk River Zone as critical patch habitats for grizzly bears; 0.4 ha of wetlands will be affected in this area and 50% of this is shallow open water which is not prime grizzly habitat. The LRMP also states that the best management practices from the *Riparian Management Area Guidebook* (BC MOE and MOF 1995) should be followed (BC ILMB 2000). The guidelines presented in the guidebook were used to develop the primary mitigation measure used to mitigate effects on extent and function. The mitigation measures presented in this assessment improve upon the zones presented in the guidebook in that they are extended to all wetlands, regardless of size and complexity.

The Project Mine Site does not lie within the Nass South SRMP.

The effect of the loss of wetland extent associated with the following areas is of low magnitude because each of them account for less than 25% of all wetland loss.

- Treaty Creek access road;
- Coulter Creek access road;
- Camp 7: Unuk North Camp; and
- Treaty OPC.

The effect is local because it will be confined to specific features/activities within the footprint. The duration of the effect is far-future because lost wetlands, outside of the TMF, will not be reclaimed. The frequency of the effect is sporadic because, although they will only occur once at a given site, they will occur at a variety of times in a variety of areas until the completion of a given Project phase. The effect is irreversible given that affected wetlands will not be reclaimed. The context of the effect of the loss of wetland extent is neutral because wetlands can be persistent, particularly when their hydrological regime is maintained and they are not communities of special concern. Although there is a loss of wetlands at the local scale, the loss within the RSA is not expected to threaten the sustainability of wetlands in the region. The residual effect of wetland loss within these areas is not significant (Table 16.8-3).

The Treaty OPC and TCAR do not fall within the CIS LRMP or the Nass South SRMP and thus effects are not assessed in the context of these plans. These plans do reference establishment of buffers around wetlands as a preferred mitigation tool; this recommendation was used as the primary mitigation measure in this assessment; wetland buffers were extended to all wetlands, regardless of size and complexity.

The loss of wetland extent associated with the TMF is of high magnitude because approximately 82% of all wetland losses will occur in this area. The extent of the effect of the loss of wetland extent in the TMF is local because it will occur within the footprint. The duration of the effect is far-future because any wetlands created through site reclamation will not be completed until the operation phase ceases (51.5 years). The frequency of the effect is sporadic because, although it will only occur once at a given site, it will occur at sites throughout a given Project area. The effect of wetland loss in the TMF area is irreversible because the area will be irrevocably altered. The context of this effect is neutral because no special communities were identified in the TMF area and because the loss of wetlands at the local scale is not expected to threaten the sustainability of wetlands in the region. A wetland compensation plan will be developed to specifically address the loss of wetlands within the TMF area. This mitigation measure will reduce the significance of the effect making the residual effect of lost wetland extent within the TMF not significant (moderate; Table 16.8-3). Site reclamation and the development of a wetland within the TMF footprint at closure will further mitigate the effects of lost extent.

The TMF does not sit within the CIS LRMP or the Nass South SRMP and thus effects are not assessed in the context of these plans. These plans do reference establishment of buffers around wetlands as a preferred mitigation tool. This recommendation was used as the primary mitigation measure in this assessment, and wetland buffers were extended to all wetlands, regardless of size and complexity.

16.8.2.2 Loss of Wetland Function

The residual effect of a loss of wetland function will occur at a number of Project areas for a number of Project activities. With a few exceptions, the loss of function mirrors the loss of wetland extent because wetland function is proportional to extent. The extent of the effect of loss of wetland function is regional because the functions of wetlands are realized within regions that extend beyond a single site or watershed.

The assessment of the residual effects of the loss of wetland function is analogous to the assessment of wetland extent. A loss of function will occur where there is a loss of extent. Given that the area is pristine and no regionally important (red- or blue-listed wetlands) were identified, it was assumed that the magnitude of the loss of function was the same as the loss to extent. However, as wetland functions are realized at the watershed scale, the extent of the effect is summarized in Table 16.8-3 at the regional scale. All residual effects on wetland function are assessed as not significant, with the notable exception of wetland function supported by wetlands in the TMF (Table 16.8-3). The loss of wetland function resulting from TMF development is assessed as not significant (moderate).

