APPENDIX F:

Supplemental Soil Information

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Purpose of Appendix

This purpose of this appendix is to provide supplemental information pertaining to soil types and characteristics associated with the proposed Donlin Gold Project infrastructure and EIS Analysis Area. The technical information in Appendices F-1 through F-5 detail supporting baseline conditions summarized and referenced throughout Section 3.2, Soils; planned mitigation programs for soil erosion; and methodology for calculation of fugitive dust impacts to soil. A brief description of each is provided below.

Appendix F-1: Soil Types and Erosion Information

Tables F-1a through F-1e provide additional Affected Environment baseline soil conditions for each of the major Project Area components. Summarized soil classification information are based on numerous U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) soil studies and literature resources pertinent to the proposed Donlin Gold Project study area, which include a variety of baseline soil data intended to assist in land resource planning and management, including classifications based on soil taxonomy, geomorphology, drainage, slopes, and erosion.

Appendix F-2: Contaminated Sites Information

Tables F-2a through F-2c provide additional information for soil quality and contaminated sites regarding Affected Environment baseline information for the Transportation Corridor and Pipeline Corridor (i.e., Alternative 2). The summarized information is based on a contaminated sites review of the ADEC Contaminated Sites database for known conditions that are generally within about ¼ mile of the Project Area component. Provided information includes listed contaminated site names and ADEC Hazard ID; locations relative to the project, as well as cleanup status. Reviews were conducted for all of the proposed Donlin Gold Project components; however, there were no listings in the vicinity of the Mine Site.

Appendix F-3: Planned Mitigation Programs for Soil Erosion

Appendix F-3 describes planning documents, instituted programs, and associated permitting requirements that either comprehensively or partially address soil impacts through design features and Best Management Practices (BMPs). These are considered part of the proposed project and are assumed to be in place in the analysis of effects in Section 3.2, Soils.

Appendix F-4: Pipeline Soil and Permafrost Data

Table F-4 provides Affected Environment baseline descriptions of available surface material types, terrain, surface organics, and permafrost for the Pipeline corridor. Information provided in Table F-4 is based on geotechnical and topographical studies conducted on behalf of the Donlin Gold Project. The purpose of this table is to present component specific (i.e., Pipeline) physical attributes of affected soils, and surrounding terrain (slope).

Appendix F-5: Fugitive Dust Methodology

Appendix F-5 contains supplemental information related to fugitive dust effects on soils at the Mine Site, including methodologies used in calculations of predicted dust deposition from air quality models, calculation of predicted concentrations of selected constituents of concern (arsenic, antimony, and mercury) in soil at the end of mine life, and additional details on baseline data for these elements.

Appendix F-1 Soil Types and Erosion Information

Table 0-1a: Mine Site Soil Types and Erosion Hazards

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
R30FPA: Yukon-Kuskokwim Highlands, Boreal Floodplains and Terraces							
Boreal forest, gravelly floodplains and similar soils	Fluventic Haplocryepts	Loamy alluvium over sandy and gravelly alluvium	Toeslopes of floodplains on mountains	0 to 2	Moderately well drained; occasional flooding	Slight	Moderate
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse-loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate
Boreal scrub, gravelly floodplains and similar soils	Aquic Cryorthents	Sandy and gravelly alluvium	Floodplains	0 to 7	Somewhat poorly drained, occasional flooding	Slight	Moderate
Boreal scrub, silty terraces and similar soils	Typic Cryaquepts	Organic mat over silty alluvium and/or loess over gravelly alluvium	Terraces	0 to 5	Very poorly drained, no flooding	Slight	Slight
R30MTC: Yukon-Kuskokwim Highlands, Boreal and Subalpine Mountains							
Boreal forest, gravelly colluvial slopes and similar soils	Typic Haplocryods	Loamy colluvium and/or loess over gravelly colluvium	Backslopes of mountains, hills	12 to 110	Well drained; no flooding	Severe	Slight
Boreal scrub, silty colluvial slopes and similar soils	Histic Cryaquepts	Organic mat over loamy alluvium over sandy and silty alluvium	Backslopes, footslopes of mountains	0 to 1	Very poorly drained; no flooding	Slight	Slight
Subalpine woodland, gravelly colluvial slopes and similar soils	Typic Dystrocryepts	Gravelly colluvium	Summits, backslopes, shoulders of hills, mountains	5 to 46	Wells drained; no flooding	Moderate	Moderate
Boreal taiga, loamy colluvial slopes and similar soils	Typic Histoturbels	Organic mat over loamy cryoturbate over permanently frozen loamy slope alluvium	Footslopes, backslopes of mountains, hills	2 to 29	Poorly drained; no flooding	Severe	Slight

Notes:
Soil Map Units shown on Figure 3.2-1
Source: NRCS 2008.

Table F-1b: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Soil Descriptions Common to Angyaruaq (Jungjuk) and BTC Mine Access Roads, and Crooked Creek Winter Road							
R30FPA: Yukon-Kuskokwim Highlands, Boreal Floodplains and Terraces							
Boreal forest, gravelly floodplains and similar soils	Fluventic Haplocryepts	Loamy alluvium over sandy and gravelly alluvium	Toeslopes of floodplains on mountains	0 to 2	Moderately well drained; occasional flooding	Slight	Moderate
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse-loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate
Boreal scrub, gravelly floodplains and similar soils	Aquic Cryorthents	Sandy and gravelly alluvium	Floodplains	0 to 7	Somewhat poorly drained, occasional flooding	Slight	Moderate
Boreal scrub, silty terraces and similar soils	Typic Cryaquepts	Organic mat over silty alluvium and/or loess over gravelly alluvium	Terraces	0 to 5	Very poorly drained, no flooding	Slight	Slight
R30MTB: Yukon-Kuskokwim Highlands, Boreal and Subalpine Low Mountains							
Boreal taiga, loamy colluvial slopes and similar soils	Typic Histoturbels	Organic mat over loamy cryoturbate over permanently frozen loamy slope alluvium	Footslopes, backslopes of mountains, hills	2 to 29	Poorly drained; no flooding	Severe	Slight
Boreal forest, gravelly colluvial slopes and similar soils	Typic Haplocryods	Loamy colluvium and/or loess over gravelly colluvium	Backslopes of mountains, hills	15 to 25	Well drained; no flooding	Severe	Slight
Boreal scrub, loamy eolian slopes and similar soils	Typic Haplocryods	Coarse-loamy eolian deposits	Shoulders, backslopes of terraces, hills	1 to 40	Well drained; no flooding	Severe	Severe
Subalpine forest, gravelly residual slopes and similar soils	Spodic Dystrocryepts	Gravelly residuum	Backslopes, shoulders of hills, mountains	4 to 50	Well drained; no flooding	Severe	Moderate
Subalpine scrub, loamy colluvial slopes and similar soils	Typic Dystrocryepts	Loamy colluvium over gravelly colluvium	Backslopes of swales on hills, drainage ways on hills	2 to 45	Moderately well drained; no flooding	Severe	Moderate

Table F-1b: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Soil Descriptions Specific to Angyaruaq (Jungjuk) Mine Access Road							
R30MTC: Yukon-Kuskokwim Highlands, Boreal and Subalpine Mountains							
Boreal forest, gravelly colluvial slopes and similar soils	Typic Haplocryods	Loamy colluvium and/or loess over gravelly colluvium	Backslopes of mountains, hills	12 to 110	Well drained; no flooding	Severe	Slight
Boreal scrub, silty colluvial slopes and similar soils	Histic Cryaquepts	Organic mat over loamy alluvium over sandy and silty alluvium	Backslopes, footslopes of mountains	0 to 1	Very poorly drained; no flooding	Slight	Slight
Subalpine woodland, gravelly colluvial slopes and similar soils	Typic Dystrocryepts	Gravelly colluvium	Summits, backslopes, shoulders of hills, mountains	5 to 46	Wells drained; no flooding	Moderate	Moderate
Boreal taiga, loamy colluvial slopes and similar soils	Typic Histoturbels	Organic mat over loamy cryoturbate over permanently frozen loamy slope alluvium	Footslopes, backslopes of mountains, hills	2 to 29	Poorly drained; no flooding	Severe	Slight
D30HIB: Boreal Eolian Hills; common permafrost							
Boreal forest, silty eolian slopes and similar soils	Typic Dystrocryepts	Loess	Toeslopes, backslopes, shoulders of hills, alluvial fans, terraces	4 to 38	Well drained; no flooding	Severe	Severe
Boreal taiga, loamy eolian slopes and similar soils	Typic Histoturbels	Organic mat over coarse-loamy cryoturbate over permanently frozen coarse-loamy eolian deposits	Footslopes, toeslopes of terraces, hills	1 to 23	Poorly drained; no flooding	Moderate	Slight
Boreal scrub-sedge, loamy eolian slopes and similar soils	Typic Haplocryods	Organic mat over coarse-loamy eolian deposits	Footslopes, toeslopes of hills	2 to 12	Poorly drained; no flooding	Moderate	Slight
D30FPH: Boreal Floodplains and Terraces, common permafrost							
Boreal scrub, loamy floodplains and similar soils	Typic Aquorthels	Loamy alluvium over permanently frozen sandy and silty alluvium	Floodplains	0 to 2	Poorly drained; occasional flooding	Slight	Slight
Boreal scrub, silty floodplains and similar soils	Fluvaquentic Cryaquepts	Coarse-silty alluvium	Footslopes, backslopes of hills, floodplains	0 to 8	Poorly drained; occasional flooding	Slight	Severe

