

APPENDIX E

Part I: ASAP Revegetation Plan

Part II: Analysis of Potential Indirect Impacts to Wetlands Related to Buried Pipeline Construction

Part III: Segregation of the Surface Layer

Part IV: Comparative Belowground Designs and Return of Wetlands

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ALASKA STAND ALONE PIPELINE/*ASAP* PROJECT

Revegetation Plan

Prepared for AGDC by the
Alaska Department of Natural Resources
Plant Materials Center

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NOTICE

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ACRONYMS AND ABBREVIATIONS

ACP	Arctic Coastal Plain
ADNR	Alaska Department of Natural Resources
AGDC	Alaska Gasline Development Corporation
ASAP	Alaska Stand Alone Pipeline
BLM	Bureau of Land Management
BMP	Best Management Practice
DNP	Denali National Park
DR&R	Dismantlement, Removal and Remediation
GCF	Gas Conditioning Facility
ISPMP	Invasive Species Prevention and Management Plan
MP	milepost
NGL	natural gas liquid
O&M	Operations and Maintenance
PLS	pure live seed
POD	Plan of Development
psig	pounds per square inch gauge
ROW	Right-of-Way
SPCS	State Pipeline Coordinator's Section
RP	Revegetation Plan
TAPS	Trans-Alaska Pipeline System
TW	Temporary Workspace
USACE	United States Army Corps of Engineers
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
VSM	Vertical Support Member

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1. INTRODUCTION

The purpose of this Revegetation Plan (RP) is to describe the process and procedural guidelines for the Alaska Stand Alone Pipeline (ASAP) Project that would meet state and federal requirements. Pipeline revegetation actions and subsequent monitoring of those actions would occur throughout project construction, operations and maintenance (O&M), and dismantlement, removal and remediation (DR&R).

ASAP is committed to revegetating the temporary construction and permanent operational rights-of-way during the construction, O&M, and DR&R phases of the Project. The Alaska Gasline Development Corporation (AGDC) will request the maximum operations term available because ASAP may be operational for a period that could exceed 50 years.

Ground-disturbed areas within the project area associated with pipeline construction include the permanent right-of-way (ROW) as well as the temporary construction areas, ice roads and pads, temporary workspaces (TWs), ancillary support areas including campsites, temporary access roads, and pipe storage yards. This plan includes revegetation recommendations for the various project components, including implementation guidance, performance monitoring and standards, and reporting requirements.

AGDC is responsible for stabilization and revegetation during all phases of the pipeline project. The Field Surveillance Program will include monitoring of stabilization and revegetation efforts related to project construction, O&M and DR&R to ensure that measureable standards are being achieved.

Upon completion of the ASAP project, DR&R efforts will be initiated. The final disposition of the project infrastructure, including the land, will be determined by the landowner. Most of the land will be remediated pursuant to the State of Alaska Right-of-Way Lease and the Federal Grant of Right-of-Way. On municipal, tribal or private land, AGDC would implement procedures and guidance of this RP as approved by the landowner.

The objective of the ASAP RP is to prevent or minimize unnecessary degradation of the environment during project construction, O&M, and DR&R by revegetating so that the disturbed areas are as functionally and visually compatible as practicable with the surrounding areas.

In accomplishing this goal, AGDC will take the necessary revegetation actions necessary to accomplish the following:

- Ensure public safety.
- Stabilize disturbed slopes and stream banks.
- Rehabilitate areas where required.
- Re-establish vegetation by preparing and allowing for natural revegetation of native plant species to occur.

- Perform revegetation seeding or hydroseeding when and where necessary and appropriate for erosion control.
- Prevent and manage invasive species.
- Comply with federal, state, and local agencies that have regulatory authority over different aspects of the ASAP Project.

Success will be measured by the performance of revegetation actions of disturbed areas, and will include long-term monitoring and evaluation prior to agency and landowner acceptance and release of ASAP revegetation obligations. ASAP would apply a programmatic maintenance cycle standard of 'Monitor, Detect, Correct' to its soil stabilization efforts during all phases of the project so that any potential issues related to revegetation success are managed in a programmatic manner. AGDC revegetation efforts would:

- Use landowner-approved revegetation methods and procedures for reapplying material to reclaim areas and establish conditions that would enhance development of stable conditions and self-generating vegetation.
- Establish stable slopes, surface, and drainage conditions to manage water and drainage within the ROW.
- Allow natural revegetation by native plant species or, if determined appropriate, vegetate disturbed areas with plant species appropriate for the site conditions in order to establish long-term, productive vegetation compatible with the area; and concurrently minimize the chances for invasive species to establish. Species would be native to the area unless otherwise authorized.
- Re-establish topography compatible with the surrounding landscape.
- Monitor revegetation actions during the project construction, O&M and DR&R to ensure the achievement of performance success.
- Minimize temporary construction impacts along the route to reduce impacts to soil and vegetation, where practical and safe.

An Invasive Species Prevention and Management Plan (ISPMP) will be developed for the ASAP Project and must be approved by the Alaska Department of Natural Resources (ADNR) and the Bureau of Land Management (BLM) prior to project construction. Prior ISPMPs have been developed for select regions of the state, and AGDC would likely use one of these plans as a basis for its plan (ADNR 2015; UAF 2010; USDA 2008; KP-CWMA 2007). The ISPMP would provide procedures to prevent and control the introduction and spread of invasive species as part of project construction and post-construction, including O&M and DR&R activities. Invasive species can be introduced and spread into an area from many sources including those under control of ASAP and its contractors, which includes equipment, personnel, delivery of goods, equipment and materials at airstrips and barge landings. Public use of portions of the project area can also be a contributing factor.

2. PROJECT DETAILS

2.1 DESCRIPTION

The Alaska Stand Alone Pipeline ASAP Project is comprised of a Gas Conditioning Facility (GCF) near Prudhoe Bay capable of producing an annual average of 500 million standard cubic feet per day of natural gas; a 36-inch, 733-mile-long, 1,480-pound per square inch gauge (psig) buried natural gas pipeline connecting the GCF to the existing ENSTAR Natural Gas Company (ENSTAR) pipeline system in the Matanuska-Susitna Borough; a 12-inch, 30-mile-long, 1,480-psig buried lateral line connecting the Mainline to Fairbanks; and associated facilities. The pipeline system will be designed to transport natural gas that will be accessible to and useable by communities, government entities, and natural resource development projects.

The proposed pipeline will typically be buried with a minimum cover of 30 inches and a bottom-of-ditch depth of 6 to 8 feet, except at fault crossings, elevated bridge stream crossings, pigging facilities, and block valve locations. The ASAP route will generally parallel the Trans-Alaska Pipeline System (TAPS) and Dalton Highway corridor to near Livengood, northwest of Fairbanks. At Livengood, the mainline route will continue south and to the west of Fairbanks and Nenana. The pipeline will bypass Denali National Park and Preserve (DNP) to the east and will then generally parallel the Parks Highway corridor to Willow, continuing south to its connection with ENSTAR's distribution system at Mile Post (MP) 39 of the Beluga Pipeline southwest of Big Lake (Figure 1). The Fairbanks Lateral tie-in will be located approximately 2.5 miles south of the Mainline Chatanika River crossing at MP 440. From the tie-in, the Fairbanks Lateral pipeline will traverse east following the Murphy Dome and Old Murphy Dome Roads, then extending southeast into Fairbanks (Figure 2).