Table 16.8-3. Summary of Residual Effects on Wetland Extent and Function

Description of Residual Effect	Project Component (s)	Timing of Effect	Magnitude	Extent	Duration	Frequency	Reversibility	Context	Likelihood of Effects: Probability	Likelihood of Effects: Confidence Level	Significance Determination	Follow-up Monitoring
Loss of Wetland Extent	Treaty Creek access road	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Coulter Creek access road	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Camp 3: Eskay Staging Camp	Construction	Negligible	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	Camp 7: Unuk North Camp	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	North Cell	Construction	High	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	South Cell	Construction	High	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	Centre Cell	Construction	High	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	Treaty OPC	Construction	Low	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Sulphurets laydown area	Operations	Negligible	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	Kerr Pit	Operations	Negligible	Local	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
Loss of Wetland Function	Treaty Creek access road	Construction	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Coulter Creek access road	Construction	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Camp 3: Eskay	Construction	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	Camp 7: Unuk North	Construction	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	North Cell	Construction	Medium	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	South Cell	Construction	Medium	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	Centre Cell	Construction	Medium	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Moderate)	Required
	Treaty OPC	Construction	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Required
	Sulphurets laydown area	Operation	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
	Kerr Pit	Operation	Negligible	Regional	Far future	Sporadic	Irreversible	Neutral	High	High	Not significant (Minor)	Not Required
Overall Residual Effect	All	Post-closure										

For all Moderate (Not Significant) determinations follow up monitoring is required for Project effects, wetland management, wetland compensation, and reclamation in the TMF at closure
REV D.1-b, July 2013

16.8.2.3 Overall Effect on Wetland Extent and Function

Wetland extent and function will be affected by development the Project; however, the majority of effects are not significant. Footprint analysis identified that 12% of the study area wetlands will be affected by the Project, which is not significant. However, when effects to wetlands are examined by Project area at the local scale it was determined that the loss of fen and swamp wetland area within the TMF was considered potentially significant. Thus a compensation plan was developed to mitigate the loss of local wetland extent function; effectively reducing the significance of lost extent and function to not significant (moderate).

In addition to the above mitigation measures a follow up program will be conducted to verify the wetland compensation projects are effective at offsetting the loss of wetland extent and function as predicted.

Compensation success will be based upon a greater than 1.25:1 area ratio of all compensation wetlands to impacted wetlands at the end of the five-year regulatory monitoring period for each site. Additional reclamation at closure will bring the post-Project wetland ratio to in excess of 2.5:1. The follow up program will focus on conducting vegetation surveys, biomass, and photopoint monitoring at compensation sites.

16.9 Potential Cumulative Effects for Wetlands

16.9.1 Scoping of Cumulative Effects

16.9.1.1 Spatial Linkages with Other Projects and Human Actions

A wetland VC boundary was determined to assess spatial linkages between the KSM Project potential effects on terrestrial ecosystems with effects from other projects. To account for rare or endangered wetland communities, major watershed boundaries were used to define the wetland VC boundary.

Considering the wetland VC boundary that encompasses the Unuk and Bell-Irving watersheds, the following projects and activities are considered to have a potential spatial overlap with loss of wetland functions and loss of wetland extent (Figure 16.9-1):

- the past producing Eskay Creek Mine;
- the proposed Northwest Transmission Line (NTL);
- the proposed Brucejack Mine;
- the proposed Kitsault Mine;
- the proposed Arctos Anthracite Coal Project;
- the proposed Schaft Creek Mine;
- forestry activity; and
- mineral and resource exploration activity.