Table F-1b: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse-loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate
Soil Descriptions Specific to BTC Mine Access Road							
D30MTB: Boreal and Subalpine Eolian Mountains, common permafrost							
Boreal woodland, loamy eolian slopes and similar soils	Aquic Dystrocryepts	Coarse-loamy eolian deposits	Backslopes, shoulders, toeslopes, summits of hills, terraces	3 to 40	Well drained; no flooding	Moderate	Severe
Boreal taiga, loamy eolian slopes and similar soils	Typic Histoturbels	Organic material over coarse-loamy cryoturbate over permanently frozen coarse-loamy eolian deposits	Toeslopes, footslopes of hills, terraces	1 to 23	Poorly drained; no flooding	Moderate	Slight
Boreal forest, loamy eolian slopes and similar soils	Typic Haplocryods	Coarse-loamy eolian deposits over gravelly colluvium	Backslopes, shoulders, summits of mountains, hills	4 to 20	Well drained; no flooding	Severe	Moderate
R30MTD: Yukon Kuskokwim Highlands, Subalpine and Alpine Glaciated Igneous Mountains							
Alpine herbaceous, gravelly colluvial slopes and similar soils	Typic Dystrogelepts	Loess and/or silty colluvium over gravelly colluvium	Summits, shoulders, backslopes of mountains, hills	5 to 27	Well drained; no flooding	Severe	Moderate
Subalpine woodland, gravelly colluvial slopes and similar soils	Typic Dystrocryepts	Gravelly colluvium	Summits, backslopes of hills	5 to 46	Well drained; no flooding	Moderate	Moderate
Alpine dwarf scrub, gravelly till slopes and similar soils	Typic Humigelods	Gravelly till	Summits, shoulders of mountains	2 to 12	Well drained; no flooding	Slight	Moderate
R30UPD: Yukon-Kuskokwim Highlands, Portage Mountains Uplands							
Boreal tussock-scrub, loamy plains and similar soils	Typic Histoturbels	Organic mat over silty cryoturbate over permanently frozen loess	Toeslopes of hills and plains	2 to 8	Poorly drained; no flooding	Slight	Slight
Boreal dwarf scrub, silty plains and similar soils	Typic Aquiturbels	Silty cryoturbate over permanently frozen loess	Terraces and plains	2 to 5	Poorly drained; no flooding	Slight	Slight

Table F-1b: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Boreal sedge, organic depressions and similar soils	Histosols	Organic mat and/or grassy organic mat over loamy alluvium	Toeslopes of depressions on mountainsides	1 to 5	Very poorly drained; no flooding	Slight	Slight
Boreal scrub, loamy terraces and similar soils	Typic Histoturbels	Organic material over coarse-loamy cryoturbate and/or permanently frozen coarse-loamy eolian deposits	Terraces	0 to 8	Poorly drained; no flooding	Slight	Slight
R30UPE: Yukon-Kuskokwim Highlands, Tundra Glaciated Uplands							
Boreal tussock-scrub, loamy plains and similar soils	Typic Histoturbels	Organic material over silty cryoturbate over permanently frozen loess	Footslopes, toeslopes, backslopes of plains, hills	2 to 8	Poorly drained; no flooding	Slight	Slight
Boreal taiga, loamy eolian slopes and similar soils	Typic Histoturbels	Organic material over coarse-loamy cryoturbate over permanently frozen coarse-loamy eolian deposits	Toeslopes, footslopes of terraces, hills	1 to 23	Poorly drained; no flooding	Severe	Slight
Soil Types Specific to Crooked Creek Winter Road							
D30FPH: Boreal Floodplains and Terraces, common permafrost (see descriptions specific to Angyaruaq (Jungjuk)							
R30MTC: Yukon-Kuskokwim Highlands, Boreal and Subalpine Mountains (see descriptions specific to Angyaruaq (Jungjuk)							
30TQ02: Teggiuq peat, 8 to 15 percent							
Teggiuq and similar soils	Coarse-loamy, mixed, superactive, nonacid Typic Cryofluvents	Mossy organic materials over coarse-silty cryoturbate over permanently frozen coarse-silty eolian deposits	Footslopes, backslopes	8 to 15	Poorly drained; no flooding	Severe	Slight
D30FPA: Boreal Floodplains							
Boreal forest, loamy floodplains and similar soils	Aquic Cryofluvents	Coarse loamy alluvium	Floodplains	0 to 5	Moderately well drained; occasional flooding	Slight	Moderate

Table F-1b: Soil Types and Erosion Hazards for Mine Road Alternatives

Soil Map Unit and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
30DP03: Oskawalik Family							
Oskawalik family and similar soils	Coarse-silty, mixed, superactive, nonacid Fluvaquentic Cryaquepts	Loamy slope alluvium and/or gravelly slope alluvium	Alluvial fans	0 to 2	Poorly drained; occasional flooding	Slight	Slight

Notes:
BTC = Birch Tree Crossing
Soils map units shown on Figure 3.2-1.
Source: NRCS 2008.

Table F-1c: Soil Types at Bethel and Kuskokwim River Floodplain and Dutch Harbor

Soil Map Unit and Principal Components and Associations	Parent Material Description	Landscape Position	Drainage	Erosion Parameters	
				$K_{w\ (max)}$ / T Factor	WEG
Bethel and Kuskokwim Floodplain Soil Descriptions					
IQ3 – Histic Pergelic Cryaquepts-Typic Cryofluvents, loamy, nearly level association					
IQ3-Histic Pergelic Cryaquepts, loamy, nearly level	Organic material over silt loam to sandy loam.	Floodplains	Poorly drained	--	--
IQ3-Typic Cryofluvents, loamy, nearly level	Stratified silt loam and fine sand	Floodplains	Well drained	--	--
IQ3-Pergelic Cryofibrists, nearly level	Organic material over permafrost	Floodplains	Poorly drained	--	--
IQ3-Typic Cryothents, very gravelly, nearly level	Stratified sand and silt over gravelly sand	Floodplains	Well drained	--	--
Dutch Harbor/Unalaska Soil Description					
IA2 – Typic Cryandepts, loamy, hilly, to steep-Rough mountainous land association					
IA2-Typic Cryandepts, loamy, hilly to steep	Organics over loamy, sandy, and cindery ash	Hills, footslopes	Well drained	--	--
IA2-Typic Cryandepts, loamy, Rough mountainous land	Volcanic cinders and hardened lava.	Mountains, volcano flanks	--	--	--
IA2-Typic Cryandepts, very gravelly, hilly to steep	Sandy volcanic ash	Mountains and hillslopes	--	--	--
IA2-Dystric Cryandepts, loamy, hilly to steep	Thixotropic volcanic ash and sandy or cindery ash	Hills, toeslopes	--	--	--
IA2-Fluvaquentic Cryofibrists	Organic fibrous sedge peat	Valley bottom depressions	Poorly drained	--	--

Table F-1c: Soil Types at Bethel and Kuskokwim River Floodplain and Dutch Harbor

Soil Map Unit and Principal Components and Associations	Parent Material Description	Landscape Position	Drainage	Erosion Parameters	
				$K_{w\ (max)}$ / T Factor	WEG

Notes:
-- no erosion hazard description, K-, or T-factor data available.
K Factor = unitless indicator of soil erodibility from runoff.
$K_{w\ (max)}$ = Maximum K_w for shallow soils up to 18 inches deep
T Factor = Soil loss tolerance (in tons per acre).
WEG = Wind erodibility group (resistance to soil blowing in cultivated areas).
Source: USDA-SCS 1979.

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
203 - Chichantna peat	Euic Fluvaquentic Borosaprists	Peat deposits with interlayered with ash-influence loess	Muskegs and depressional areas	0 to 8	Very poorly drained	na	na
204 - Chuit-Nakochna-Chichantna complex							
Chuit	Medial over loamy, mixed Andic Humicryods	Ash-influenced loess deposited over massive, firm glacial till	Mountain sideslopes	2 to 7	Well drained	Slight	Severe
Nakochna	Medial, Lithic Humicryods	Ash-influenced loess deposited over bedrock	Mountain side slopes and ridges	2 to 7	Well drained	Slight	Severe
Chichantna	Euic Fluvaquentic Borosaprists	Peat deposits interlayered with ash-influenced loess	Muskegs and depressional areas	2 to 5	Very poorly drained	na	na
207 - Clunie peat	Loamy, miced, euic Terric Borofibrists	Coarse peat overlying loamy tidal sediments	Tidal flats	0 to 2	Very poorly drained; frequent flooding	na	na
208 - Doroshin peat	Loamy, miced, euic Terric Borohemists	Peat deposits over silty mineral deposits	Muskegs	0 to 5	Very poorly drained	na	na
211 - Hewitt peat	Loamy, mixed, euic Terric Borohemists	Peat over silty alluvium	Muskegs on floodplains	0 to 2	Very poorly drained; occasional flooding	Slight	Slight
214 - Killey and Hiline silt loams							

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Hiline	Coarse-loamy, mixed, acid Typic Cryaquents	Alluvium	Floodplains and stream terraces	0 to 2	Very poorly drained; frequent flooding	Severe	Slight
Killey	Coarse-loamy over sandy or sandy-skeletal, mixed, acid Typic	Stratified loamy alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Very poorly drained; frequent flooding	Severe	Slight
216 - Kroto-Strandline-Cryothents complex							
Kroto	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines, hills, and mountain footslopes	30 to 45	Well drained	Severe	Severe
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines, and mountain footslopes	30 to 40	Well drained	Severe	Severe
Cryothents	Cryothents	Firm glacial till	Escarpments on moraines, drumlins, and mountain sideslopes	35 to 45	Well drained	Severe	Severe
217 - Lucile silt loam	Medial over sandy or sandy-skeletal, mixed Andic Cryaquods	Ash-influenced loess over sandy and gravelly material	Stream terraces	0 to 2	Poorly drained	Slight	Severe
218 - Nancy-Kashwitna complex							
Nancy	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	0 to 2	Well drained	Slight	Severe
Kashwitna	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	0 to 2	Well drained	Slight	Severe
220 - Nancy-Kashwitna complex							
Nancy	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	7 to 12	Well drained	Severe	Severe

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Kashwitna	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	7 to 12	Well drained	Severe	Severe
221- Nancy-Kashwitna complex							
Nancy	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	12 to 20	Well drained	Severe	Severe
Kashwitna	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	12 to 20	Well drained	Severe	Severe
222- Nancy-Kashwitna complex							
Nancy	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	20 to 30	Well drained	Severe	Severe
Kashwitna	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	20 to 30	Well drained	Severe	Severe
223- Nancy-Kashwitna complex							
Nancy	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	30 to 45	Well drained	Severe	Severe
Kashwitna	Medial over sandy or sandy-skeletal, mixed Andic Haplocryods	Ash-influenced loess overlying sandy and gravelly alluvium	Alluvial terraces	30 to 45	Well drained	Severe	Severe
225 - Niklason silt loam	Coarse-loamy over sandy or sandy-skeletal, mixed, non-acid Typic Cryofluvents	Stratified loamy material over sandy and gravelly underlying material	Floodplains, alluvial fans, and natural levees	0 to 2	Well drained; frequent flooding	Moderate	Severe
226 - Puntilla silt loam	Medial over loamy, mixed Andic Humicryods	Ash-influenced loess deposited over firm glacial till substratum	Mountain side slopes	7 to 20	Well drained	Moderate to severe	Severe