Figure 1. Alaska Stand Alone Pipeline Route

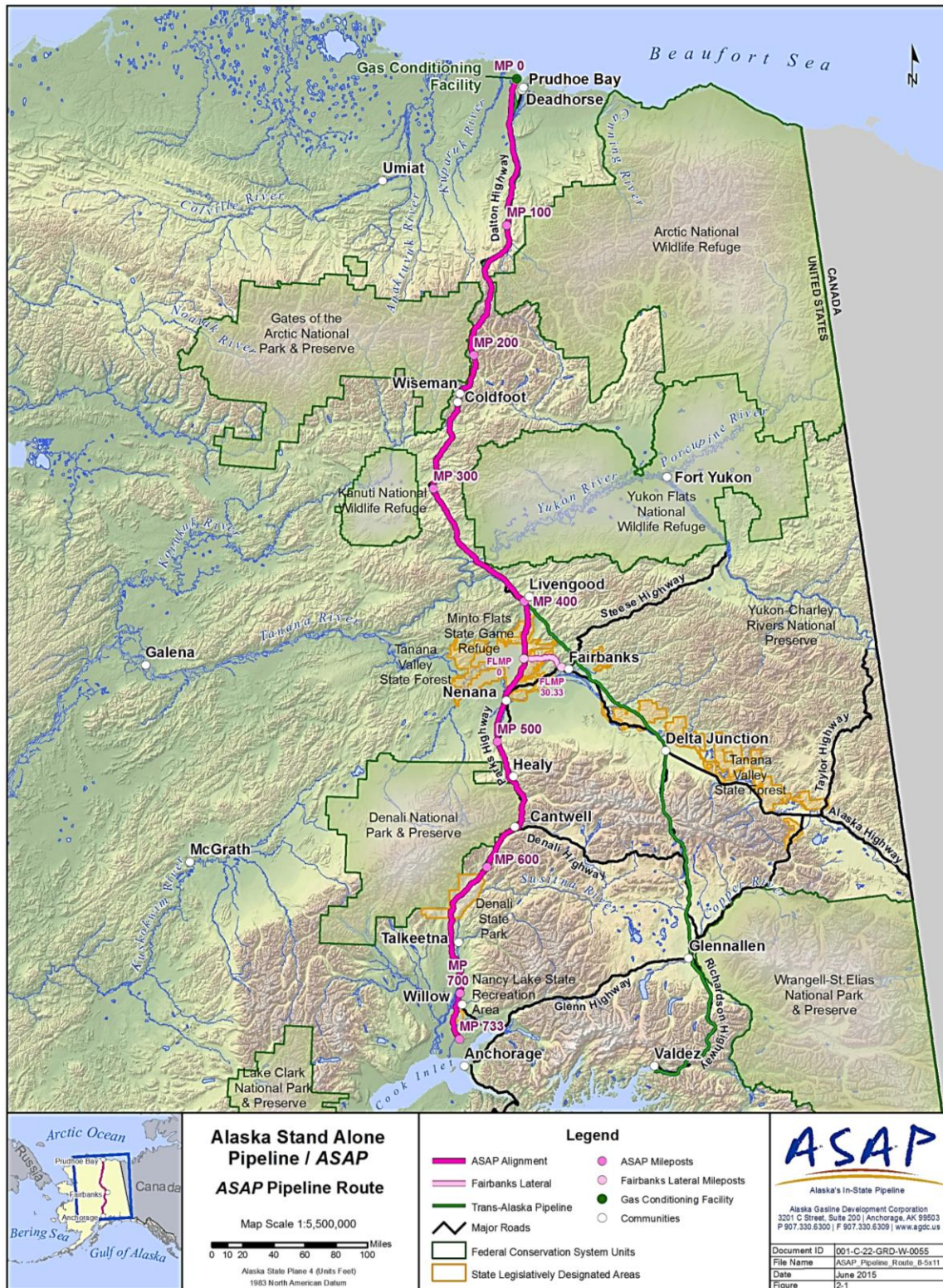
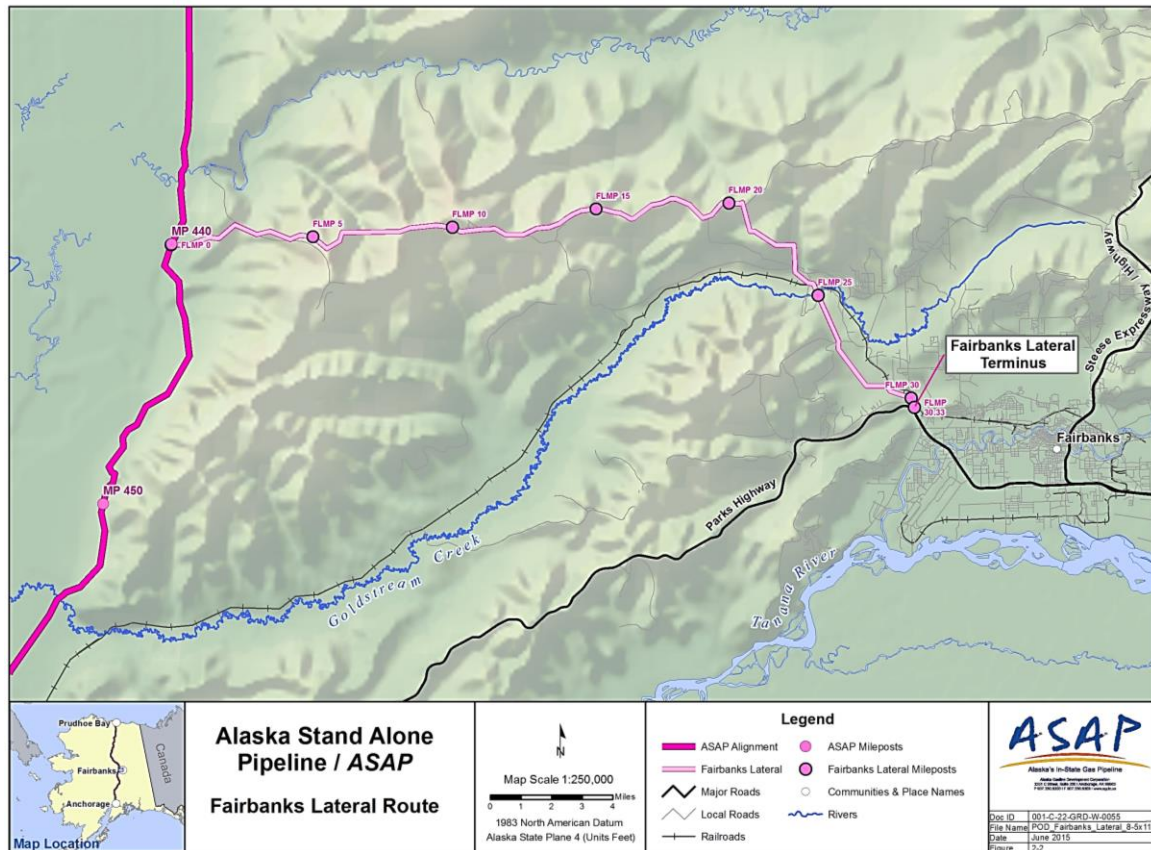


Figure 2. Fairbanks Lateral Route



Changes to the ASAP conceptual design and additional design refinements have occurred since the publication of the 2012 ASAP Final Environmental Impact Statement. These changes and refinements are summarized in the ASAP Environmental Evaluation Document (EED) (AGDC 2016a).

2.1.1 Right-of-Way

The proposed ROW for the ASAP Project will cross federal, state, borough, private, and Alaska Native Corporation lands. AGDC will enter into land use agreements with either state government (through a ROW Lease) or federal government (through a federal Grant of ROW) over approximately 85 percent of the route.

The ASAP Project was designed with consideration of cross slope, terrain type, and avoidance and minimization of impacts to environmental resources where possible. The ASAP Project will require a variable-width temporary construction ROW. The Mainline construction ROW is 120ft nominally, meaning it will range from a 120ft easement at its narrowest point to a 350ft easement at its widest point where additional workspace is required around sideslope cuts. The Fairbanks Lateral construction ROW is 100ft nominally, meaning it will range from a 100ft easement at its narrowest point to a 350ft easement at its widest point. Temporary Workspaces and Horizontal Directional Drilling False ROWs used during construction will require up to an 800ft wide easement.

The ASAP Project will require a permanent operational ROW that is 53ft nominally, meaning it will range from a 53ft easement at its narrowest point to a 350ft easement at its widest point to maintain certain side slope cuts performed during construction. The Fairbanks Lateral operational ROW is 30ft nominally, meaning it will range from a 30ft easement at its narrowest point to a 350ft easement at its widest point to access and maintain land.

2.1.2 Schedule

The GCF construction is planned over a 4-year period, commencing with site preparation activities in year 1; dock improvements in year 2; channel dredging activities, and receipt and installation of modules in year 3; and then completion of the GCF and facilities and commissioning in year 4.

Pipeline construction is planned for a 3-year period. Construction will be completed in separate sections, referred to as ‘spreads.’ The Mainline pipeline will be divided into four spreads; each spread will be further divided into sections to accommodate varying terrain or seasonal challenges. The Fairbanks Lateral is an additional construction spread, resulting in a total of five spreads for the entire project. Pre-construction activities such as land clearing, ROW preparation; and construction access roads, pipe storage yards, and camps will begin prior to the first summer season of pipeline construction (AGDC 2016a).

The life of the project or operational term is expected to extend beyond 30 years, at which point DR&R would commence.

2.1.3 Construction, Operation, Maintenance and Termination

During the period of pipeline construction, concurrent stabilization and revegetation would be performed. Follow-up and maintenance of construction related revegetation will be accomplished as soon as possible after completion of construction.

Revegetation actions would be performed on TWs as needed. Areas disturbed in preparing for and during construction would most likely not be subject to re-disturbance during O&M and DR&R. These areas would be reclaimed concurrently with or immediately following construction as conditions allow. Facilities that would remain throughout the life of the project would be addressed at termination (facility dismantled and removed and revegetation performed) but would undergo stabilization and revegetation actions to address land disturbance as a result of construction, and if necessary, as a result of maintenance actions that may occur during O&M activities.

Concurrent with or following installation of the pipeline, GCF, block valves, and related facilities, stabilization and revegetation actions would be performed. The permanent ROW, pipeline and associated facility areas would remain throughout the life of the project until DR&R, at which time final revegetation and pipeline and facility abandonment actions would take place. Disturbed areas that are not being used for production or O&M would undergo interim reclamation consisting of cleanup, recontouring, and soil stabilization practices through erosion control, such as revegetation.