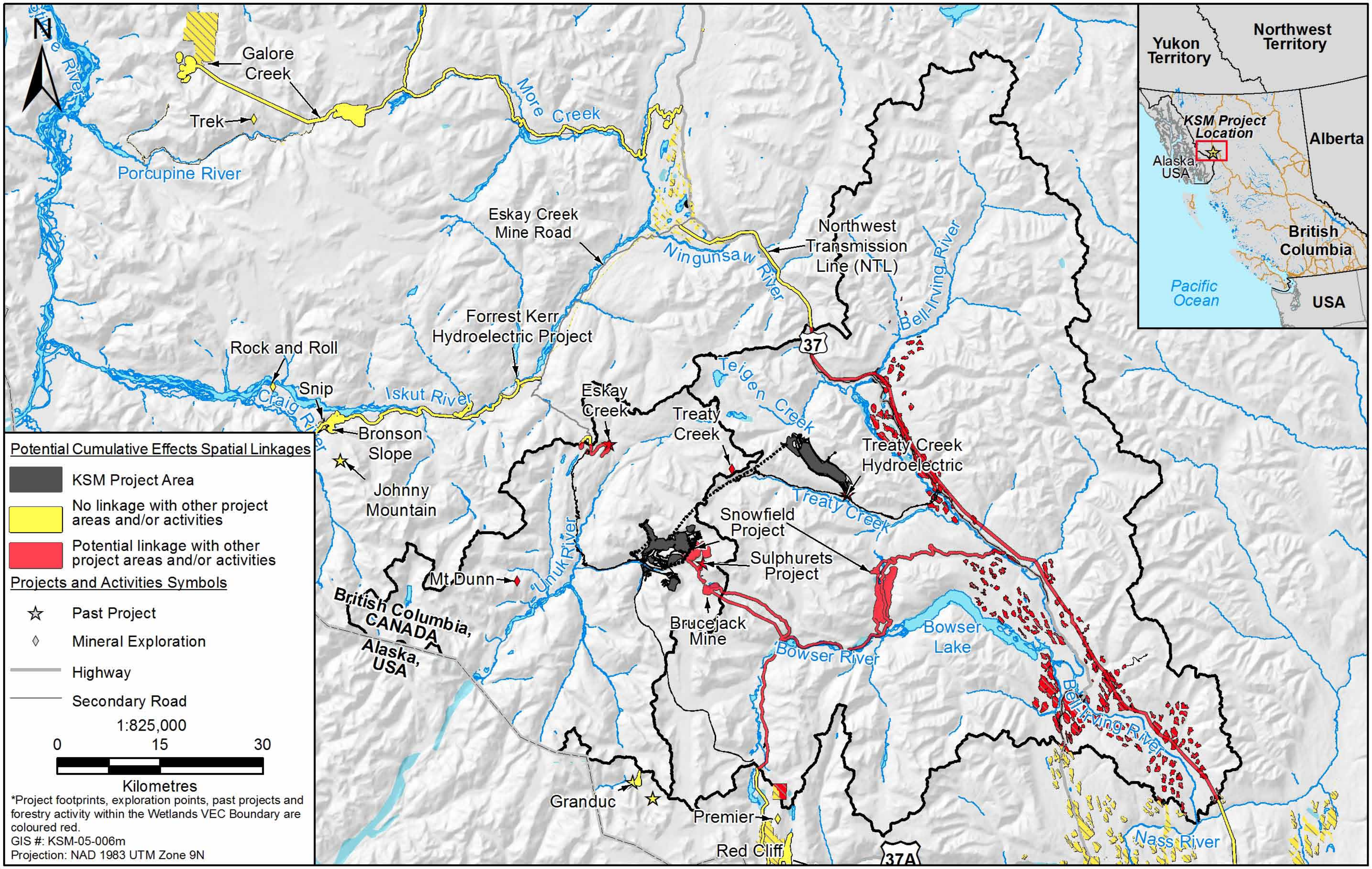


Figure 16.9-1

SEABRIDGE GOLD
KSM PROJECT

KSM Cumulative Effects Issue Scoping: Potential Spatial Linkages for Wetlands

Figure 16.9-1

Rescan Engineers & Scientists

16.9.1.2 Temporal Linkages with Other Projects and Human Actions

Effects from past and present human actions and projects that have the potential to overlap temporally with effects to the extent and function of wetlands from the KSM Project are:

- mineral exploration;
- forestry activity;
- the past producing Eskay Creek Mine; and
- the NTL.

Future human actions with temporal linkages with the KSM Project include:

- ongoing present and future mineral exploration;
- future forestry activity;
- construction of the NTL, which may overlap with Project construction and operation phases;
- the proposed Brucejack Mine's construction and operations, which are likely to overlap with the KSM Project's operation phase; and
- the proposed Arctos Anthracite Coal Project, and Schaft Creek Mine, which have the potential to reduce wetland extent, which translates into a reduction of wetland function within northwest BC.

Table 16.9-1 summarizes the linkages between the KSM Project and other human actions in regard to possible loss of wetland ecological function.

Table 16.9-1. Summary of Potential Linkages between KSM Project and Other Human Actions in Regard to Wetlands

Action/Project	Past	Present	Future
Past Projects			
Eskay Creek Mine	X; loss of wetland extent and function within the region	NL	NL
Granduc Mine	NL	NL	NL
Johnny Mountain Mine	NL	NL	NL
Kitsault Mine (Closed)	NL	NL	NL
Snip Mine	NL	NL	NL
Sulphurets Project	NL	NL	NL
Swamp Point Aggregate Mine	NL	NL	NL
Present Projects			
Forrest Kerr Hydroelectric	NL	NL	NL

(continued)

Table 16.9-1. Summary of Potential Linkages between KSM Project and Other Human Actions in Regard to Wetlands (continued)