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
227 - Puntilla silt loam	Medial over loamy, mixed Andic Humicryods	Ash-influenced loess deposited over firm glacial till substratum	Mountain side slopes	20 to 30	Well drained	Severe	Severe
228 - Puntilla silt loam	Medial over loamy, mixed Andic Humicryods	Ash-influenced loess deposited over firm glacial till substratum	Mountain side slopes	30 to 45	Well drained	Severe	Severe
231 - Salamatoff peat	Dysic Sphagnic Borofibrists	Coarse peat deposits	Muskegs	0 to 2	Very poorly drained	na	na
232 - Schrock silt loam	Medial over loamy, mixed Entic Haplocryods	Ash-influenced loess deposited over coarser textured alluvium	Stream terraces	0 to 2	Well drained	Slight	Severe
233 - Slikok muck	Coarse-silty, mixed, acid Histic Cryaquepts	Volcanic ash-influenced mineral materials over glacial till	Toeslopes of moraines, muskeg borders, and depressional areas	0 to 5	Very poorly drained	Slight to moderate	Slight
234 - Slikok-Starichkof-Strandline complex							
Slikok	Coarse-silty, mixed, acid Histic Cryaquepts	Volcanic ash-influenced mineral materials over glacial till	Footslopes of moraines and muskeg borders	0 to 5	Very poorly drained	Slight to moderate	Slight
Starichkof	Dysic Fluvaquentic Borhemists	Coarse peat containing thin stratas of mineral material	Muskegs	0 to 2	Very poorly drained	na	na
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines, and mountain footslopes	2 to 7	Well drained	Slight to moderate	Severe
235 - Spenard silt loam	Medial over loamy, mixed Andic Cryaquods	Volcanic ash-influence loess over firm glacial till substratum	Moraines and mount side slopes and footslopes	0 to 7	Very poorly drained	Moderate	Severe
236 - Starichkof peat	Dysic Fluvaquentic Borhemists	Coarse peat containing thin stratas of mineral material	Muskegs	0 to 7	Very poorly drained	na	na
237 - Strandline-Kroto complex							

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	20 to 45	Well drained	Severe	Severe
Kroto	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines, hills, and mountain footslopes	20 to 45	Well drained	Severe	Severe
238 – Strandline-Kroto-Chichantna complex							
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	3 to 20	Well drained	Moderate to severe	Severe
Kroto	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	3 to 20	Well drained	Moderate to severe	Severe
Chichantna	Euic Fluvaquentic Borosaprists	Peat deposits interlayered with ash-influenced loess	Muskegs	1 to 8	Very poorly drained	na	na
239 – Strandline-Kroto-Slikok complex							
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	2 to 12	Well drained	Slight to moderate	Severe
Kroto	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	1 to 12	Well drained	Slight to moderate	Severe
Slikok	Coarse-silty, mixed, acid Histic Cryaquepts	Volcanic ash-influenced mineral materials over glacial till	Toeslopes of moraines, muskeg borders, and depressional areas	1 to 5	Very poorly drained	Slight	Slight
240 - Strandline-Spenard-Kroto complex							
Strandline	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines and mountain footslopes	5 to 30	Well drained	Slight to severe	Severe
Spenard	Medial over loamy, mixed Andic Cryaquods	Volcanic ash-influenced loess over firm glacial till substratum	Moraines, mountain side slopes and foot slopes	2 to 12	Very poorly drained	Slight to moderate	Severe

Table F-1d: Soil Types and Erosion Hazards Along Eastern Pipeline Segment

Soil Map Unit[1] and Major Components	Family or Taxonomic Class	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Water	Erosion Air
Kroto	Medial over loamy, mixed Andic Haplocryods	Ash-influenced loess overlying firm glacial till	Moraines, hills, and mountain footslopes	5 to 30	Well drained	Moderate to severe	Severe
241 - Suntrana silt loam	Medial over loamy, mixed Andic Cryaquods	Loess deposited over alluvial sediments which overlie firm glacial till	Remnant glacial moraines adjacent to Cook Inlet	2 to 7	Poorly drained	Slight to moderate	Severe
242 -Susitna-Niklason silt loam							
Susitna	Coarse-loamy, loamy, mixed, non-acid Typic Cryofluvents	Stratified loamy alluvium over sand and gravel	Floodplains and alluvial terraces	0 to 2	Well drained; occasional flooding	Moderate	Severe
Niklason	Coarse-loamy over sandy or sandy-skeletal, mixed, non-acid Typic Cryofluvents	Stratified loamy material over sandy and gravelly underlying material	Floodplains, and natural levees	0 to 2	Well drained; occasional flooding	Moderate	Severe
243 – Susitna and Niklason silt loams							
Susitna	Coarse-loamy, loamy, mixed, non-acid Typic Cryofluvents	Stratified loamy alluvium over sand and gravel	Floodplains and alluvial terraces	0 to 2	Well drained; frequent flooding	Severe	Severe
Niklason	Coarse-loamy over sandy or sandy-skeletal, mixed, non-acid Typic Cryofluvents	Stratified loamy material over sandy and gravelly underlying material	Floodplains, and natural levees	0 to 27	Well drained; frequent flooding	Severe	Severe
244 - Tyonek peat	Euic Fluvaquentic Borosaprists	Organic materials interlayered with ash-influenced loess	Toeslopes of moraines	0 to 2	Very poorly drained	na	na
245 -Wasilla silt loam	Fine-loamy, mixed acid Humic Cryaquepts	Silty alluvium	Floodplains and alluvial terraces	0 to 2	Poorly drained; frequent flooding	Moderate	Severe

Notes:
Tyonek to MP 0, and MP 0 to MP 78 (Soils map units shown on Figure 3.2-6).
na = not available due to parameter insignificance.
Source: NRCS 1998.

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E23M5 - Cook Inlet Mountains-Boreal Subalpine and Alpine-Mountains, Acid						
E23-Boreal subalpine scrub/meadow mosaic-silty acid slopes, ash influenced and similar soils	Organic material over silty volcanic ash and/or silty eolian deposits over gravelly till derived from diorite	Mountains	15 to 35	Well drained; frequent flooding	0.37/2	1
E23-Boreal rock outcrop and rubble land	Colluvium and/or scree and/or talus	Mountains	20 to 150	na	na/na	na
E23-Boreal alpine scrub-gravelly acid colluvial slopes and similar soils	Organic material over silty volcanic ash over gravelly colluvium derived from diorite	Mountains	20 to 65	Well drained; frequent flooding	0.24/3	6
E23M7 - Cook Inlet Mountains-Boreal Alpine-Barren Mountains						
E23-Boreal rock outcrop and rubble land	Colluvium and/or scree and/or talus	Mountains	20 to 150	na	na/na	na/na
Boreal permanent snow and ice	Permanent snow and ice	Mountains	20 to 150	na	na/na	na/na
E23V - Cook Inlet Mountains-Boreal Upland and Lowland-Valleys						
E23-Boreal subalpine scrub/meadow mosaic-silty till slopes, ash influenced and similar soils	Organic material over silty volcanic ash and/or silty eolian deposits over gravelly till derived from diorite	Mountains	15 to 35	Well drained; frequent flooding	0.37/2	1
E23-Boreal forest-silty till slopes, ash influenced and similar soils	Organic material over silty volcanic ash and/or silty eolian deposits over gravelly till	Mountains	15 to 35	Well drained; frequent flooding	0.37/2	1
E23-Boreal forest-silty till slopes, ash influenced and similar soils	Organic material over ash-influenced silty eolian deposits over gravelly till	Hills, mountains	5 to 30	Well drained; frequent flooding	0.43/5	2
E24P5 - Cook Inlet Lowlands-Boreal Upland-Till Plains						
E24-Boreal forest-silty till slopes, moderately thick, ash influenced and similar soils	Organic material over ash-influenced silty eolian deposits over gravelly till	Hills, mountains	2 to 28	Well drained; frequent flooding	0.43/5	2

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E24-Boreal forest-silty till slopes, moderately wet, ash influenced and similar soils	Organic material over ash-influenced silty eolian deposits over glacial gravelly till	Hills, plains	4 to 6	Very poorly drained; frequent flooding	0.43/5	8
E24-Boreal scrub/sphagnum-organic depressions and similar soils	Organic material	Depressions on plains	0 to 1	Very poorly drained; frequent flooding	na/2	8
E28FP1 - Interior Alaska Mountains-Boreal Lowland-Floodplains, Terraces and Fans						
E28-Boreal rock outcrop and rubble land	Sandy gravel and alluvium	Floodplains	0 to 2	na	0.02/na	na
E28-Boral scrub-gravelly floodplains and similar soils	Stratified sandy and silty alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Somewhat poorly drained; frequent flooding	0.28/3	7
E28-Boreal taiga-loamy frozen terraces and similar soils	Mossy organic material over silty eolian deposits over stratified sandy and silty alluvium	Stream terraces	0 to 1	Poorly drained; no flooding	0.32/2	8
E28-Boreal taiga/tussock-silty frozen terraces and similar soils	Organic material over sandy and silty cryoturbate	Turf hummocks on stream terraces	0 to 1	Very poorly drained; no flooding	na/2	8
E28-Boreal forest-loamy high floodplains and similar soils	Mossy organic material over stratified sandy and silty alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Well drained; rare flooding	0.28/1	7
E28GP2 - Interior Alaska Mountains-Boreal Glaciated Plains and Hills						
E28-Boreal taiga-gravelly frozen till slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly till	Hills, till plains	2 to 16	Poorly drained; no flooding	0.37/2	8
E28-Boreal forest-silty wet till slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly till	Hills, till plains	0 to 10	Poorly drained; no flooding	0.43/1	2
E28-Boreal forest-gravelly till slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly till	Hills, till plains	4 to 25	Well drained; no flooding	0.43/3	2