Public roads will be used to transport equipment, materials, and personnel to the greatest extent possible where marine and rail transport is not available. The Elliot and Dalton Highways will be used north of Fairbanks, whereas the Parks Highway will be used between Fairbanks and the southern terminus of the pipeline. Other public access roads will be used to the greatest extent practicable to reduce the construction of temporary access roads.

Gravel access roads associated with the Project can be characterized for functional purposes as requiring permanent or temporary use, with permanent use access roads maintained for the life of the project for O&M purposes. However, with respect to analyzing wetlands impacts, both classes of access roads will result in permanent impacts to the underlying wetlands. Access roads identified for reuse by the landowner would retain improvements desirable by the landowner. Revegetation is planned for long-term stabilization of temporary use access roads for which land owners would want them removed. These roads would have any culverts or bridges removed and natural drainage areas maintained or established, as necessary and stabilized. Roadbeds would be graded where necessary to provide adequate drainage. Water bars would be used to divert run-on and run-off and control erosion, and berms to restrict human access would be incorporated where necessary, taking into account the remoteness of areas.

Any roads that would be revegetated per land owner request would be ripped, as necessary, to eliminate the effects of compaction, contoured to be compatible with the surrounding topography, covered with spoil material, and scarified to allow natural revegetation by native plant species. Any berms, side-cast material, and road drainage ditches would be reclaimed in this process. Fertilization and/or seeding will occur if a reclamation standard of 30% cover over a three-year period does not occur.

Ice roads or roads constructed as snow-packed surfaces would require a summer cleanup check to verify that all construction materials were removed from the construction ROW. Remaining debris would be removed using low-ground-pressure vehicles to minimize disturbance to surface vegetation.

Upon completion of operations, the ASAP system will require restoration to the satisfaction of the landowner. Conversations and informal understandings between the State Pipeline Coordinator (SPCS) and BLM have resulted in the development of general guidelines that appear to be acceptable and applicable to ASAP facilities.

The following general approach to DR&R for pipeline ROW closure upon completion of operations is:

- Decommissioned aboveground structures and equipment should be removed (for example, modules, structures, and fencing).
- Dismantling and removal should employ reuse and recycling options where possible
- Aboveground structures and equipment that will continue to be used should be left in place (for example, fiber-optic lines, communication stations, and bridges).
- Land identified for reuse by the landowner should retain improvements desirable by the landowner (for example, selected gravel pads, airstrips, and material sites).
- Land identified for restoration should employ DR&R methods that result in the least possible impact to the environment (for example, non-disturbance of buried Mainline pipe and previously restored ROW or workpad).
- Restoration should maintain natural drainage, stream flow, and fish passage.
- Large boulders, berms, or fencing will be used to limit access to the project ROW and any aboveground structures and equipment left in place with the intent of maintaining both project security and public safety.

3. REVEGETATION GUIDELINES

3.1 REVEGETATION GUIDELINES - APPLICATION

The intent of the revegetation guidelines is to identify the actions that would be taken to address specific issues related to ground disturbance. These revegetation guidelines are applicable to the pipeline project area unless modification is necessary to address a specific environmental condition or circumstance in the field. Modifications and field changes to address specific environmental site conditions or circumstances may be required. In such cases the revegetation action taken may require prior approval and appropriate documentation from the land owner.

The general revegetation guidelines contained in this section apply to all phases of the Project where revegetation actions are required: pre-construction, construction, O&M, and DR&R.

3.1.1 Clearing

Revegetation Guideline A: Clearing Vegetation

To reduce the amount of waste for disposal generated from downed brush and timber (other than marketable timber), the following clearing alternatives and disposal methods may be used (the preferred disposal methods of brush, timber, and stumps are the first two identified):

- Hydro-axing, chipping, or mulching brush and leaving on the ROW.
- Stockpiling brush in designated areas (uplands or previously disturbed areas) to provide firewood for local communities, as agreed to with the landowner.
- Stockpiling brush.
- Hauling brush to designated disposal site.
- Grinding stumps to ground level and leaving the root mass intact in the ROW except over the ditch line

The clearing crew would cut and remove trees and brush. Trees would be cut with a chainsaw and/or larger hydraulic mechanical equipment, limbed, and bundled off to the side of the traffic lane within the ROW for use in the construction of corduroy roads in soft, wet areas if practical. Brush would generally be cut with a hydro-axe or similar equipment. Brush, limbs, and slash would be chipped or spread on the ROW, away from traffic lanes, trench lines, and spoil areas. Trees and larger shrubs would be cut as close to the ground as possible. The limbs and brush would be shredded or chipped for use in reclamation activities or left stockpiled off the traffic lane and trench line within the ROW. Tree and shrub stumps / roots would not be grubbed out, except over the trench line and the graded traffic lane. After construction, stockpiled brush (chipped or unchipped) and unused tree trunks would be evenly dispersed over the portion of the ROW from which they were removed, to reduce erosion, serve as a mulch and impede future access along the ROW and to provide wildlife habitat.

Larger vegetative debris that cannot be used for construction of the workpad, salvaged, or left on the ROW would be placed on the ROW away from construction zones. No merchantable timber is

anticipated, but if permits stipulate providing felled timber for local use as firewood or building material in certain locations, the trees would be cut to appropriate length, limbs removed, and stockpiled for pickup by local residents.

3.1.2 Grading

The GCF Pad will be constructed using gravel placed on the existing landscape and compacted. No grading is necessary.

Pipeline grading includes excavation of waste or embankment and may include the stripping of topsoil. In situations where topsoil is removed in agricultural lands, it will be segregated and saved when practicable to enhance surface rehabilitation and aid in future revegetation of the area. The separation of topsoil will only apply to where the ROW is graded and will be limited to agricultural areas.

For construction, the ROW would be graded where necessary to provide a traffic lane that can be traversed by construction vehicles and transport equipment, and to prepare the corridor for the pipe trench to allow trenching by excavator or trenching machine. Grading would not be conducted where the ROW is level enough and firm enough for equipment to operate. For construction of the belowground pipe on the North Slope grading would not be conducted and Ice Roads, Ice Pads, and frost packing would be used to minimize impacts to high value wetlands and permafrost.

Where side slopes are steep enough to require large cuts and fills to provide a level working surface, double benching would be executed by the contractor to reduce the amount of cut-and-fill volume and associated impact to the required ROW. If crossing through wetland soils are not excessively saturated and can support mobile construction equipment, such as mats or timbers, construction will occur similarly to conventional cross-country construction techniques. Where wetland soils are too soft or wet to support construction equipment, the pipeline may be installed using the push-pull technique.

Gravel pad widths would be limited to widths required for moving materials and equipment along the ROW and supporting trenching operations.

3.1.2.1 Summer Graded Areas

In general, for summer work, the work area would be graded, if required, to provide a level surface to work from, and either gravel pads or crane mats would be used to support equipment if the ground is soft.

Revegetation Guideline B: Summer Graded Areas

Summer grading would be done in thaw-stable permafrost, competent thawed soils, weathered bedrock, and bedrock and would use normal pipeline graded ROW construction techniques. These would include cutting and/or filling side slopes and cutting the ROW to smooth the grade to match how the pipe would be bent and how the trench would be dug.

Grading would be done in summer wherever native soils are strong enough to support construction equipment. If thaw-stable permafrost is present, it would not present a problem. There may be isolated instances of thaw-unstable permafrost within an area to be graded in summer. Such areas

would need a gravel workpad on the ground surface or possibly on the horizontal surface of the cut after grading.

In summer, at construction areas where significant organic surface material consisting of topsoil crosses agricultural lands, the topsoil would be segregated from the mineral soil during grading activities and set off to the side for use in revegetation efforts after completion of construction.

3.1.2.2 Winter Graded Areas

For winter construction, ice roads and pads will be constructed in order to provide a flat, stable working surface and move heavy equipment along the pipeline route on the North Slope. Frost packing (use of condensed snow as a driving surface) will also be used in some areas, where possible.

Revegetation Guideline C: Winter Graded Areas

Winter grading would be possible where soils are naturally strong enough to support equipment or on soils that are strong enough after shallow natural frost penetration. In winter, freezing temperatures would be sufficient to strengthen these soils, and no frost packing would be necessary other than compacting or removing snow to prevent it from serving as an insulator over the ground. Most of the North Slope is considered wetlands and has thaw-unstable permafrost soils. No grading would occur on the North Slope segment, considered to be from the GCF to the Brooks Range foothills.

Heavy equipment working over an ice workpad (trencher, sidebooms, and trucks) will work north-to-south to dig a 5 foot-wide trench to the desired depth (generally, six to eight feet), casting spoils to the opposite side of the trench (Figure 3). For trenching and pipe installation on the North Slope, heavy equipment and trucks will drive on the working side of the trench, which will be protected by an ice pad and result in no impacts to wetlands from transportation (Figure 3).