Action/Project	Past	Present	Future
Present Projects (cont'd)			
Long Lake Hydroelectric	NL	NL	NL
NTL	NL	X; construction overlaps; watercourse crossings in the Bell-Irving watershed	X; construction overlaps; watercourse crossings in the Bell-Irving watershed
Red Chris Mine	NL	NL	NL
Wolverine Mine	NL	NL	NL
Reasonably Foreseeable Future Projects			
Bear River Gravel	NL	NL	NL
Bronson Slope Mine	NL	NL	NL
Brucejack Mine	NL	NL	X; downstream/adjacent water bodies include, Todedada Creek and Mitchell Creek
Galore Creek Mine	NL	NL	NL
Granduc Copper Mine	NL	NL	NL
Kitsault Mine	NL	NL	NL
Kutcho Mine	NL	NL	NL
McLymont Creek Hydroelectric	NL	NL	NL
Arctos Anthracite Coal Project	NL	NL	X; loss of wetlands, which will result in reduced regional wetland function
Schaft Creek Mine	NL	NL	X; loss of wetlands, which will result in reduced regional wetland function
Snowfield Project	NL	NL	NL
Storie Moly Mine	NL	NL	NL
Turnagain Mine	NL	NL	NL
Treaty Creek Hydroelectric	NL	NL	NL
Land Use Activities			
Agricultural Resources	NL	NL	NL
Fishing	NL	NL	NL
Guide Outfitting	NL	NL	NL
Resident and Aboriginal Harvest	NL	NL	NL
Mineral and Energy Resource Exploration	X; loss of wetland extent and function due to land clearing	X; loss of wetland extent and function due to land clearing	X; loss of wetland extent and function due to land clearing

(continued)

Table 16.9-1. Summary of Potential Linkages between KSM Project and Other Human Actions in Regard to Wetlands (completed)

Action/Project	Past	Present	Future
Land Use Activities (cont'd)			
Recreation and Tourism	NL	NL	NL
Timber Harvesting	X; loss of wetland extent and function due to timber harvest in wetlands < 5 ha	NL	X; loss of wetland extent and function due to timber harvest in wetlands < 5 ha
Traffic and Roads	NL	NL	NL

NL = No Linkage (no spatial and temporal overlap, or potential effects do not act in combination).
X = Potential spatial and temporal linkage with Project or action.

16.9.2 Cumulative Effects Assessment for Wetland Extent and Function

A summary of possible interactions for each project identified in Table 16.9-1 is presented in Table 16.9-2.

Table 16.9-2. Summary of Projects and Activities with Potential to Interact Cumulatively with Expected Project-specific Residual Effects on Wetlands

Description of KSM Project Residual Effect	Potential for Cumulative Effect: Relevant Projects and Activities							
	NTL	Brucejack Mine	Mineral and Energy Resource Exploration	Timber Harvesting	Kitsault Mine	Arctos Anthracite Coal Project	Schaft Creek Mine	Eskay Creek Mine
Loss of Wetland Extent	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	No Interaction	No Interaction	No Interaction	Possible Interaction
Loss of Wetland Function	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction	Possible Interaction

16.9.2.1 Cumulative Effect of Loss of Wetland Extent

The KSM Project will affect wetlands as will other projects in the region (Tables 16.9-1 and 16.9-2). The cumulative effects on wetland extent will be limited to projects within the vicinity of the KSM Project as effects on individual wetlands are local. Projects where an expected cumulative loss of the extent of wetlands is expected are detailed in Table 16.9-2.

16.9.2.1.1 Project Specific Cumulative Effects Mitigations for Loss of Wetland Extent

A wetland compensation plan was developed for the KSM Project. This compensation plan and wetland reclamation in the TMF at closure will mitigate cumulative effects on wetland extent. The compensation plan and reclamation at closure will result in 2.5 times as many wetlands at closure than were present at baseline.

16.9.2.1.2 Determination of Potential for Residual Cumulative Effect and Significance

A residual cumulative effect on the loss of wetland extent is expected. However, it is not expected that this effect will be significant because of the compensation and reclamation activities planned.

16.9.2.2 Cumulative Effect of Loss of Wetland Function

The KSM Project will affect wetland function, as will other projects in the region (Tables 16.9-1 and 16.9-2). The cumulative effects on wetland function, which is a VC of regional importance, will include all identified projects where a loss of wetland extent is expected. Projects where an expected cumulative loss of wetland extent is expected are detailed in Table 16.9-2.

16.9.2.2.1 Project Specific Cumulative Effects Mitigations for Loss of Wetland Extent

A wetland compensation plan was developed for the KSM Project. This compensation plan and wetland reclamation in the TMF at closure will provide some degree of mitigation to cumulative effects on wetland function.

16.9.2.2.2 Determination of Potential for Residual Cumulative Effect and Significance

A residual cumulative effect on the loss of wetland function is expected. However, it is not expected that this effect will be significant because of the compensation and reclamation activities planned. Compensation and reclamation at closure will result in 2.5 times as many wetlands at closure than were present at baseline.