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E28GP5 – Interior Alaska Mountains-Boreal Alpine-Glaciated Plains and Hills						
E28- Boreal alpine scrub-gravelly till slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly till	Hills, plains	14 to 35	Well drained; no flooding	0.43/3	2
E28GP6 – Interior Alaska Mountains-Boreal Upland and Subalpine-Glaciated Plains and Hills, Ash Influenced						
E28-Boreal forest-ashy till slopes and similar soils	Mossy organic material over silty volcanic ash and/or silty eolian deposits over gravelly till	Hills, plains	10 to 25	Well drained; no flooding	0.37/1	5
E28-Boreal forest-ashy wet till slopes and similar soils	Organic material over loamy volcanic ash over gravelly drift	Hills, depressions on till plains	4 to 24	Very poorly drained; no flooding	0.43/4	2
E28-Boreal subalpine scrub-meadow –ashy till slopes and similar soils	Silty volcanic ash and/or silty eolian deposits over gravelly till	Hills	4 to 28	Well drained; no flooding	0.43/2	5
E28GV - Interior Alaska Mountains-Boreal Alpine-Mountain Valleys						
E28-Boreal alpine scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium derived from shale	Mountains	25 to 75	Well drained; no flooding	0.43/3	5
E28-Boreal alpine dwarf scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium derived from volcanic and sedimentary rock	Mountains	25 to 75	Well drained; no flooding	0.43/3	5
E28-Boreal forest-silty wet till slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly till	Mountains	0 to 4	Poorly drained; no flooding	0.43/1	2
E28LM3 – Interior Alaska Mountains-Boreal Alpine-Rounded Mountains						
E28-Boreal alpine dwarf scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 65	Well drained; no flooding	0.43/3	5
E28-Boreal alpine dwarf scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 65	Well drained; no flooding	0.43/1	2

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\,(max)}$ / T Factors	WEG
E28-Boreal alpine scrub-sedge-gravelly frozen slopes and similar soils	Organic material and/or organic material over silty eolian deposits over gravelly residuum	Mountains	0 to 25	Poorly drained	0.37/1	8
E28-Boreal rock outcrop and rubble land	Colluvium and/or scree and/or talus	Mountains	5 to 40	na	na/na	na
E28-Boreal alpine tussock-scrub-silty frozen slopes and similar soils	Organic material over silty cryoturbate	Mountains, turf hummocks	0 to 10	Very poorly drained	0.32/2	8
E28RC - Interior Alaska Mountains-Boreal Alpine-Barren Mountains						
E28—Boreal alpine rock outcrop and rubble land	na	Mountains	0 to 100	na	na/na	na
E28V - Interior Alaska Mountains-Boreal Upland and Lowland-Mountain Valleys						
E28-Boreal forest-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over sandy and gravelly colluvium	Mountains	2 to 60	Well drained; no flooding	0.37/1	2
E28-Boreal forest-gravelly wet colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 45	Somewhat poorly drained; no flooding	0.43/1	2
E28-Boreal taiga-loamy eolian frozen slopes and similar soils	Boreal taiga-loamy eolian frozen slopes and similar soils	Mountains	0 to 24	Poorly drained; no flooding	0.43/2	8
E29FP1 – Interior Alaska Lowlands-Boreal Lowland-High Floodplains and Terraces						
E29-Boreal taiga-loamy frozen terraces and similar soils	Organic material and/or mossy organic material over silty eolian deposits over sandy and silty alluvium	Stream terraces	0 to 2	Poorly drained; no flooding	0.32/2	8
E29-Boreal scrub-loamy low floodplains and similar soils	Stratified sandy and silt alluvium	Floodplains	0 to 2	Poorly drained; frequent flooding	0.64/5	1
E29-Boreal forest-loamy floodplains and similar soils	Mossy organic material over stratified sandy and silty alluvium	Floodplains	0 to 2	Moderately well drained; occasional flooding	0.64/5	2

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E29-Boreal wet meadow-loamy depressions and similar soils	Organic material over loamy alluvium	Channels on floodplains, depressions on floodplains, terraces	0 to 2	Very poorly drained; occasional flooding	0.43/5	8
E29FP2 - Interior Alaska Lowlands-Boreal Lowland-Floodplains and Terraces, High Elevation						
E29-Boreal taiga-loamy frozen terraces and similar soils	Mossy organic material over silty eolian deposits over stratified sandy and silty alluvium over sandy and gravelly alluvium	Stream terraces	0 to 2	Poorly drained; no flooding	0.37/1	8
E29-Boreal forest-loamy floodplains and similar soils	Mossy organic material over stratified sandy and silty alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Well drained; rare flooding	0.28/2	7
E29-Boreal forest-loamy frozen floodplains and similar soils	Organic material and/or organic material over stratified sandy and silty alluvium	Floodplains	0 to 2	Poorly drained; rare flooding	0.28/1	5
E29-Boreal forest-loamy low floodplains and similar soils	Mossy organic material over stratified sandy and silty alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Somewhat poorly drained; occasional flooding	0.28/2	1
E29FP5 - Interior Alaska Lowlands-Boreal Lowland-Fan Terraces and Stream Terraces						
E29-Boreal taiga-loamy frozen terraces and similar soils	Organic material and/or mossy organic material over silty eolian deposits over stratified sandy and silty alluvium over sandy and gravelly alluvium	Stream terraces	0 to 2	Poorly drained; no flooding	0.37/1	8
E29-Boreal forest-gravelly terraces and similar soils	Organic material over silty eolian deposits over sandy and gravelly alluvium	Stream Terraces	0 to 2	Somewhat excessively drained; no flooding	0.43/1	2
E29-Boreal forest-loamy frozen floodplains and similar soils	Organic material and/or mossy organic material over loamy alluvium	Floodplains	0 to 2	Poorly drained; rare flooding	0.32/1	5
E29-Boreal taiga-loamy frozen channels and similar soils	Organic material and/or mossy organic material over sandy and silty alluvium	Channels on stream terraces	0 to 2	Very poorly drained; no flooding	0.32/2	8

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E29P1 - Interior Alaska Lowlands-Boreal Lowlands-Peatlands and Alluvial Plains						
E29-Boreal forest-loamy floodplains and similar soils	Mossy organic material and/or stratified sandy and silty alluvium	Floodplains	0 to 2	Moderately well drained; occasional flooding	0.64/5	2
E29-Boreal wet meadow-organic plains and similar soils	Organic material and/or mossy organic material	Plains	0 to 1	Very poorly drained; frequent flooding	na/1	8
E29-Boreal taiga-loamy frozen terraces and similar soils	Organic material and/or mossy organic material over silty eolian deposits over stratified sandy and silty alluvium	Plains	0 to 4	Poorly drained; no flooding	0.32/2	8
E29-Boreal taiga-organic frozen peat plateaus and similar soils	Organic material and/or mossy organic material	Peat plateaus on plains	0 to 3	Well drained; no flooding	na/1	5
E30M1 - Yukon Kuskokwim Highlands-Boreal Upland-Loess Hills						
E30-Boreal taiga-silty frozen loess slopes and similar soils	Organic material and/or mossy organic material over silty eolian deposits	Hills	0 to 25	Poorly drained; no flooding	0.43/1	8
E30-Boreal forest-silty loess slopes and similar soils	Mossy organic material over loamy eolian deposits over schist or acid igneous gravelly colluvium	Hills	0 to 30	Well drained; no flooding	0.43/3	2
E30-Boreal taiga/tussock-silty frozen slopes and similar soils	Organic material over silty cryoturbate	Turf hummocks on hills	0 to 10	Very poorly drained; no flooding	0.32/2	8
E30-Boreal scrub-silty frozen drainage ways and similar soils	Organic material and/or mossy organic material over silty alluvium	Drainage ways on hills, plains	0 to 2	Very poorly drained; frequent flooding	0.28/2	5
E30M3 - Yukon Kuskokwim Highlands-Boreal Upland-Rounded Mountains						
E30-Boreal forest-silty slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly colluvium	Mountains	4 to 20	Well drained; no flooding	0.64/2	2
E30-Boreal taiga-loamy frozen colluvial slopes and similar soils	Organic material over loamy colluvium	Mountains	2 to 30	Poorly drained; no flooding	0.28/2	8

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E30M4 - Yukon Kuskokwim Highlands-Boreal Upland and Alpine-Rounded Mountains						
E30-Boreal forest-silty slopes and similar soils	Mossy organic material over silty eolian deposits over gravelly colluvium	Mountains	4 to 35	Well drained; no flooding	0.64/2	2
E30-Boreal alpine scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 35	Well drained; no flooding	0.43/3	5
E30-Boreal taiga-loamy frozen colluvial slopes and similar soils	Organic material over loamy colluvium	Mountains	2 to 34	Poorly drained; no flooding	0.37/2	8
E30M5 - Yukon Kuskokwim Highlands-Boreal Alpine and Subalpine-Rounded Mountains						
E30-Boreal alpine scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 60	Well drained; no flooding	0.43/3	5
E30-Boreal alpine dwarf scrub-gravelly colluvial slopes and similar soils	Organic material over silty eolian deposits over gravelly colluvium	Mountains	5 to 55	Well drained; no flooding	0.43/3	5
E30Boreal subalpine woodland-gravelly colluvial slopes and similar soils	Organic material over gravelly colluvium	Hills	5 to 60	Well drained; no flooding	0.37/2	3
E30MV1 - Yukon-Kuskokwim Highlands-Boreal Upland-Valleys						
E30-Boreal taiga-silty frozen colluvial slopes and similar soils	Organic material and/or organic material over schist or acid igneous silty colluvium	Mountains	2 to 20	Poorly drained; no flooding	0.43/2	8
E30-Boreal tussock-scrub-silty frozen colluvial slopes and similar soils	Organic material over silty colluvium	Turf hummocks on mountains	0 to 8	Very poorly drained; no flooding	0.32/2	8
E30-Boreal forest-loamy floodplains and similar soils	Mossy organic material over stratified sandy and silty alluvium over sandy and gravelly alluvium	Floodplains	0 to 2	Well drained; rare flooding	0.28/2	7
E30-Boreal taiga-organic frozen peat plateaus and similar soils	Organic material and/or mossy organic material	Hills, plains	0 to 3	Well drained; no flooding	na/1	5