The diagram illustrates the typical right-of-way for a Tundra Ice Workpad. It shows a cross-section of the work area with various dimensions and components labeled.

Dimensions:

- Working Width Limits:** 600' Max Construction ROW (Total)
- Construction ROW:** 120' Construction ROW
- ROW Segments:** 53' ROW, 53' Min Operational ROW, 120' Min Construction ROW
- Workpad Components:**
 - ICE PAD:** 6" THICK ICE PAD (MIN)
 - WETLANDS:** Indicated by small tree symbols.
 - ICE PAD WIDTH:** 5.0'
 - TRENCHER PAD WIDTH:** 20'
 - WELDING SHELTER WIDTH:** 10'
 - TRAFFIC LANES:** 20'
 - WORK PAD:** 70'
 - SPOIL SIDE:** 100'
 - TEMPORARY REMOVAL SPACE:** 100' (on both ends)

Labels:

- ORIGINAL GRADE
- TRENCH SPOIL
- PIPELINE
- TOP OF PAD
- ORIGINAL GROUND

Notes:

- TCE END ADDITIONAL 100' TEMPORARY SNOW REMOVAL SPACE
- TCE END ADDITIONAL 100' TEMPORARY SNOW REMOVAL SPACE

Caption: TUNDRA ICE WORKPAD TYPICAL RIGHT OF WAY
NOT TO SCALE

Construction workpads refer to the zone along the alignment from which work is performed. Workpads will be installed to support equipment required for pipeline construction. Three main types are required: ice/snow workpads, gravel workpads, and graded workpads. Culverts and temporary bridges will be installed, as required, to permit cross-drainage during summer. The ROW will be maintained during construction to allow safe passage of construction equipment and to prevent degradation of the ROW and adjacent areas. Additional culverts, riprap embankments, or drainage ditches will be installed during construction, as required.

At this time, no summer construction is planned in areas of thaw-unstable permafrost. If this changes to include summer granular pad over permafrost, the organic layer would not be removed unless specifically required by design.

Where a gravel workpad is used for summer construction in areas of thaw-unstable permafrost or over soft soils that are unable to support construction equipment, and in wetlands overlaying thaw-unstable permafrost, the organic layer under the workpad would not be removed, as it would be detrimental to the thermal stability of the underlying permafrost. The workpad would be left in

place after construction. For workpads not required for O&M, any compacted areas of the workpad would be ripped to mitigate the compaction effects of traffic, graded to facilitate drainage, covered with any available growth media and scarified to allow natural revegetation by native plants. Fertilization and/or seeding will occur if the reclamation standard of 30% cover over a three-year period does not occur.

3.1.3.2 Winter Workpad Construction

In winter, stripping of the organic layer is not common, except in the trenched area, primarily because this material would survive better if left in place. Because the organic layer is frozen solid during the Alaska winter, it sustains much less damage from traffic compared to what would occur in summer construction where ROW is graded.

The North Slope segment of the ASAP pipeline stretches approximately from the GCF to the Brooks Range Foothills. North of the Brooks Range, the end of the winter season is late April or early May. This yields a duration from early January to late April for pipeline construction of up to 120 days.

Revegetation Guideline E: Winter Workpad Construction

For the belowground pipeline, only one winter season would be required. The winter section lengths were planned to allow as much time as possible between the completion of the pipe laying and the end of season dates.

The civil contractor will construct an ice workpad on the ROW prior to pipe stringing. Frost packing of the ROW with tundra-legal equipment could begin design in November, but on tundra, ice pad construction is assumed to start in early- or mid-December. The ice pad crew will ensure that enough ROW is prepared ahead of the pipe lay crew. The entire section is flat terrain and will be constructed during the winter pipe laying season.

In winter workpad construction, snow and ice pads would be built directly over the organic layer in thaw-unstable permafrost areas. No organic material would be removed. In areas where snow and ice pads are used in winter construction, they would be prepared to facilitate proper drainage and allowed to melt. Any further revegetation action would be determined on a case-by-case basis.

3.1.4 Granular Workpad Areas

In the places where gravel workpad is placed for summer construction and no grading occurs, the organic layer would not be removed unless specifically required by design. Granular workpad would be used in areas of thaw-unstable permafrost or over soft soils that are unable to support construction equipment, where removal of the organic layer under the workpad would be detrimental to the thermal stability of the underlying permafrost (AGDC 2017). This would also apply to wetlands overlaying thaw-unstable permafrost (AGDC 2017).

Revegetation Guideline F: Granular Workpad Areas

The workpad would be left in place after construction, leaving the organic layer intact beneath the gravel pad, which is important to slow thermal degradation of the permafrost. For workpads not required for O&M, any compacted areas of the workpad would be ripped to mitigate the compaction

effects of traffic, graded to facilitate drainage, covered with any available growth media, and scarified to allow natural revegetation by native plants. Fertilization and/or seeding will occur if the reclamation standard of 30% cover over a three-year period does not occur.

3.1.5 Ditch Excavation

A chain-type excavator will excavate the ground by breaking up the frozen soil or rock with carbide-tipped teeth mounted in sockets welded to a continuous steel chain. The chain trencher will cut with a digging chain that is driven around a rounded metal frame, or boom. This type of trencher can cut ground that is too hard to cut with a bucket-type excavator, and can also cut narrow and deep trenches. The angle of the boom can be adjusted to control the depth of the cut. To cut a trench, the boom will be held at a fixed angle while the machine creeps slowly. This method of excavation will operate efficiently and will minimize the extent of surface disturbance. Ditching machines are effective in soils without oversized material and without a high water table. The organic layer and vegetative matting will be removed only from a 5-foot-wide section where trenching will occur. Upon digging the trench, construction teams will assess surficial and subsurface hydrology, as well as the potential for erosion and ponding. Engineers will use this information to inform their decisions for placing ditch plugs or other sub-surface hydrologic control measures where possible.

For the ASAP belowground pipe on the Arctic Coastal Plain (ACP), heavy equipment working over an ice workpad (trencher, sidebooms and trucks) will work north-to-south to dig a 5 foot-wide trench to the desired depth (generally, six to eight ft), casting spoils to the opposite side of the trench. Heavy equipment and trucks will drive on the working side of the trench, which will be protected by an ice pad and result in no impact to wetlands from transportation. A trencher, which is not compatible with large cobble or boulder areas, can be used because of the presence of a uniform deposit of fine-grained soils within trench depth on the ACP. The trencher will drive over an ice pad while digging the trench.

In areas not suited for ditching machines, ditch excavation will be done by track hoe.

Revegetation Guideline G: Ditch Excavation

Construction scheduling is the most appropriate way of limiting thaw of open-ditch segments. During excavation, attempts will not be made to separate excavated soils into topsoil and subsoil. To the extent possible, thaw-unstable soils will be excavated during winter seasons. In all cases, durations of open-ditch construction activities will be minimized.

After trenching, pipe lowering in, and backfilling any compacted areas would be tracked to mitigate the compaction effects of the excavator and associated traffic, graded to facilitate drainage, covered with any available growth media, and scarified to allow natural revegetation by native plants. Fertilization and/or seeding will occur if the reclamation standard of 30% cover over a three-year period does not occur.

3.1.6 Spoil Material

For the purposes of this Plan, the term ‘spoil’ is the material consisting of terrace gravels, colluvium, loess, and other non-organic material that lies between the topsoil horizon (where present) and bedrock. Spoil may be referred to and is interchangeable with the terms ‘subsoil’, ‘trench mineral subsoil’, and ‘overburden’ in relation to the proposed ROW and ancillary areas.

The organic surface layer is the first few inches of an undisturbed soil profile with the physical and chemical properties capable of germinating and sustaining vegetation growth with or without amendments. The segregation of the surface layer will occur in select areas, consistent with the AGDC planning document, *Segregation of the Surface Layer* (AGDC 2017). The ISPMP will be implemented to assist with invasive plant control on disturbed areas and ensure native plant recruitment over time.

Revegetation Guideline H: Spoil Material

Salvaging the surface layer is intended to occur in permafrost areas where underlying soils are thaw-stable, pipeline construction is planned for summer, ROW preparation mode is grading (e.g. cut/fill), and cross slope and/or the longitudinal slope is less than or equal to 2%; where slopes range from 2 to 20%, the cut area only will be salvaged (AGDC 2017). Where underlying permafrost soils are thaw-sensitive, pipeline construction is planned for summer, and cross slope and/or longitudinal slope is greater than 10%, the surface layer will be segregated from the area to be excavated only (AGDC 2017). This will result in salvaging the surface layer over approximately 186 miles of the ROW in continuous and discontinuous permafrost areas (AGDC 2017).

In non-permafrost areas, salvaging the surface layer will occur where pipeline construction is planned for summer, ROW preparation mode is grading or cut/fill, and cross slope and/or longitudinal slope is less than or equal to 2%; where slopes range from 2 to 20%, the cut area only will be salvaged (AGDC 2017). This will result in additional mileage where the surface layer will be salvaged for future use in ROW stabilization.