Compensation efforts will include the development of wetland features into three fish habitat compensation projects. This will improved the functioning condition of the fish habitat compensation and will promote the development of wetland functions similar to those lost by the Project. In addition, a wetland near Smithers, BC, will be enhanced to restore wetland functions. This wetland is located close to a population centre that will receive education, research, and recreation benefits not currently realized in many wetlands in Northwest BC.

Wetlands will also be a reclamation endpoint in the TMF at closure. Although the communities will be different than those present at baseline, the reclaimed wetlands will provide functions such as habitat function for migratory birds and moose, hydrological functions such as water storage, and ecological functions such as complex ecosystems. Wetland compensation, reclamation, and wetland values will make the residual cumulative effect to wetland function not significant (minor; Table 16.9-3).

16.9.2.3 Overall Cumulative Effect on Wetland Extent and Function

The KSM Project will affect wetland extent and function, as have other mining and resource development projects within the region. However, by the post-closure phase of the KSM Project approximately 2.5 times as many wetlands will exist in northwest BC. Reclamation in the TMF will create approximately 275 ha of wetlands and the wetland compensation plan will see the development of 48 ha. Successional development of compensation and reclamation areas will have to be continually checked and monitored to make sure that similar communities to those lost will be created.

Table 16.9-3. Summary of Residual Cumulative Effects on Wetland Extent and Function

															Likelihood of Effects							
Description of Residual Effect	Other Project(s)/ Activity(ies)	Timing of Effect	Magnitude	Magnitude Adjusted for CE	Extent	Extent Adjusted for CE	Duration	Duration Adjusted for CE	Frequency	Frequency Adjusted for CE	Reversibility	Reversibility Adjusted for CE	Context	Context Adjusted for CE	Probability	Probability Adjusted for CE	Confidence Level	Conf. Level Adjusted for CE	Significance Determination	Significance Determination Adjusted for CE	Follow-up Monitoring	Follow-up Monitoring Adjusted for CE
Loss of wetland extent (Treat Creek Access Rd, Coulter Creek Access Road, Camp 7, and Treaty OPC	NTL, Brucejack Mine, Resource Exploration, and Timber Harvest	Construction	Low	Negligible	Local	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Minor)	Not Significant (Minor)	Required	not required
Loss of wetland extent (Camp 3, Sulphurest Laydown Area, Kerr Pit	NTL, Brucejack Mine, Resource Exploration, and Timber Harvest	Construction	Negligible	Negligible	Local	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Minor)	Not Significant (Minor)	Required	not required
Loss of wetland extent (North Cell South Cell, and Centre Cell)	NTL, Brucejack Mine, Resource Exploration, and Timber Harvest	Construction	High	Low	Local	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Moderate)	Not Significant (Minor)	Required	not required
Loss of wetland function (Treat Creek Access Rd, Coulter Creek Access Road, Camp 3, Camp 7, Treaty OPC, Sulphurest Laydown Area, and Kerr Pit)	NTL, Brucejack Mine, Resource Exploration, and Timber Harvest	Construction	Negligible	Negligible	Regional	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Minor)	Not Significant (Minor)	Required	not required
Loss of wetland function (North Cell South Cell, and Centre Cell)	NTL, Brucejack Mine, Resource Exploration, and Timber Harvest	Construction	Medium	Negligible	Regional	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Moderate)	Not Significant (Minor)	Required	not required
Loss of wetland function (Treat Creek Access Rd, Coulter Creek Access Road, Camp 3, Camp 7, Treaty OPC, Sulphurest Laydown Area, and Kerr Pit)	Kitsault mine (closed), Arctos Anthracite Coal Mine, Schaft Creek Mine, Eskay Creek Mine	Construction	Negligible	Negligible	Regional	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Minor)	Not Significant (Minor)	Required	not required
Loss of wetland function (North Cell South Cell, and Centre Cell)	Kitsault mine (closed), Arctos Anthracite Coal Mine, Schaft Creek Mine, Eskay Creek Mine	Construction	Medium	Negligible	Regional	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Moderate)	Not Significant (Minor)	Required	not required
Overall Effect	All	Post-closure	Low	Low	Regional	Regional	Far future	Far future	Sporadic	One-time	Irreversible	Irreversible	Neutral	Neutral	High	Medium	High	Intermediate	Not Significant (Minor)	Not Significant (Minor)	Required	Optional

CE = Cumulative Effect.

16.10 Summary of Assessment of Potential Environmental Effects on Wetlands

Activities throughout the life of the Project will affect wetland extent and wetland function. Generally, the magnitude of the interaction is expected to be low or negligible; thus, the interactions are not considered significant, with the exception of the TMF. The loss of wetland extent and function in this area is a high magnitude effect. As such, a wetland compensation plan was developed to mitigate the effects on wetland extent.