Table F-1e: Soil Types and Erodibility Data for Central Pipeline Segment

Soil Map Unit and Major Components	Parent Material Description	Landscape Position	Slope Range (%)	Drainage Class	Erosion Factors	
					$K_{w\ (max)}$ / T Factors	WEG
E30PH - Yukon-Kuskokwim Highlands-Boreal Upland-Plains and Hills						
E30-Boreal taiga-silty frozen loess slopes and similar soils	Organic material and/or mossy organic material over silty eolian deposits	Hills, plains	0 to 20	Poorly drained; no flooding	0.43/1	8
E30-Boreal taiga/tussock-silty frozen slopes and similar soils	Organic material over silty cryoturbate	Turf hummocks on plains	0 to 12	Very poorly drained; no flooding	0.32/2	8
E30-Boreal forest-silty loess slopes and similar soils	Organic material and/or mossy organic material over silty eolian deposits over gravelly colluvium	Hills	10 to 25	Well drained; no flooding	0.43/3	2

Notes:
Includes Alaska Range, north front of Alaska Range, and eastern Kuskokwim Mountains, MP 78 to MP 270 (Figure 3.2-7).
$K_{w\ (max)}$ Factor = maximum K-factor for shallow soils up to 18 inches below surface, unitless. K-Factor is an index (measure) of soil erodibility from run-off. Higher values represent greater erodibility.
T Factor = Soil loss tolerance (sustainable loss in annual tons per acre). Lower values generally correspond to thinner, more erosion-susceptible soils.
WEG = Wind erodibility group (resistance to soil blowing in cultivated areas). Lower values represent increased erosion susceptibility.
na = applicable to soil type (e.g., rock, ice)
Source: STATSGO data; USDA-NRCS 2011, 2013.

Appendix F-2 Contaminated Sites Information

Table F-2a: Contaminated Sites within Kuskokwim River Corridor

ADEC Hazard ID	Site Name[1]	Distance (feet) and Direction from Kuskokwim River	Status
Bethel			
69	Bethel Airport (Former)	400' N	O
285	Bethel Fuel Sales Pumphouse	400' N	CC
1858	Bank Stabilization Project	400' N	CC
2108	ADOT&PF MarkAir - Bethel	400' N	C-IC
2127	Bethel Fuel Sales	600' W	CC
2450	Bethel Utilities Corp. Power Plant	1,300' N	O
2831	Bethel Radio Relay Station	400' N	O
2899	Bethel BIA Headquarters	400' N	C-IC
3048	AKARNG Bethel Old AAOF	100' N	CC
3049	AKARNG Bethel OMS	100' N	O
22900	FWS – Yukon Delta NWR Headquarters	400' N	CC
22910	Robair Repair – Bethel Airport	400' N	CC
22955	Bethel Public Works Yard	400' N	O
Kuskokwim Corridor – Napakiak			
2454	AKARNG Napakiak FSA	500' W	O
Kuskokwim Corridor – Napaskiak			
2813	AKARNG Napaskiak FSA	0	O
25240	Napaskiak Incorporated Store Former Tank Farm	300' SE	O
25241	Napaskiak Former BIA School Day Tanks	300' SE	O
Kuskokwim Corridor – Kwethluk			
2814	Akarng Kwethluk FSA	400' S	O
Kuskokwim Corridor – Akiachak			
2459	AKARNG Akiachak FSA	900' N	CC
Kuskokwim Corridor – Akiak			
2456	AKARNG Akiak FSA	700' W	O
3367	Akiak Elementary School Former Tank Farm	700' W	O
3368	Akiak High School Former Tank Farm	700' W	O
3369	Akiak Korarmiut Corporation Tank Farm	500' W	O
3370	Akiak Old City Tank Farm and Power Plant	1,300' W	O
Kuskokwim Corridor – Tuluksak			
25309	Tuluksak Old Power Plant	200' SW	O
Kuskokwim Corridor – Lower Kalskag			

Table F-2a: Contaminated Sites within Kuskokwim River Corridor

ADEC Hazard ID	Site Name[1]	Distance (feet) and Direction from Kuskokwim River	Status
4686	Old AVEC Tank Farm, Lower Kalskag	600' NW	O
Kuskokwim Corridor – Aniak			
1577	FAA Aniak Pesticide Releases	200' W	O
1578	ADOT&PF Aniak Building 301	200' W	C-IC
1579	FAA Aniak Bldg. 200 POL Releases	200' W	CC
2110	Alaska Commercial Prop. – Aniak	200' S	CC
2462	Aniak Apartments	0' W	CC
3792	IHS Aniak Clinic	100' W	CC
22981	MarkAir Facility – Aniak	200' W	CC
32	Eareckson Air Station ST34	1,300' SW	CC
30	Eareckson Air Station ST32	1,000' SW	CC
Kuskokwim Corridor – Other			
24930	FAA Aniak DF – UST 17-A-1	1,100' SW	CC
3382	BLM Kolmakof Mine	300' N	O
499	BLM Red Devil Mine Site	1,000' SW	O

Notes:
1 Includes sites within about ¼ mile of project footprint or Kuskokwim River (Figure 3.2-4).

Abbreviations:
AAOF = Army Airfield Operations Facility
ADOT&PF = Alaska Department of Transportation & Public Facilities
AKARNG = Alaska Army National Guard
AVEC = Alaska Village Electric Corporation
ADEC = Alaska Department of Environmental Conservation
BIA = Bureau of Indian Affairs
DOC = Department of Corrections
FAA = Federal Aviation Administration
FSA = Federal Scout Armory
IHS = Indian Health Services
OMS = Organizational Maintenance Shop
NWR = National Wildlife Refuge
FWS = U.S. Fish & Wildlife Service
UST = Underground Storage Tank
YK = Indian Health Service Yukon-Kuskokwim

Site Status:
CC = Cleanup Complete C-IC = Cleanup Complete with Institutional Controls O = Open (characterization /remediation ongoing)

Source: ADEC 2013a.

Table F-2b: Contaminated Sites at Dutch Harbor

ADEC Hazard ID	Site Name	Distance and Direction from Nearest Existing Tank Farms and Docks[1]	Status
3660	Dutch Harbor-Power Plant	700' NW	C-IC
517	Dutch Harbor – Aqua Fuel System #1	1,000' NW	O
25106	FAA Dutch Harbor	0	CC
25576	Delta Western Tank Farm Dutch Harbor	0	CC
25993	Delta Western Dutch Harbor Dock Pipelines	0	O
1350	Dutch Harbor- Pre WW II Tank Farm	400' NW	O
3659	Dutch Harbor- Warehouse WWII B 551	200' W	O
487	Delta Western Bulk Plant – Dutch H.	0	O
2256	Dutch Harbor- Tar Pond B Rocky Point	500' SE	O
509	Dutch Harbor- Rocky Point Tank Hill	0	O
514	Dutch Harbor- Rocky Point Thermal Treat	1,200' NW	O
25817	Dutch Harbor- Iliuliuk Lake and the Floating Pump House	1,300' SW	O
25704	Dutch Harbor- Rocky Point Bldg. 627	900' NE	O
2154	Dutch Harbor- Tar Pond A Rocky Point	800' E	O
510	Dutch Harbor- Rocky Point Tanks 17-18	800' E	O
512	Dutch Harbor – Rocky Point Lower Tank	0	O
2155	Dutch Harbor- Tar Ponds C-D Rocky Point	500' SE	O

Notes:
Includes sites within about ¼ mile of assumed tank farm expansion site at or near existing tank farms and docks (Figure 3.2-5).

ADOT&PF = Alaska Department of Transportation & Public Facilities
AWS = Aircraft Warning Station
FAA = Federal Aviation Administration
LSA = Little South America
NDSA = Naval Defensive Sea Area
PCR = Project Control Room
SREB = Snow Removal Equipment Building
USPS = U.S. Postal Service
UST = Underground Storage Tank
ADEC = Alaska Department of Environmental Conservation

Site Status:
CC = Cleanup Complete
C-IC = Cleanup Complete with Institutional Controls
O = Open (characterization /remediation ongoing)

Source: ADEC 2013a.

Table F-2c: Contaminated Sites along Pipeline Corridor

ADEC Hazard ID	Site Name	Distance and Direction from Pipeline ROW or Infrastructure	Status
Tyonek/Beluga			
3030	VECO Three-Mile Creek Camp	2,900' SE	CC
2798	Tyonek North Forelands Facility	1,300' SE	O/CC
23511	Three-Mile Creek Services	3000' SE	CC
1845	West Cook Inlet Construction Yard	2,200' SE	CC
1000	Beluga River Abandoned Diesel Tank Farm	2,100' SE	O
1001	Beluga River Field	1,100' SE	CC
999	Beluga River 232-4`	1,200' SE	O
1273	Beluga River North Main Road Diesel	1,000' SE	CC
1284	Beluga River 214-35	2,100' SE	CC
991	Beluga River Tank Farm	1,300' SE	O
995	Beluga River 212-35	2,100' SE	O
990	Beluga River Pump Area Assessment	1,200' SE	O
2797	Marco Kaloa Property	2,100' SE	CC
1002	Beluga River 241-34	200' SE	CC
998	Beluga River Enstar Metering Facility	500' E	CC
25708	Chugach Electric Beluga Power Plant Transformer TRF183	500' W	C-IC
993	Beluga River CEA Meter Site Release	500' W	CC-IC
1282	Beluga River Fuel Line Removal	650' W	CC
667	Chugach Electric Power Plant Floor Drain	500' W	CC
996	Beluga River 224-23/232-26	800 SE	CC
994	Beluga River 212-24	1,650' SE	C-IC
987	Beluga River 221-23	2,000' NW	CC
Rainy Pass			
1811	FAA Puntilla Lake Station	1,000' SW	O
Farewell			
1873	FAA Farewell Station	13,000' NW	O

Notes:
Includes sites within about ¼ mile of Pipeline ROW and infrastructure (Figure 3.2-9).