In addition, maximization of topsoil salvage in agricultural areas will adhere to the following principles:

- Pedestals of topsoil will be used to help verify soil removal depth
- A qualified soil scientist or environmental inspector will be consulted to assist in verifying topsoil thickness and supervise the salvage operations
- A contractor with experience in soil salvage operations will be consulted to help minimize soil disturbance and mixing of the soil layers

Stockpiled agricultural topsoil changes chemically, biologically, and physically over time during storage. To keep the soil in as productive state as possible, salvaged topsoil will be applied concurrently with construction activities through agricultural areas where possible. If the topsoil must be stored before application it will be stored in a manner that limits sun exposure, increases surface area and minimizes storage depth. A wide, shallow stockpile helps retain more viable seeds, earthworms, and microbes. In addition, stockpiles should be isolated from potential contamination sources and protected from flooding.

3.1.7 Backfilling

Trench spoils will be cast onto the non-traffic side of the ROW onto either the temporary ROW working area, or during winter construction, onto either ice, frost packing or snow (in agricultural areas the topsoil would be placed on the non-traffic side of the ROW and the spoils material on the non-traffic side next to the pipeline trench centerline). After the pipeline is placed in the trench the mixed soil layers will be backfilled into the trench and mounded over the top of the pipe, with

the toe of the mound extending approximately two feet outward from the edge of the ditch. The pipe will be placed within the trench and filled during the same construction season in which it was dug. Excessive ditch subsoil spoil will be feathered and blended across areas of the disturbed construction corridor, creating a roughened surface to capture precipitation, decrease erosion, and provide safe sites for plant establishment.

If necessary thaw-stable bedding and padding material will be added prior to backfilling to provide structural support and to help with settlement. This will help to protect the pipeline whenever the ditch passes through material that could damage the pipe coating, to mitigate buoyancy problems, and to protect against excessive loss of pipe cover due to erosion. In areas where these problems do not exist, the spoil material will be placed directly around the pipe.

Revegetation Guideline I: Backfilling

During construction, spoil will be replaced as soon as possible after the pipeline section is laid down to reduce the introduction of rain or snow into the trench. Per federal regulation, at least 30 inches of normal soil cover must be used to cover the pipe. Trench backfill would be mounded (crowned) over the top of the trench to account for settlement of fill as time progresses so that a depression does not form over the top of the pipe and to direct surface water flow away from the trench line.

Stabilization of the backfilled trench may be a multi-year process in some areas, particularly areas with fine-grained, ice-rich soils and wetlands. The proposed pipeline trench may intercept overland flow, but natural water flow paths will be maintained through the use of trench breakers (see below) and terrain contouring. Some areas may be covered with erosion control fabric or other material to prevent erosion. It is important that vegetation will be able to grow through the fabric. Disturbed areas where the vegetated mat is not available, the surface would be prepared for natural revegetation by native plant species or seeded with plant species adapted to site conditions at the earliest opportunity to minimize erosion and siltation.

Seeding of the backfilled trench will be monitored after construction to confirm that the reseeded ditch line is supporting long term native plant establishment and that fill above the pipe has not eroded.

3.1.8 Trench Breakers

Trench breakers are used to prevent soil migration from longitudinal flow of water and are made of different types of materials (Figure 4). Trench breakers would be installed after lowering in, and prior to backfilling. These berms may be constructed with expanding foam sprayed from a nozzle, sandbags, bentonite, or compacted, cohesive soils and placed across the ROW to mitigate or reduce erosion along the pipeline trench and the ROW. Sandbags are durable, yet flexible and will conform to gradual shifting of pipeline and backfill, while serving their function: impede the flow of subsurface water along the trench.

Trench breakers are typically installed on each side of an excavated water crossing and in other locations along the ROW as required during construction. They are also used in the trench on either side of stream crossings to ensure water does not penetrate into the ditch and create erosion, thereby allowing vegetation to re-establish fully across the seeded area of the ROW.

Figure 4. Examples of Trench Breakers from Different Types of Materials



Revegetation Guideline J: Trench Breakers

Trench breakers would be constructed as needed to prevent longitudinal flow of water along the buried pipe.

3.1.9 Crowning

Crowning is a procedure that is important for both soil stabilization and water management. It is characterized as a mild mounding of trench spoils above the pipeline trench to an appropriate finish grade that will help to direct moisture away from the top of the pipe and mitigate against slumping. The slope over the crown is critical to stabilizing soils and directing ponding, thereby mitigating some erosion and drainage impacts. Crowning promotes movement of water along a desired vertical and horizontal gradient. As the ditch soils thaw in spring, the extra weight and height of soil will compact the soil below and bring the surface above the pipeline near to flat.

The remaining spoil material not used for backfilling and crowning will be feathered and blended across the construction corridor, creating a roughened surface to capture precipitation, decrease erosion, and provide safe sites for plant establishment.

Revegetation Guideline K: Crowning

Options available to direct surface water flow away from the crowned trench line include:

- Installation of wattles (intentional depressions) at an angle and at predetermined spacing along the crowned trench line based on slope angle to direct flow away from the ditch line.
- Installation of flexible piping to carry offsite and upgradient water across the ditch line to vegetated downslope areas.
- Periodic installation of armored flow breaks in the crowned section to transfer water from one side of the ditch line to the other for storm drainage.
- Use of native fill berms to direct flow away from the crowned ditch at specified intervals based on slope.
- Construction of drainage channels to direct flow from the construction area.
- Installation of permanent culverts in some areas.

- Development of earthen ditch blocks used to retain or direct water.
- Use of gravel or gabion channels or swales.
- Installation of temporary or permanent erosion control products such as Rolled Erosion Control Products or Turf Reinforcement Mats for use in troublesome areas highly susceptible to surface water flow and erosion.

3.1.10 Earthwork / Recontouring

Material sites, worker camps, ice roads and pads, temporary-use areas, and temporary access roads will be recontoured to conform with the surrounding landscape based on landowner desires and applicable permits. Top surface areas will be graded and shaped to promote run-off while minimizing ponding and erosion.

Revegetation Guideline L: Earthwork/Recontouring

Recontouring would be done in a way to emphasize the use of existing drainage patterns and landform types to blend with and be compatible with the surrounding landscape to the extent practicable. Recontouring disturbed areas would be done with site complexity in mind. Ensuring that the site is characteristically complex means that there will be a greater diversity of habitats available for species to use. For example, when preparing the site for planting, instead of smoothing out the surface of the soil, it may be desirable to purposely create a rough surface. This can help to create shallow depressions which can act as microsites that capture moisture and protect small seedlings that are germinating. On a larger scale, complex sites may support a few different habitat sites such as a wetland, open area, and an open or closed forest adjacent to each other. This diversity of habitat structures may be important to some types of wildlife that like to forage in open areas, require the wetland for drinking water, but use the nearby forest to hide from predators.

Generally, revegetation of disturbed areas is planned for long term stabilization. After contouring and prior to revegetation, the site will be track-walked to increase establishment success and decrease erosion. Track-walking relies on the cleats of equipment to leave depressions on the soil surface. Just prior to seeding all surfaces will be roughened by track-walking up and down the slope such that the cleat marks left after track-walking are roughly perpendicular to the slope. If the cleat marks are parallel to the slope, then it would encourage rivulets to form and runoff to be more rapid and prone to erosion.

3.1.11 Site De-Compaction

If required, in areas, such as access roads, camp sites, storage yards, or other sites where material has been compacted from traffic, equipment use, storage, or from other construction related activities, the areas would need to be prepared for revegetation purposes which would include de-compaction to facilitate site revegetation. Subsoil de-compaction would occur where necessary on a case-by-case basis.

Revegetation Guideline M: Site De-Compaction

In areas that have been compacted as a result of construction activities and require de-compaction to facilitate revegetation, the areas would be ripped to mitigate the compaction effects of the traffic, equipment use, storage, or from other construction-related activities and other use. Identified areas

will be ripped to a minimum depth of 8-20in (20-50cm) prior to surface soil replacement. Heavy equipment, such as graders and front-end loaders are frequently used on highly compacted rocky soils. A dozer blade can be modified with 'tiger teeth' at regular intervals and used to break up the soil. A chisel plow, disk, or other equipment can also be used on compacted soils. The equipment used to rip the soil should be operated along the contours to minimize soil erosion and facilitate soil-water retention to aid revegetation. For sloped sites, ripping along the contour will intercept runoff as it flows downslope.

Revegetation actions would be performed as soon as practicable after site compaction has been alleviated. Site areas that are no longer needed for construction and O&M would be contoured to be compatible with the surrounding topography, covered with available spoil material cast aside during trenching, and scarified to allow natural revegetation by native plant species. Fertilization and/or seeding will occur if the reclamation standard of 30% cover over a three-year period does not occur.