Table 16.10-1 provides a summary of all potential and residual effects considered in this assessment.

16.11 Wetland Conclusions

The KSM Project will affect wetland ecosystems. Wetland extent will be lost in the LSA and wetland function will be lost within the RSA. The effect of lost wetlands on the sustainability of wetland extent and function was assessed for the areas where wetlands were affected. The loss of wetlands in all areas, other than the TMF, was determined to be negligible or low magnitude effects resulting in a determination of not significant. The reason for this conclusion is that Project mitigation activities such as avoidance (Treaty Creek access road alignment and Treaty OPC redesign) and wetland management (Wetland Management Plan) limit the loss of wetland extent and function.

The loss of wetland extent and function in the North Treaty and South Teigen creeks (North Cell, South Cell, and Centre Cell of the TMF) is a high magnitude effect. Avoidance and minimization were determined to be insufficient when attempting to mitigate this effect. Thus a compensation plan was developed. This plan will be implemented in conjunction with fish habitat compensation projects to create functioning, complex, ecosystems capable of compensating the loss of wetland extent and providing an avenue for the long-term development of wetland function. In addition to the fish/wetland compensation projects a specific wetland will also be developed to promote wetland values not currently realized by wetlands within the RSA. This site, close to Smithers, will support education, research, and educational values. Implementation of the wetland compensation plan (Appendix 16-B) and reclamation in the TMF at closure will result in an increase of 2.5 times as much wetland area in the region over the life of the Project. These mitigation measures resulted in a determination of not significant (moderate) for the loss of wetland extent and function within the TMF.

The uncertainty associated with the effectiveness of wetland compensation in offsetting losses of wetland extent and function will be tracked through a follow up program. In addition, Section 7 of Appendix 16-B describes follow up monitoring which will be used to identify compensation success. Adaptive management strategies will be implemented where and when necessary to achieve targets associated with loss, compensation, and reclamation of wetland extent and function.

The conclusion of not significant does not indicate that no effect will result but it does imply that the long-term sustainability of wetlands will not be adversely affected. To this end, the qualification of moderate was applied to the significance determination in an effort to recognize the scale of the Project, its effect on wetland extent and function, and the mitigation measures necessary to reduce the significance of developing the KSM Project.

Table 16.10-1. Summary of Assessment of Potential Environmental Effects: Wetlands