Abbreviations:
ADOT&PF = Alaska Department of Transportation & Public Facilities
ADEC = Alaska Department of Environmental Conservation
FAA = Federal Aviation Administration

Source: ADEC 2013a.

Appendix F-3 Planned Mitigation Programs for Soil Erosion

F-3.1 Introduction

A variety of plans pertaining to soil resource management and erosion have been developed by Donlin Gold or would be developed during final design. This appendix describes planning documents, instituted programs, and associated permitting requirements that either comprehensively or partially address soil impacts through design features and Best Management Practices (BMPs). These are considered part of the proposed project and are assumed to be in place in the analysis of effects in Section 3.2, Soils. The plans and programs described below would generally apply to all alternatives unless stated otherwise. Additional details regarding soil and erosion construction practices are described in Chapter 2 (Alternatives, Section 2.3.2.3), and specific mitigation measures that apply to soil disturbance, permafrost, and erosion are included in Sections 3.2.3.2.1 through 3.2.3.2.3, respectively.

F-3.2 Mine Site and Transportation Facilities

ADEC – Stormwater: A Stormwater Pollution Prevention Plan (SWPPP) would be prepared by Donlin Gold, and discharge permit obtained from ADEC prior to constructions as required by the APDES program. The SWPPP would address erosion control features, reclamation, and mitigation measures to control erosion and stormwater runoff during and after construction, and throughout mine site and transportation facilities (mine access road, Angyaruaq [Jungjuk] Port) operation and closure. The prepared plan would be consistent with a SWPPP format described in the Alaska Construction General Permit (ACGP) Part 5 and the BMPs format in Part 4 of the ACGP.

Plan of Operations: A Plan of Operations would be made available for courtesy review by regulatory agencies. The plan would provide an overview of planned erosion and sedimentation control features in response to specific regulatory permit and planning requirements. Control features in the current Donlin Gold Plan of Operations and associated documents (SRK 2016a, b, c, d, e, f, g, h; 2017b, c, d) include, but are not limited to:

- Overburden stockpile management of stormwater runoff using perimeter berms and settling ponds;
- Diversion dams and channels to minimize runoff and erosion surrounding the Tailings Storage Facility (TSF);
- Rock drains, contact water ponds, and controlled runoff and erosion at the Waste Rock Facility (WRF);
- Open pit perimeter interceptor ditches, gravity sumps, haul road ditches, bench dewatering wells, and horizontal drains to control runoff, mass wasting, and erosion in the pit interior;
- Plant site runoff catchment and diversion to the TSF; and
- Culverts to control runoff and erosion at mine access road drainage crossings.

ADNR Land Use Permits and Leases, ROWs, Easements, and BLM Surface Estate Leases: These generally govern areas of ground disturbance permitted under the project.

ADNR Reclamation Plan Approval: No mining activities would commence until ADNR approves a reclamation plan for the project. A draft Reclamation and Closure Plan (RCP) has been developed by Donlin Gold for purposes of providing guidelines for implementing soil stabilization and reclamation procedures for mining, processing, and ancillary facilities (SRK 2012b). The plan is designed to be compatible with post-mining land uses which include wildlife habitat and recreation, but does not alleviate compliance with other agencies (e.g., ADF&G, ADEC). The plan also addresses concurrent reclamation activities throughout mine site operation. Plan revisions would be made as necessary to accommodate changes in design, construction, operations, and ongoing stabilization and reclamation measures based on monitoring research and evaluation, and/or utilization of new reasonable and practical reclamation techniques as they are developed. Objectives of the RCP include provisions for protecting surface soils from hydraulic and wind erosion through slope contouring and leveling for soil stabilization and seedbed suitability, and establishment of vegetative communities.

Donlin Gold Monitoring Plan: Programmatic soil monitoring activities are described in the Monitoring Plan component of Donlin Gold's Integrated Waste Management Plan (IWMD) (SRK 2012a) in conjunction with compliance monitoring for surface water, groundwater, and process water media. These include:

- Characterization of overburden over the active mine life for segregation and material management purposes; and
- Operations and post-closure erosional stability compliance inspections associated with designated waste management storage systems and post-mine infrastructure (WRF, TSF, solid waste landfill trenches, and pits).

The Monitoring Plan includes schedules for monitoring frequency and submission of monitoring reports. Continued use and refinement of the plan would proceed throughout construction, operations, closure, and post-closure phases of the project.

F-3.3 Natural Gas Pipeline

The following planning and regulation mandated documents specific to the proposed pipeline address potential soil impacts, BMPs, and associated mitigation and response measures that are considered part of the proposed project under Alternative 2. Although these plans each serve a unique purpose, some overlap in subject matter where interdependent relationships exist between soil disturbances, permafrost, and erosion.

Stormwater Pollution Prevention Plan (SWPPP): A pipeline-specific SWPPP would be prepared prior to construction as required by APDES permitting (the Multi-Sector General Permit or MSGP). The plan would address erosion control measures, reclamation, and mitigation measures to control erosion and storm water runoff during and after construction.

Erosion and Sedimentation Control Plan (ESC Plan): A preliminary ESC Plan exclusive to the pipeline portion of the proposed Donlin Gold Project (SRK 2013a) has been modeled after the 2011 Alaska Construction General Permit (ACGP) issued by the ADEC under the APDES program. Future modifications to the preliminary ESC Plan (final plan) would directly apply towards a Statewide Pipeline GP (approach) consistent with the ACGP. Elements of the plan are to prevent and control erosion and sedimentation which could otherwise impact water quality and the environment. The plan defines applied erosion control measures and procedures, inspection, evaluation, and reporting. The plan is based on current construction and engineering designs, and would be modified as needed to accommodate future changes in ACGP regulatory requirements or design requirements. This would also include any State Pipeline General Permit developments addressing inadvertent point source contingency discharge of HDD drilling fluids. Discharge authorizations would include HDD crossing evaluation for fish habitat, water quality, hydraulic data for mixing zone evaluation, and drilling fluids. Measures and BMPs detailed in the ESC Plan are generally associated with immediate or concurrent stabilization and rehabilitation activities. Specific ESC measures pertinent to soil disturbance, permafrost, and erosion are summarized in Sections 3.2.3.2.1 through 3.2.3.2.3 under "Pipeline".

Stabilization, Rehabilitation and Reclamation (SRR) Plan: An SRR plan would be developed for the pipeline during final design clarifying regulatory approved requirements for all disturbed areas (soil and vegetation) throughout the life of the proposed pipeline project (SRK 2013a). Similarities exist between the SRR Plan and the ESC Plan; however, the ESC Plan primarily addresses temporary stabilization goals associated with pipeline construction. Disturbed pipeline areas addressed by the SRR Plan include the ROW, airstrips, material sites, camps, barge landing sites, pipe storage yards, temporary use areas, and maintenance sites. The plan would address final stabilization, rehabilitation, and reclamation at termination, as well as unique conditions related to thaw unstable permafrost, areas susceptible to erosion, and stream bank and streambed restoration. Conditions addressed in the plan related to soils would include removal and replacement, cleanup, stockpiling and use of salvageable growth medium, disposal of excess spoil and excavated material, ESC measures, revegetation, and invasive species prevention and management. A Non-Native Invasive Plants Prevention Plan would be included as part of the SRR Plan, which is addressed in Section 3.10, Vegetation.

ROW access to facilitate prescribed actions would be addressed in the SRR Plan. A description of activities expected during operations would include both routine maintenance and emergency reclamation situations, and a schedule for inspections and maintenance. The SRR Plan would identify the status of temporary use areas following construction, termination and final reclamation actions, and an estimated cost and unconditional guaranty for performance. The unconditional guaranty provided by Donlin to the BLM and ADNR would include a financial guaranty or surety bond as required for performance of approved duties and obligations in a form approved by BLM and ADNR. The SRR Plan would be revised at closure to comply with applicable regulations at the time of termination, and to incorporate BMPs and ESC/ restoration measures based on review of prior practices.

Common Elements of SWPPP, ESC and SRR Plans: These plans would address both temporary and permanent measures for drainage and erosion control, clean-up, and reclamation along the ROW and off-ROW facilities (temporary or permanent). ESC measures in the plans would consider climate and seasonal impacts, extent and duration of surface disturbance, and grading requirements; pre-existing soil conditions such as texture, thermal regime, and drainage patterns; and future land use by the public and wildlife. ESC structures and methods would be designed with the purpose of minimizing erosion from hydraulic (water) processes, permafrost degradation by thermal erosion, and siltation of waterbodies and water quality disturbances. The plans would comply with applicable requirements of the Federal Pipeline ROW Grant, the State Pipeline ROW Lease, and any other applicable landowner authorizations or agreements.

Donlin Gold Permits and Environmental Compliance Program: This program would be prepared to facilitate project compliance with approved permits by Donlin Gold personnel and contractors during all phases of the project (SRK 2013a). The program would provide procedures for regulatory compliance, including the requirements of the ROW authorizations. The program would also detail reporting and monitoring requirements for temporary and permanent drainage/erosion control measures and BMPs along the pipeline ROW and ancillary facilities/sites.

Operations and Maintenance (O&M) Plan/Manual: An O&M Plan/Manual would be prepared in accordance with federal Pipeline and Hazardous Materials Safety Administration (PHMSA) requirements under 49 CFR 192.605. The plan would provide procedures for operations and maintenance activities, and include a ROW maintenance schedule. Any new or expanded roads or airstrips would be limited to unforeseen circumstances for operation and maintenance. A pipeline inspection, surveillance, and monitoring program would be developed to observe surface conditions on and adjacent to the 50-foot permanent ROW (or 51 feet, 2 inches on BLM-managed lands). Inspections would be performed twice a year, and at intervals not exceeding 9 months. Additional inspections would be warranted due to major storm or seismic events. Documented observations associated with soil conditions and impacts would include stream bank erosion, migration, and scour; slope movements; thaw settlement or frost heave, including ground temperature observations from thermistor string networks; and an assessment of reclamation problems and potential remedial actions.