3.2 REVEGETATION GUIDELINES - METHODS

3.2.1 Revegetation

AGDC's approach to revegetation includes allowing natural revegetation by native plant species, or if determined appropriate, revegetating disturbed areas by seeding with plant species appropriate for the site conditions in order to establish long-term, productive vegetation compatible with the area, thereby minimizing the chances for invasive plant species to establish. Dormant seeding is included for discussion, but AGDC does not propose to use this method. Dormant seeding is very specialized and requires careful planning and timing to implement successfully, which leads to higher project costs and risks than more standard approaches of natural revegetation and seeding.

Disturbed areas to be seeded would be determined in consultation with a qualified reclamation specialist or appropriate resource specialist (i.e., soils, wildlife, weeds). Seeding may be necessary where areas are site sensitive (erodibility, weeds) and have a low likelihood to restore naturally based upon routine surveillance and monitoring.

3.2.1.1 Natural Revegetation

This approach to revegetation depends on plants species from the surrounding area to naturally recolonize the site, usually through wind dispersal.

Initially, ASAP would, upon completion of seedbed preparation, leave areas unseeded to allow for natural revegetation/recolonization of the site. If these areas do not meet the revegetation criteria (cover and density standard) within the time period (usually 3 years) they would be seeded or some form of adaptive management considered. For ground disturbed areas that are highly sensitive and erosive, natural revegetation would not be an option and the process of seeding will begin immediately. Natural revegetation would not apply in site specific cases such as the 'Dormant Period' of the below ground pipe where trench stabilization may be a multi-year process or the 'Alternate Route' thru DNP that is not planned currently but could conceivably be the preferred route in the future. These two impacts will be discussed individually with regards to revegetation further in this document.

Revegetation Guideline N: Natural Revegetation

Natural revegetation by native plant species takes place without any management input, but can be assisted or enhanced with any combination of surface preparation or modification techniques, fertilizers, and soil amendments. Scarification is a surface preparation technique that disturbs the soil surface providing micro-sites favorable for plant growth. Fertilizer will provide nutrients that plants will uptake for growth. Inputs such as these may aid the natural revegetation process.

3.2.1.2 Seeding

Natural revegetation may be the preferred method for revegetating disturbed areas where a seed bank of native species already exists in spoil material or natural terrain. However, in some areas seeding may be necessary. Seed will be obtained from commercial vendors or collected locally by seed collectors.

As with any seed mix, a degree of flexibility is necessary depending on seed availability and site-specific conditions. The mix may change over time to include forbs and woody species, depending on factors such as internal and external research results, changes in technology, changes in land management philosophy, and commercial availability. Native and annual species would be the preferred mix, unless information developed by the ADNR Plant Materials Center and onsite test plots indicate other, more desirable species meet the post-operational land use criteria. No single species or monoculture would account for the majority of total vegetation mix composition unless it is evident at high levels in the adjacent landscape. The development of the seed mix was based on it being native and non-invasive, adapted to the site, erosion control capability, availability of commercially and locally collected seed, and its ability to propagate from seed in disturbed areas (i.e., species that are known to have high germination rates and ability to colonize disturbed areas).

Stabilization of disturbed areas to be seeded following project construction, O&M, or DR&R would be determined based on site conditions including erosion potential, low likelihood to restore naturally and agency recommendations including those of the Alaska Plant Materials Center. ASAP does not intend to transplant or plant container stock.

Revegetation Guideline O: Seeding

When determined that seeding of disturbed areas should be done, it would be decided in consultation with BLM and ADNR and would follow methods described in the *Interior Alaska & Erosion Control Guide* published by the ADNR, Division of Agriculture, Plant Materials Center (Czapla, Wright 2012) and the *Alaska Coastal Revegetation & Erosion Control Guide* published by the ADNR, Division of Agriculture, Plant Materials Center (Wright, Czapla 2010). The methods and procedures outlined in these manuals provide specific regional information for revegetation of disturbed areas with native plants to limit the potential for colonization by invasive plant species.

Seeding would be implemented after spring break-up to allow the seed to take advantage of the summer moisture period; seeding as soon as possible following seedbed preparation. The seeding schedule would be adjusted in response to site conditions, weather, and the construction schedule. Seeding would occur as soon as possible after site preparation if weather conditions and the season are suitable. Table 3 approximates the end of planting season across the different geographic regions the ASAP will traverse. Planting after this date will greatly diminish the success of the revegetation effort. Planting after this date would be considered dormant seeding, as discussed below.

The recommendations of the Alaska Plant Materials Center would be followed for the appropriate seed mixture, application rates, and fertilizer if needed.

Table 1. Latest Date to Seed

LATEST DATE TO SEED	
Arctic Coast	July 15
Interior Region	August 15
Southcentral Region	August 31

Dormant Seeding

The definition of dormant seeding is planting seed during late fall or early winter when soil temperatures become too low for seed germination to occur so that seed germination occurs the following spring. Choosing dormant seeding as a revegetation approach will allow for an extended planting season. The planting window for revegetation projects can be extended by several months when dormant seeding is incorporated into a revegetation plan.

Planting seed later in the season can also naturally break seed dormancy mechanisms. Some native species require exposure to cold and moisture (overwintering) to break internal and external dormancy. In these species, the winter season allows for stratification and scarification processes to take place. A spring/summer planting schedule may require the artificial recreation of these conditions in a controlled environment to break seed dormancy. However, most if not all grasses used for revegetation in Alaska do not require this treatment. Forbs are more likely to require stratification.

Another benefit is the head-start given to species in competing with weeds. Seed present in the soil at the start of the growing season will have less competition with weeds for resources.

Dormant seeding projects can also result in significant and unanticipated problems. Unseasonably warm temperatures after placing the seed can trigger germination and possible loss of the seeding effort due to mortality of the seedlings. Also, seed predation by rodents and possibly birds can conceivably cause a project to fail if the seed was not adequately protected. Seed can also be transported off the intended site by wind during some winters or water erosion during spring break-up.

Revegetation Guideline: Dormant Seeding

As a general rule, dormant seeding should only be used after the first hard killing frost but not after four inches of snow. This will prevent premature germination and allow good seed-to-soil contact. It should never be used on crested snow. Higher seed application rates are recommended for dormant seeding because seed mortality rate and seed predation is higher. A 15-25% increase is appropriate.

Seeding methods become more limited with dormant seeding. The ground should be frozen with a soil temperature below 40 degrees so that the seed will not germinate. Dormant seeding is intended to remain un-germinated and in place until after the next growing season starts.

Late season planting restricts what type of site preparation equipment shall be used as well as the method used to apply the seed mix. Frozen soil is harder to manipulate on a project site, affecting the variability of the seedbed. Broadcasting and hydroseeding both work well in distributing seed on frozen ground. A mechanical implement, such as a drill seeder, is not as adaptable to frozen ground due to the specialized nature and precision of seed placement and soil cover; two constants that are hard to adapt in frozen soil. If hydroseeding is chosen, dark-colored mulch should not be incorporated into the slurry. Dark mulches may raise the soil temperature promoting early germination.

Mulch application may be relevant at sites that are unprotected and windy to protect the seed and prevent it from blowing offsite. The mulch used and application rates are determined by the project engineer or as part of a Storm Water Pollution Prevention Plan (SWPPP). Application rates are usually per product manufacturers specifications.

3.2.1.3 Seed Specifications

Seed is the most commonly used plant material for revegetating disturbed areas, because it is easy to collect, clean, store, transport, mix and apply to the site using drill or broadcast methods. The use of native plant seed that live or grow in a particular region of Alaska prevents the introduction of potentially unwanted invasive plants or noxious weeds. The benefits of native seed include:

1. They are truly adapted to the area because the seed is harvested from different geographic regions the ASAP traverses and is tested for its traits and adaptability to varying site conditions through off-site plots around the state and,
2. Their appearance is more aesthetically pleasing.

Revegetation Guideline P: Seed Specifications

Quality seed is a critical component to success. Specifying 'certified' seed assures quality germination and purity; certification also provides some assurance of genetic quality. Some native seed species are not available as certified seed. Seed quality can still be ascertained by examining percent germination and percent purity; information that will be clearly labeled for any seed sold in Alaska. This labeling is required by 11 AAC, Chapter 34: Seed Regulations (Attachment 1). All seed sold or used in the State of Alaska must also be free of noxious weeds (11 AAC 34.075). This is noted on seed tags, along with germination and purity.

For BLM-managed lands that require seeding their policy are as follows:

1. On BLM lands all seed must have a valid seed test, within one year of the acceptance date, from a seed analysis lab by a registered seed analyst (Association of Official Seed Analysts). The seed lab results shall show no more than 0.5 percent by weight of other weed seeds; and the seed lot shall contain no noxious, prohibited, or restricted weed seeds according to State seed laws in the respective State(s).

2. The seed procured for use on public land will meet the Federal Seed Act criteria. Seed may contain up to 2.0 percent of 'other crop seed' by weight which includes the seed of other agronomic crops and native plants; however, a lower percent of other crop seed is recommended.
3. Copies of the seed lab test results, including purity and germination (viability) rate, must be forwarded to the appropriate BLM office prior to seed application. If the seed does not meet the BLM and State/Federal standard for noxious weed seed content or other crop seed allowances, it shall not be applied to public land. All seed test results must be retained in the seeding project file.
4. All donated seed or seed used for 'mitigation or restoration' by contractors per a reclamation plan must meet BLM's noxious weed seed policy prior to use on public lands.
5. Straw or mulches applied as part of seeding, stabilization, rehabilitation, or restoration projects on public lands must be certified to be weed seed-free.