Valued Component	Phase of Project	Potential Effect	Key Mitigation Measures	Significance Analysis of Project Residual Effects	Significance Analysis of Residual Cumulative Effects
Wetland Hydrological Function	Construction and Operation	Degradation/Alteration to Wetland Function	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); implement buffer around wetlands; and follow the Wetland Management Plan.	No	No[1]
Wetland Biochemical Function	Construction and Operation	Degradation/Alteration to Wetland Function	Avoid wetlands, specifically active hydrological areas (seepage slopes, channels, and deep water areas); monitor point source and non-point source water contributions to wetlands; monitor vegetation cover in receiving wetlands; implement buffer around wetlands.	No	No[1]
Wetland Ecological Function	Construction and Operation	Degradation/Alteration to Wetland Function	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; implement a buffer around wetlands; and follow the Wetland Management Plan.	No	No[1]
Wetland Habitat Function	Construction and Operation	Degradation/Alteration to Wetland Function	Avoid wetlands; locate necessary construction on wetland margins to mitigate wetland fragmentation; implement a buffer around wetlands; and follow the Wetland Management Plan.	No	No[1]
Wetland Hydrological Function	Construction and Operation	Loss of Wetland Function	Avoidance - Changes to Treaty OPC from 2010 pfs to 2012 pfs to reduce affected wetland areas; new road alignment along Treaty Creek to reduce wetland areas crossed by access road. Minimization - Establishment of riparian area buffers around all wetlands; commitment to monitoring and adaptive management in the Wetland Management Plan. Compensation - Development of a wetland compensation plan in the spirit of the federal policy on wetland conservation; creation of wetlands in the TMF at closure as part of the reclamation plan.	Yes	No[2] - Development of wetland compensation providing education, recreation, and research values not currently realized in northwest BC and reducing the significance of the residual cumulative effect.
Wetland Biochemical Function	Construction and Operation	Loss of Wetland Function	Avoidance - Changes to Treaty OPC from 2010 pfs to 2012 pfs to reduce affected wetland areas; new road alignment along Treaty Creek to reduce wetland areas crossed by access road. Minimization - Establishment of riparian area buffers around all wetlands; commitment to monitoring and adaptive management in the Wetland Management Plan. Compensation - Development of a wetland compensation plan in the spirit of the federal policy on wetland conservation; creation of wetlands in the TMF at closure as part of the reclamation plan.	Yes	No[2] - Development of wetland compensation providing education, recreation, and research values not currently realized in northwest BC and reducing the significance of the residual cumulative effect.
Wetland Ecological Function	Construction and Operation	Loss of Wetland Function	Avoidance - Changes to Treaty OPC from 2010 pfs to 2012 pfs to reduce affected wetland areas; new road alignment along Treaty Creek to reduce wetland areas crossed by access road. Minimization - Establishment of riparian area buffers around all wetlands; commitment to monitoring and adaptive management in the Wetland Management Plan. Compensation - Development of a wetland compensation plan in the spirit of the federal policy on wetland conservation; creation of wetlands in the TMF at closure as part of the reclamation plan.	Yes	No[2] - Development of wetland compensation providing education, recreation, and research values not currently realized in northwest BC and reducing the significance of the residual cumulative effect.
Wetland Habitat Function	Construction and Operation	Loss of Wetland Function	Avoidance - Changes to Treaty OPC from 2010 pfs to 2012 pfs to reduce affected wetland areas; new road alignment along Treaty Creek to reduce wetland areas crossed by access road. Minimization - Establishment of riparian area buffers around all wetlands; commitment to monitoring and adaptive management in the Wetland Management Plan. Compensation - Development of a wetland compensation plan in the spirit of the federal policy on wetland conservation; creation of wetlands in the TMF at closure as part of the reclamation plan.	Yes	No[2] - Development of wetland compensation providing education, recreation, and research values not currently realized in northwest BC and reducing the significance of the residual cumulative effect.
Wetland Extent	Construction and Operation	Loss of Wetland Extent	Avoidance - Changes to Treaty OPC from 2010 pfs to 2012 pfs to reduce affected wetland areas; new road alignment along Treaty Creek to reduce wetland areas crossed by access road. Minimization - Establishment of riparian area buffers around all wetlands; commitment to monitoring and adaptive management in the Wetland Management Plan. Compensation - Development of a wetland compensation plan in the spirit of the federal policy on wetland conservation; creation of wetlands in the TMF at closure as part of the reclamation plan.	Yes	No[2] - Development of wetland compensation plan and closure plan will provide approximately 2.5 times as much wetland area at closure as there was at baseline. Thus no residual cumulative effects were identified.

No indicates no residual effect and thus no significance determination
Yes indicates a residual effect was identified and a significance determination was made
[1] Indicates no significant determination was made
[2] Indicates not significant
Significance determination made on the maximum extent of disturbance.

References

Almas, A. R. and B. R. Singh. 2001. Plant Uptake of Cadmium-109 and Zinc-65 at Different Temperature and Organic Matter Levels. *Journal of Environmental Quality*, 30: 869-77.

BC ILMB. 2000. *Cassiar Iskut-Stikine Land and Resource Management Plan*. http://www.ilmb.gov.bc.ca/slrp/lrmp/smithers/cassiar/index.html (accessed December 2012).

BC MFLNRO. 2012. *Nass South Sustainable Resource Management Plan*. http://www.ilmb.gov.bc.ca/slrp/srmp/south/nass/index.html (accessed December 2012).

BC MOE. 2007. *BC Species and Ecosystems Explorer*. Government of British Columbia: n.p.

BC MOE. 2011. *Wetlands in B.C.* http://www.env.gov.bc.ca/wld/wetlands.html (accessed December 2012).

BC MOE and B. MOF. 1995. *Forest Practices Code Riparian Management Area Guidebook*. *Forest Practices Code of British Columbia Act*. Government of British Columbia: n.p.

Bedford, B. L. and K. S. Godwin. 2003. Fens of the United States: Distribution, characteristics, and scientific connection versus legal isolation. *Wetlands*, 23 (3): 608-29.

Brunham, W. G. and L. Bendell. 2010. The Effect of Temperature on the Accumulation of Cadmium, Copper, Zinc, and Lead by Scirpus acutus and Typha latifolia: A comparative analysis. *Waterter, Air, & Soil Pollution*, 219 (2011): 417-28.

Cox, K. and A. Grose. 2000. *Wetland Mitigation in Canada: A Framework for Application*. North American Wetlands Conservation Council: Ottawa, ON.

Daly, R. 2005. *Our box was full: An ethnography for the Delgamuukw plaintiffs*. Vancouver, BC: UBC Press.

Environment Canada. 1991. *The Federal Policy on Wetland Conservation*. Canadian Wildlife Service: Ottawa, ON.

Gambrell, P. R. 1994. Trace and Toxic Metals in Wetlands: A Review. *Journal of Environmental Quality*, 23: 883-91.