Appendix F-4 Pipeline Soil and Permafrost Data

Table F-4: Pipeline Soil and Permafrost Data

Appendix F-5 Fugitive Dust Methodology

F-5.1 Introduction

This appendix contains supplemental information related to fugitive dust effects on soils at the Mine Site, including methodologies used in calculations of predicted dust deposition from air quality models, calculation of predicted concentrations of selected constituents of concern (arsenic, antimony, and mercury) in soil at the end of mine life, and additional details on baseline data for these elements. The rationale used for selecting these three elements for further analysis of dust effects on soil is provided in Section 3.2.3.2.4, Soil Quality/Contaminated Sites – Mine Site, and is based on screening of concentrations in fugitive dust alone. A description of the air dispersion models used at the Mine Site is also provided in Section 3.2.3.2.4 as well as Section 3.8, Air Quality.

F-5.2 Mine Site

F-5.2.1 Dust Deposition on Soils

The amount of dust that is predicted to be deposited on soils at the Mine Site is shown on Figure 3.2-10. This figure provides annual deposition rates in terms of mass per area, as well as the total fraction of dust that is predicted to accumulate in shallow soils at the end of mine life.

For the Mine Site (Figure 3.2-10), dust deposition was calculated as follows, based on the results of the CALPUFF model used to predict mercury (Hg) deposition:

$$\text{Dust deposition rate (mass/area-time)} = \frac{\text{Hg deposition due to dust (mass/area-time)}}{\text{Hg concentration in dust (mass/mass)}} \quad \text{[Eq. 1]}$$

Because mercury deposition from both fugitive dust and stack sources combined were provided in the Environ (2015) CALPUFF model output (Figure 3.8-5), these values were reduced by the estimated fraction coming from particulates (Hg[p]) in total mercury deposition, in order to derive the value for "Hg deposition due to dust" in Equation 1. Mercury deposition due to fugitive dust alone is estimated to comprise approximately 77 percent of total mercury deposition at the Mine Site, the rest coming from gaseous mercury forms (Environ 2015). The value for "Hg concentration in dust" used in Equation 1 was the same as that used in the model, or 0.77 ppm overall, based on concentrations of 1.62 ppm in ore and 0.62 ppm in waste rock, and relative contributions of 14 and 86 percent, respectively (Environ 2014a, 2015, Table 3-7; Donlin Gold 2015d). Tailings were assumed to be composed of waste rock in these estimates.

Estimates of total dust accumulation in soil at the end of mine life, expressed as a mass fraction (Mp) or percent of particulates in soil, are based on the following:

$$Mp = \frac{\text{Dust mass}}{\text{Soil+dust mass}} = \frac{\text{Dust deposition (mass/area-time) x area x time}}{\text{Soil+dust density (mass/volume) x volume}} = \frac{\text{Dust deposition x time}}{\text{Soil+dust density x depth}} \quad \text{[Eq. 2]}$$

The soil density and depth assumptions used in Equation 2 are consistent with EPA (2005) methodology, and are the same as those used by ARCADIS (2014) and ERM (2017b) to predict concentrations in soil: a bulk density of 1.5 grams/cubic centimeters (g/cc) was used represent to density of soil and dust combined based on a USGS estimate for silty soils, and a 2 cm (0.8-inch) soil depth was used to capture the maximum effect on near-surface soils. As described by ARCADIS (2014), soils just below this depth and in layers with the highest organic content have been shown to have the greatest potential for metal accumulation. In addition, biotic transfer from dust-affected soils to humans, wildlife, and plants would be most likely to occur at this depth. A value of 35 years was used in Equation 2 to represent the end of mine life and dustgenerating activities. This includes 3.5 years for construction, 27.5 years of operations, and 4 years of reclamation activities.

Annual dust deposition rates and the dust fraction in soil at Year 35 are shown on Figure 3.2-10 averaged across several watersheds, which represent USGS Hydrologic Unit Code 12 (HUC12) watersheds used in the Environ (2015) CALPUFF model. Total dust deposition is predicted to be highest in the Eta-Crooked Creek watershed, where shallow soils are predicted to contain about 0.55 percent dust by the end of mine life. While the watershed boundary for this HUC12 watershed extends from the Mine Site to the Kuskokwim River, the results for the southern portion near Crooked Creek Village are likely to be closer to those of adjacent Village and Bell watersheds and the village itself, which are an order of magnitude less, with predicted levels of dust at 0.05 to 0.06 percent.

The model takes a number of factors into account besides dominant wind direction, such as terrain (ridges), vertical and horizontal dispersion, mixing heights, surface roughness, and vegetation, which could affect the location of dust fallout. While the dominant air transport direction is to the northwest and south-southeast (see Figure 3.8-5 in Section 3.8, Air Quality), the apparent northeast-southwest trend of the deposition map (Figure 3.2-10) is partly an artifact of the model averaging over the large size and trends of the upper Crooked Creek and Donlin Creek HUC 12 watersheds. Most deposition within these two watersheds would be in the portions of the watersheds closer to the Mine Site. The relatively high deposition value in the upper Crooked Creek watershed reflects the fact that the Mine Site dust sources would almost entirely be located in that HUC 12 unit. The relatively high value in the Donlin Creek watershed reflects the fact that the pit and WRF would reach or cross the watershed divide with Donlin Creek, and that these two mine components would be the source of about three-quarters of all dust from the mine. In addition, the model conservatively assumes that dust from the pit, which comprises nearly half of fugitive dust emissions, would not be redeposited in the pit (Environ 2015).

F-5.2.2 Estimated Mercury Concentrations in Soil

Estimated mercury concentrations in soil at the end of mine life were calculated using three different statistical approaches as described below. The objective of this exercise was to determine whether end-of-mine-life concentrations of mercury in soil might represent a concern to human health. Humans or ecological receptors would be exposed to the total concentration of mercury in soil, as represented by the sum of the baseline concentration and the incremental concentration deposited due to Mine Site activities. In all three methods, soil concentrations at Year 35 were calculated as follows, consistent with EPA (2005) methodology:

$$Cf = MbCb + MpCp \quad \text{[Eq. 3]}$$

Mb and Mp are the mass fractions of baseline soils and dust, respectively, and Cb and Cp are the mercury concentrations in baseline soil and dust, respectively.

Environ (2015) CALPUFF Model Results

Estimated mercury concentrations in shallow soil at Year 35 are shown on Figure 3.2-12, averaged across the HUC12 watersheds used in the Environ (2015) CALPUFF model. Mercury data for individual samples in each watershed are listed in Table F-5a. Predicted concentrations in Year 35 were calculated based on arithmetic mean concentrations in baseline soils, the geometric mean of mercury in dust, and the same soil density and depth assumptions described above for the Mine Site (ARCADIS 2014, SRK 2014a, Rieser 2015b, EPA 2005). For HUC12 watersheds in the southeastern portion of the study area with no baseline soil data (e.g., Village and Bell watersheds, Figure 3.2-3), samples from adjacent watersheds were used to represent baseline conditions (ARCADIS 2014, Weglinski 2015a).

The results indicate that mercury concentrations could increase over the life of the mine by up to 6 percent in the northern part of Eta-Crooked Creek watershed, and from 0.1 to 1.5 percent in other nearby watersheds (ARCADIS 2014, Environ 2015, SRK 2014a). Grouse Creek watershed exhibits the highest mercury concentration at Year 35 (919 ug/kg) primarily due to higher baseline concentrations.

Table F-5a: Concentrations of Arsenic, Antimony, and Mercury in Baseline Soils

Reasonable Maximum Exposure Concentrations

Mercury concentrations in soil were also estimated using the watershed with the highest fraction of total dust at the end of mine life (0.55 percent, Figure 3.2-10), combined with more conservative statistics for baseline and dust concentrations (95 percent upper confidence limit [95% UCL] for baseline, and arithmetic mean for dust), to explore the upper bounds of potential average exposure concentrations.

In the evaluation of contaminated sites, a long-established and commonly used statistic to represent exposure concentrations in soil is the 95 percent UCL on the mean (EPA 1989, 1992, 2002c). This value represents an upper bound estimate of the mean and the level of confidence in it (i.e., 95 percent of the time, the true mean would fall below the 95 percent UCL). It is considered a conservative "reasonable maximum exposure" concentration for human health risk assessment by the EPA (1989, 2013a), who analyzed different distributions and skewed data sets in order to provide an appropriate mean to be used for this purpose. The rationale for using the 95 percent UCL of the mean as an exposure concentration is that a human or ecological receptor would not be expected to spend long durations exposed only to the maximum values in an area. Rather, because of the heterogeneous nature of chemical distributions in soil and the mobility of most receptors, the average is considered to better represent potential exposures, and the use of maximum values or similar upper range values, such as upper prediction limits (UPLs) or 95th percentiles of the actual distribution, would be inappropriate.

Because sampling for future concentrations in soil is not possible, a modified approach to predicting upper-bound estimates of future mean concentrations was adopted. The 95 percent UCL of current baseline concentrations was estimated based on field sampling, and an incremental mercury addition based on the arithmetic mean of predicted dust deposition rates in the watershed with the highest level of dust (Crooked Creek watershed) was estimated separately. For dust estimates, the arithmetic mean is notably higher than the geometric mean used in the Environ (2015) model. This is because the dust data, which are derived from the pit resource block model dataset, are positively skewed and influenced by high-value outliers (Rieser 2015a). Thus, use of the arithmetic mean for dust, when added to either the 95 percent UCL or arithmetic mean for baseline, is considered more conservative than that of the Environ (2015) model. Thus, the total predicted concentration was estimated by addition of the arithmetic mean incremental concentration to the baseline 95 percent UCL (i.e., final concentration = 95 percent UCL of baseline + arithmetic mean of increment). This final value was compared to health-protective values for mercury in soil.

The purpose of this exercise was not to "dilute" out the incremental concentrations or to make the increment appear to be proportionately small in comparison to baseline. Rather, the goal was to develop a final total concentration that may be used as a conservative reasonable maximum exposure concentration for risk-based comparisons. By using the 95 percent UCL of the baseline and the mean increment from the likely most impacted watershed, a conservative exposure concentration was developed that is consistent with EPA risk assessment methodology. Other possible variations of this approach would be expected to yield similar conclusions.