An exemption will be allowed for small reclamation projects, less than 20-acres or not to exceed 200 pounds of seed, which have an approved BLM reclamation or rehabilitation plan or permit. The seed will be accepted if accompanied by an official seed analysis report that provides documentation to show no noxious weed seed per State(s) weed law and no more than 0.5% other weed seeds. For this exception, any one of three seed test documents will be accepted:

- A certified 'blue' tag or tags.
- An independent seed lab test.
- A seed lab analysis supplied by a vendor either by seed lot or by seed mix.

3.2.1.4 Seed Mixtures

The seed mixes were developed with forethought to the different geographic regions and landform types found in Alaska. The six seed mixtures (A to F) proposed for use are listed in tables below and consist of a variety of native species that have been used extensively in other Alaska stabilization and revegetation activities. The six seed mixtures are designated for specific areas and landforms, listed as, for example, Upland-Arctic, mix D or Wetland-Southcentral, mix C. If the seed mixtures do not fit the landform type and region in the field or a specific circumstance arises, additional seed mixtures may be necessary and would be developed in consultation with the BLM and Alaska Plant Materials Center.

The application rate for hydric or wetlands seeding using the proposed seed mix would be 30 pounds of pure live seed (PLS) per acre. Pure live seed is a number derived from percent purity multiplied by percent germination and reflects the make-up and quality of the seed. This higher seeding rate takes into account a site that may be completely devoid of vegetation where native species cannot move into the site naturally. For all other sites, a seeding range between 15-30 pounds of PLS per acre would be applied, depending upon surface contours, grade, aspect, and rockiness of the specific site.

The application rate for the mesic or upland seeding using the proposed seed mix would be 43 pounds of PLS per acre, or approximately 1 pound per 1,000 square feet. This higher seeding rate takes into account a site that may be completely devoid of vegetation where native species cannot move into the site naturally. For all other sites a seeding range between 15-30 pounds of PLS per acre would be applied depending upon surface contours, grade, aspect, and rockiness of the specific

site. If components of either the wetland or upland seed mixes are not available, consult with the Alaska Plant Materials Center for the next best available option.

Revegetation Guideline Q: Seed Mixtures

The milepost ranges for the proposed seed mixes are below. These seed mixes were assigned based on the landform type and geographic region of the disturbed area needing to be stabilized. If the seed mix is not adapted to the site conditions at the time of seeding, then additional mixture(s) would be developed with consideration of the landform type and BLM and Alaska Plant Materials Center input.

Use seed mixture **A** for the following milepost ranges:

- **MP** 0-39, 40.5-96, 99-129, 136-159.5, 161-162, 162.5-163, 164-167, 171-175

Use seed mixture **B** for the following milepost ranges:

- **MP** 175-178, 180-182.5, 183.5-184.5, 186.5-187.5, 196-201, 203-204, 205-207, 207-211.5, 211.5-217.5, 219.5-221, 222-225, 231-235, 236.5-256, 257-259, 260.5-282.5, 285-286, 288-294.5, 298.5-299.5, 301-304, 306-316, 318-324, 326-330, 334-338, 355-356.5, 361-363, 369-373, 386-387.5, 400-402, 428.5-430, 432-434, 454-457, 458-468, 471.5-472.5, 473-482, 498-499, 501-506, 507-511, 512-521, 526-530, 538-541
- **FLMP** 6-7, 18.5-19, 28-30

Use seed mixture **C** for the following milepost ranges:

- **MP** 565-568, 572.5-573.5, 592-594, 701-702, 705, 706

Use seed mixture **D** for the following milepost ranges:

- **MP** 39-40.5, 96-99, 129-136, 159.5-161, 162-162.5, 163-164, 167-171

Use seed mixture **E** for the following milepost ranges:

- **MP** 178-180, 182.5-183.5, 184.5-186.5, 187.5-189, 192-195, 217.5-219.5, 225-227, 235-236.5, 256-257, 259-260.5, 282.5-285, 286-288, 294.5-298.5, 299.5-301, 304-306, 316-318, 324-326, 330-334, 338-355, 356.5-361, 363-369, 373-386, 387.5-400, 402-428.5, 430-432, 434-454, 457-458, 468-471.5, 472.5-473, 482-498, 499-501, 506-507, 511-512, 521-526, 530-538, 541-564
- **FLMP** 0-6, 7-18.5, 19-28, 30-30.33

Use seed mixture **F** for the following milepost ranges:

- **MP** 564-565, 568-572.5, 573.5-592, 594-701, 702-705, 706-733

Table 2. Proposed Reclamation Seed Mix: Wetland – Arctic (Mix A)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Alyeska' Polargrass	<i>Arctagrostis latifolia</i>	30	9
'Arctared' Red fescue	<i>Festuca rubra</i>	30	9
'Norcoast' Bering hairgrass	<i>Deschampsia beringensis</i>	15	4.5
'Tundra' Glaucous bluegrass	<i>Poa glauca</i>	15	4.5
'Egan' American sloughgrass	<i>Beckmannia syzigachne</i>	10	3

Table 3. Proposed Reclamation Seed Mix: Wetland – Interior (Mix B)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Egan' American sloughgrass	<i>Beckmannia syzigachne</i>	30	9
'Norcoast' Bering hairgrass	<i>Deschampsia beringensis</i>	30	9
'Alyeska' Polargrass	<i>Arctagrostis latifolia</i>	20	6
'Arctared' Red fescue	<i>Festuca rubra</i>	20	6

Table 4. Proposed Reclamation Seed Mix: Wetland – Southcentral (Mix C)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Norcoast' Bering hair-grass	<i>Deschampsia beringensis</i>	40	12
'Egan' American sloughgrass	<i>Beckmannia syzigachne</i>	35	10.5
'Arctared' Red fescue	<i>Festuca rubra</i>	15	4.5
'Sourdough' Bluejoint reedgrass	<i>Calamagrostis canadensis</i>	10	3

Table 5. Proposed Reclamation Seed Mix: Upland – Arctic (Mix D)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Arctared' Red fescue	<i>Festuca rubra</i>	30	12.9
'Norcoast' Bering hair-grass	<i>Deschampsia beringensis</i>	20	8.6
'Tundra' Glaucous bluegrass	<i>Poa glauca</i>	20	8.6
'Gruening' Alpine bluegrass	<i>Poa alpina</i>	20	8.6
'Alyeska' Polargrass	<i>Arctagrostis latifolia</i>	10	4.3

Table 6. Proposed Reclamation Seed Mix: Upland – Interior (Mix E)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Wainwright' Slender wheatgrass	<i>Elymus trachycaulus</i>	50	21.5
'Arctared' Red fescue	<i>Festuca rubra</i>	20	8.6
'Nortran' Tufted hairgrass	<i>Dechampsia caespitosa</i>	20	8.6
'Gruening' Alpine bluegrass	<i>Poa alpina</i>	10	4.3

Table 7. Proposed Reclamation Seed Mix: Upland – Southcentral (Mix F)

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Nortran' Tufted hairgrass	<i>Deschampsia caespitosa</i>	45	19.35
'Arctared' Red fescue	<i>Festuca rubra</i>	25	10.75
'Wainwright' Slender wheatgrass	<i>Elymus trachycaulus</i>	20	8.6
'Gruening' Alpine bluegrass	<i>Poa alpina</i>	10	4.3

3.2.1.5 Wild Seed Collection

If commercial sources of seed are unavailable at the correct time and at an acceptable cost, an alternative is seed collection in the wild. Wild seed can be harvested from native grass, forbs, shrubs, and trees found at or near the project site. This is not a practical or feasible solution for the ASAP. Wild seed collection requires more equipment and more personnel time leading to higher project costs than the relatively simpler method of sourcing seed from commercial suppliers.

Revegetation Guideline R: Wild Seed Collection

Collection of wildland seed is a lengthy process that benefits from prior planning. Seed collection includes locating donor plant communities, collecting seed, and choosing a method of harvest.

Proper timing in the season is critical for successful seed collection. A number of field visits may be required in order to collect seed that is ripe and mature. Seeds go through different stages of maturity; being able to recognize these stages allows one to collect seed in the proper ripening window. This collection window may vary from a few days to several weeks.

Grass seed will be harvested by hand, usually by shaking it off the stem or cutting off the seed head with a knife or scissors. Shrub seed will be picked by hand or lightly shaken into a tarp or bucket for collection. Cloth bags will be used for collection because they allow airflow, preventing moisture and mold that can damage the seed.