Gilliam, J. W. 1994. Riparian wetlands and water quality. *Journal of Environmental Quality*, 23: 896-900.

Gitxsan Chiefs' Office. 2010. *Gitxsan Chiefs' Office Homepage*. www.gitxsan.com (accessed April 2010).

Hanson, A., L. Swanson, D. Ewig, G. Grabas, S. Meyer, L. Ross, M. Watmough, and J. Kirkby. 2008. *Wetland Ecological Functions Assessment: An Overview of Approaches, Atlantic Region*. Technical Report 497. Environment Canada: Sackville, NB.

Huel, D. 2000. *Managing Saskatchewan Wetlands – A Landowner's Guide*. Saskatchewan Wetland Conservation Corporation: Regina, SK.

Johnson, L. L. and R. C. Smardon. 2011. Case study of a restored wetland best management practice. *Wetlands*, 31 (5): 921-31.

Johnston, C. A. 1991. Sediment and nutrient retention by freshwater wetlands: Effects on surface water quality. *Critical Reviews in Environtal Control*, 21: 491–565.

Lausen, C. 2006. *Bat Survey of Nahanni National Park Reserve and Surrounding Areas, Northwest Territories*. Prepared for Parks Canada and Canadian Parks and Wilderness Society: n.p.

Lynch-Stewart & Associates. 2000. *Using Ecological Standards, Guidelines, and Objectives for Determining Significance: An Examination of Existing Information to Support Significance Decisions Involving Wetlands*. Prepared for Research and Development Monograph Series. Research supported by the Canadian Environmental Assessment Agency's Research and Development Program. http://www.acee-ceaa.gc.ca/default.asp?lang=En&n=46DA6C97-1&toc=show&offset=1 (accessed December 2010).

MacKenzie, W. H. 1999. *Field Description of Wetlands and Related Ecosystems in British Columbia*. Ministry of Forest Research Program: Victoria, B.C.

MacKenzie, W. H. and J. R. Moran. 2004. *Wetlands of British Columbia: A Guide to Identification*. Land Management Handbook 52: Victoria, B.C.

Milko, R. 1998. *Wetland Environmental Assessment Guideline*. n.p.: Biodiversity Protection Branch. Canadian Wildlife Service, Environment Canada.

Mitsch, W. J. and J. G. Gosselink. 2000a. The value of wetlands: importance of scale and landscape setting. *Environmental Economics*, 35 (1): 25-33.

Mitsch, W. J. and J. G. Gosselink. 2000b. *Wetlands*. Third ed. New York: John Wiley and Sons, Inc.

Mitsch, W. J. and R. F. Wilson. 1996. Improving the success of wetland creation and restoration with know-how, time and self-design. *Ecological Applications*, 6: 77-83.

NLG, Province of BC, and Government of Canada. 1998. *Nisga'a Final Agreement*. Nisga’a Lisims Government, Province of British Columbia, and Government of Canada New Aiyansh, BC.

Reilly, W. K. 1991. A New Way with Wetlands. *Journal of Soil and Water Conservation*, 43 (3): 1992-94.

Rescan. 2009. *Northwest Transmission Line Project: Skii km Lax Ha Traditional Knowledge and Use Study*. Prepared for the BC Transmission Corporation by Rescan Environmental Services Ltd.: Vancouver, BC.

SD 92. 1996. *From Time Before Memory*. School District No. 92 (Nisga'a): New Aiyansh, BC.

The Ramsar Convention on Wetlands. 2010. *Wetland Ecosystem Services*. http://www.ramsar.org/cda/en/ramsar-pubs-info-ecosystem-services/main/ramsar/1-30-103%5E24258_4000_0__ (accessed July 2010).

THREAT. 2009. *Tahltan Traditional Use Study of the proposed Northwest Transmission Line Project - Interim Report*. Tahltan Transmission Line Project Team, Tahltan Heritage Resources Environmental Assessment Team: n.p.

Walbridge, M. R. and J. P. Struthers. 1993. Phosphorus retention in non-tidal palustrine forested wetlands of the mid-Atlantic region. *Wetlands*, 13: 84-94.

Warner, B. G. and C. D. A. Rubec. 1997. *The Canadian Wetland Classification System: The National Wetlands Working Group*. Wetlands Research Centre, University of Waterloo: Waterloo, ON.

Weller, M. 1994. *Freshwater Marshes: Ecology and Wildlife Management*. Third ed. Minneapolis, MN: The University of Minnesota.

Personal Communications

Pojar, J. 2009. Discussion of wetlands at NTL Open House. March 31, 2009 at Hudson Bay Lodge Smithers, BC.