Comparable Arithmetic Means

An estimate of mercury in soil at the end of mine life was also calculated using arithmetic means for both baseline and dust, in order to identify the incremental contribution from the mine using comparable statistics. The site-wide population of baseline data was used for these calculations. As shown in Table 3.2-2 and Table F-5b, arithmetic mean baseline concentrations are notably lower than the 95 percent UCLs. This approach provides a more conservative estimate of the mine contribution than the other two methods, but results in a lower end concentration. The use of the 95 percent UCL and mean baseline data, combined with the highest predicted dust fraction in soil (0.55 percent) and mean dust data, result in estimated increases in mercury concentrations in soil in the range of 11 to 22 percent (Table F-5b).

Table F-5b: Estimated Metals Concentrations in Mine Site Soil due to Fugitive Dust, based on Site-Wide Baseline Values

Element[1]	Current Soil Concentration[2] (mg/kg)	Dust Composite[3] (mg/kg)	% Dust in Soil, Year 35[4]	Soil, Year 35		ADEC Soil Cleanup Level[5] (mg/kg)
				Concentration (mg/kg)	% Increase above Baseline	
Antimony						
mean	5.35	21	0.55	5.44	1.6	41
95% UCL	11.1	-		11.2	0.5	
Arsenic						
mean	78.8	550	0.55	81.4	3.3	8.8
95% UCL	169	-		171	1.2	
Mercury (total)						
mean	0.212	8.6	0.55	0.258	22	30/10
95% UCL	0.415	-		0.460	11	

Notes:
1 Only metals exceeding ADEC cleanup levels in baseline or potential dust sources are listed.
2 Site-wide baseline values from Table 3.2-1 (Fernandez 2014a; ARCADIS 2007c, 2014).
3 Arithmetic mean of all fugitive dust sources at the mine assuming 86% waste rock/14% ore for Hg (Environ 2014a, 2015; Donlin Gold 2015d), and 97% waste rock/3% ore for As and Sb (Air Sciences 2016).
4 Highest watershed-based value in Figure 3.2-10, based on CALPUFF model results in Environ (2014a) extrapolated to total dust deposition (see Equations 1 and 2 in text).
5 18 AAC 75: Method Two, Under 40-inch Zone, Human Health; mercury guidelines are shown as mercuric chloride/methylmercury (ADEC 2017b).

Abbreviations:
- data not available
n number of samples
95% UCL 95 percent upper confidence limit on the mean
ADEC = Alaska Department of Environmental Conservation
Shaded cell = Concentrations exceed ADEC levels.

F-5.2.3 Estimated Concentrations of Other Metals in Soil

The geochemistry of baseline soils and potential dust sources, combined with comparisons to ADEC levels, suggest that other metals of potential concern for soil quality include antimony and arsenic. The effects of these constituents on soils from fugitive dust deposition have not been specifically modeled, as mercury has. Instead, their concentrations in soil at the end of mine life were estimated based on the HUC12 watershed with the highest fraction of dust extrapolated from the Environ (2015) CALPUFF model (Figure 3.2-10, and Equations 1 and 2).

Baseline data for individual samples are listed in Table F-5a by watershed to provide the range and distribution of arsenic and antimony concentrations across the Mine Site and vicinity. As described in Section 3.2.2.1.4 (Affected Environment, Soil Quality), the highest concentrations of arsenic are present within and north of the Mine Site and generally follow trends of mineralized bedrock (Figure 3.1-3). The highest concentrations of antimony follow a similar trend and are typically co-located with high arsenic results.

Year 35 soil concentrations for arsenic and antimony were estimated using two of the methods described above for mercury: 1) 95 percent UCL concentrations for site-wide baseline soils, plus the arithmetic mean for dust at the highest predicted dust deposition rate, to identify a reasonable maximum average exposure concentration for the final soil concentration; and 2) arithmetic means of both site-wide and watershed-specific baseline data, combined with watershed-specific dust deposition rates, to identify more representative values for the incremental increases caused by the mine.

Dust composite concentrations for antimony and arsenic are based on numerous samples in the resource block model database (Rieser 2015b). The average concentration of each from this database was used to estimate the dust composite using relative contributions from ore and waste rock of 3 and 97 percent, respectively) (Air Sciences 2016). Based on site-wide baseline data combined with the highest predicted dust deposition rate, concentrations of antimony and arsenic in soil were estimated to increase by about 1 to 3 percent by the end of mine life (Table 3.2-5). The lower percent increases are associated with higher baseline and final concentrations (using 95 percent UCL for baseline), and provide a reasonably conservative estimate of final soil concentration. The higher percent increases are associated with lower baseline and final concentrations (using means for baseline), and provide a reasonable site-wide conservative estimate of contribution from the mine.

The range of arsenic results based on individual watershed data is shown on Figures 3.2-13 and 3.2-14. Figure 3.2-13 provides results for all watersheds, and Figure 3.2-14 highlights watersheds of maximum impact based on different measures of effects (e.g., highest final concentration, highest incremental increase, highest dust deposition area). Where data are lacking in two of the HUC12 watersheds (Bell and Village), an average of baseline values from nearby unmineralized watersheds (10.6 ppm) was used as a proxy, as these two watersheds are located outside of mineralized areas depicted on Figure 3.1-3. The unmineralized watersheds included in the proxy average include Crooked sub-watershed, Eagle, Unnamed Tributary #1, Grouse, and Flat (Table F-5a).

Predicted increases in arsenic soil concentrations at the end of mine life range from about 1 to 10 percent for individual watersheds. As with the site-wide results in Table 3.2-13, the final predicted concentrations based on individual watershed data are driven more by high baseline conditions than dust deposition. The watershed with highest baseline data (Donlin Creek) is expected to experience the highest final concentration but lowest percent increase, while the highest percent increase in concentration would occur in a watershed with low baseline data close to the Mine Site (Grouse Creek). The watershed receiving the highest amount of dust deposition (North Crooked Creek) would have the largest net concentration increase (2.8 ppm), but a percent increase (6.6 percent) less than that of Grouse Creek.

The distribution of antimony results is similar to that of arsenic (Figure 3.2-14), with the highest final concentration in Donlin Creek watershed (9.53 ppm), and the highest percent and concentration increases in North Crooked Creek watersheds (4.5 percent, 0.1 ppm).

F-5.3 Transportation Corridor

Dust deposition rates and dust fractions in soil are shown on Figure 3.2-11 for the mine access road based on a model completed by Air Sciences (2015a) using AERMOD. Daily dust deposition rates provided in the Air Sciences (2015a) report were annualized on this figure based on 110 days/year seasonal use (Donlin Gold 2015e). The fraction of dust that accumulates in shallow soils by the end of mine life were calculated using Equation 2 (described above under Mine Site, Dust Deposition on Soils) and the same soil density, depth, and time assumptions used for the Mine Site.

The location of maximum dust deposition along the road is in Eagle Creek watershed about 2 miles south of the airstrip spur road (Figures 3.2-11 and 3.2-14). The fraction of dust that is expected to accumulate in soil at this location by the end of mine life is about 1.9 percent immediately adjacent to the road. This amount drops off by an order of magnitude (to 0.19 percent) about 160 feet from the road.

Concentrations of arsenic in soil at the end of mine life due to road dust were estimated based on baseline soil data from the Eagle Creek watershed (Figure 3.2-3 and Figure 3.2-13, Table F-5a). Antimony is not elevated with respect to ADEC levels for potential road dust sources (Table 3.2-4); thus, it was not included in this analysis. No baseline soil mercury data are available specifically for the Eagle Creek watershed or for outcrop/rubble samples. Because this watershed is located within the boundaries of the larger HUC12 watershed with highest predicted mine dust impacts, the mercury results for the road location are estimated to be the same as those described above under Mine Site.

Year 35 soil concentrations for arsenic were estimated in Table F-5c using Equation 3 and both the arithmetic mean and 95 percent UCL concentrations for baseline soils to identify reasonable upper bound estimates associated with the incremental increase caused by road dust and final soil concentrations. The results indicate that arsenic concentrations could increase by about 8 to 10 percent in soils immediately adjacent to the road, and drop to a 1 percent increase 160 feet from the road. Estimated final soil concentrations are less than those predicted for the Mine Site (Table F-5b), because arsenic concentrations at borrow sites are expected to be substantially less than those of waste rock and ore that comprise dust sources at the Mine Site. Concentrations could increase towards the north end of the road where dust may be more representative of waste rock and ore data than outcrop data (Table 3.2-4).

Table F-5c: Estimated Arsenic Concentrations in Soil along Mine Access Road due to Fugitive Dust

Element[1]	Current Soil Concentration[2] (mg/kg)	Outcrop/ Rock Rubble[3] (mg/kg)	% Dust in Soil, Year 35[4]	Soil, Year 35		ADEC Soil Cleanup Level[5] (mg/kg)
				Concentration (mg/kg)	% Increase above Baseline	
Arsenic – 3 feet from road						
mean	9.44	59	1.9	10.4	10	8.8
95% UCL	11.8	-		12.7	7.6	
Arsenic – 160 feet from road						
mean	9.44	59	0.19	9.5	1.0	8.8
95% UCL	11.8	-		11.9	0.8	

Notes:
1 Only metals exceeding ADEC cleanup levels in baseline or potential road dust sources are listed.
2 Baseline samples from watershed with maximum dust deposition - Eagle Creek (Air Sciences 2015a, Fernandez 2014a) based on 95% Student's-t UCL.
3 Outcrops and rock rubble samples along mine access road, assumed similar to potential borrow pit material to be used as road base; from Fernandez (2014a).
4 Maximum impact value on Figure 3.2-11, based on AERMOD results in Air Sciences (2015a) extrapolated to soil fraction at Year 35 (see Equation 2 in text).
5 18 AAC 75: Method Two, Under 40-inch Zone, Human Health (ADEC 2017a).

Abbreviations:
- data not available
n number of samples
95% UCL = 95 percent upper confidence limit on the mean
ADEC = Alaska Department of Environmental Conservation
Shaded cell = Concentrations exceed ADEC levels.