3.2.1.6 Seedbed Preparation

In most cases little if any surface preparation will be necessary prior to seeding since spoil will be left in a roughened condition following placement; however, in areas where disturbances result in compacted surfaces unsuitable for revegetation, preparation of a seedbed suitable for seed

germination and growth may be necessary. The top and underlying subsurface spoil material must be prepared in such a manner as to retain moisture and allow adequate root development and penetration.

An ideal surface area prior to seeding should:

- Be free of construction debris;
- Have relatively few large rocks or objects;
- Be free of ruts and gullies;
- Have the top two inches in a thoroughly tilled, friable, non-compacted condition (allowing a 170 pound person heel print to make a ¼ to ½ inch impression);
- Be scarified to a depth of 6 to 8 inches, if soil is heavily compacted;
- Devoid of non-native established weeds. Competition from weeds can be a cause of seedling failure; and
- Without a significant seed-bank of weedy species. Seed stored in the soil as hard or dormant seed may be viable and will germinate if the conditions are right. The presence of a nearby seed-bank often accounts for the surprise of a weedy species showing up on site.

Revegetation Guideline S: Seedbed Preparation

The method of primary seedbed preparation would be ripping or scarifying. If necessary, ripping would occur along contours if located in sloped areas. Highly compacted areas would be ripped in a linear fashion. If needed, the surface would be scarified after application just prior to seeding. A broken, roughened surface would serve to break up large soil clods, trap moisture, reduce wind shear, minimize surface erosion by increasing infiltration, and create micro habitats conducive to seed germination and development.

3.2.1.7 Seeding Method

Seeding would be done via hand-held methods, hydroseeding, and aerial seeding. All three are forms of broadcast seeding. The broadcast method will scatter seed on the surface and rely on natural processes or some form of management to cover the seed. Broadcast seeding would be used on terrain considered too steep or rocky for seed drill equipment. Hydroseeding would be used as needed in areas with adverse conditions (e.g., Atigun Pass, rocky soils, steep slopes) or in situations where safety is the primary consideration. Site access, terrain and other site conditions may determine what seeding method is practicable. The exact method of seeding would have to be flexible.

Revegetation Guideline T: Seeding Method

Broadcast seeding may be accomplished with a hand-operated, cyclone-type seeder or pull behind broadcast seeder. This method scatters the seed on top of the soil surface. The seed must be covered by hand-raking or dragging a chain or harrow over the seedbed. Seed placement should be at a depth of approximately 0.5 inch and the soil firm around the seed to eliminate air pockets and retain moisture. Seed coverage is very important to guard against seed predation and seed caching by birds and other animals. During seeding periods when predation of seed has occurred or is a concern, predator satiation is an option. This practice involves supplying more seed than predators can remove before germination of the desired plant species occurs. This practice is not widely used,

and any implementation of this practice should be done in consultation with the ADNR-Plant Materials Center.

Hydroseeding will be used for steep/erodible soils and rocky areas. A combination of water, fertilizer, seed, mulch and a tackifier (if required by land management agency) are combined in a tank to form slurry. To avoid damage to the seed it must be applied within one hour. This prevents seed from absorbing excess water and being damaged by the dissolved fertilizer.

Aerial seeding uses an aircraft to place seed and fertilizer onto a site. This method would be used to rapidly apply seed and to access inaccessible locations that may be difficult to reach by other broadcast methods.

If hydroseeding or broadcast equipment is unavailable or cannot be brought onto the site, then the site would be prepared for natural revegetation as described above and reassessed the following season for vegetation cover.

3.2.1.8 Mulch

Mulch is usually necessary to minimize erosion, protect seed and help retain soil moisture during the critical germination process. Numerous types of materials have been used successfully as mulch in revegetation efforts. Application rate of mulch is per product manufactures specifications.

Revegetation Guideline U: Mulch

If mulch application is necessary, it would be applied following seeding and any soil amendment application. On those areas where a hydro-seeder may be used, mulch, if needed, would be incorporated into the seed and amendment mix for one-time application. Commercial hydro-mulch generally consists of wood fiber byproducts or other forms of cellulose. The hydro-mulch would contain a tackifier, if necessary, to help hold the mulch mix in place.

Any cleared or mowed vegetation procured during pre-construction and periodic ROW clearing can be stockpiled and later serve as mulch after it is respread over the ROW. Brush, limbs, and slash would be chipped or spread on the ROW away from traffic lanes, trench lines, and spoil areas. The limbs and brush would be shredded or chipped for use in revegetation activities or left stockpiled off the traffic lane and trench line within the ROW.

3.2.1.9 Fertilizer

Reseeded areas will be fertilized at the time of seeding and application of fertilizer would be done in consultation with the BLM and ADNR. Fertilizing ground-disturbed areas, if and where determined appropriate, would be performed as construction and clean-up progresses, or during maintenance actions, and during final revegetation.

ASAP does not currently project that fertilizer would be required or desirable for establishing a permanent perennial cover. In the event that soil amendments are needed, the procedures described below would be employed.

Revegetation Guideline V: Fertilizer

Prepared seedbeds would be amended prior to, after, or during (when a hydro-seeder is used) any seeding operation. Specific soil amendment requirements would depend on the quality of spoil material in a particular area. Standard soil agricultural constituents of importance include nitrogen (N), phosphorus (P), and potassium (K).

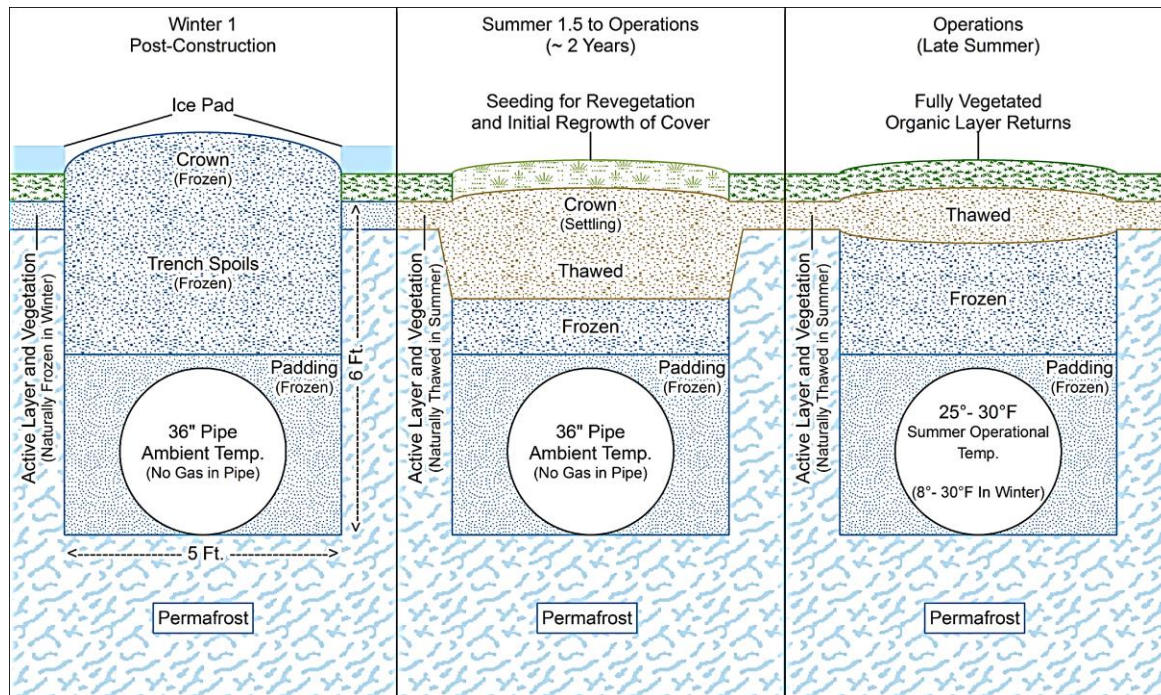
The general recommended rate of fertilizer application would be on the order of 450 pounds per acre of 20N-20P-10K. An additional application of fertilizer may be needed if the site after the first growing season does not have any plant species establishing. Adjustments will be made to the fertilizer based on annual monitoring. The selection of final products and their application rates would be determined in consultation with ADNR-Plant Materials Center.

3.2.1.10 Site Specific Revegetation

North Slope Dormant Period

The belowground (BG) pipe and surrounding material (bedding/padding, trench spoils, crown) and permafrost will remain frozen in place up through spring/summer melt (Figure 5). At that time, the crown and back-filled trench spoils will settle over the pipe and the thaw-stable bedding. The surrounding permafrost will melt slightly around the portion of the trench that thaws (Figure 5). The pipe will lay dormant at ambient temperature for approximately two years without any flow of gas while construction and testing of the GCF and pipeline occur and are completed.

Figure 5. Construction, Operation and Maintenance of the ASAP Belowground Pipe in North Slope Permafrost (MP0-MP60)



With a portion of the pipeline lying in a dormant state at ambient temperature for approximately two years, the ditch backfill and trench crown are susceptible to settle and thawing in the permafrost environment. To control soil erosion along the constructed pipeline and maintain thermal stability of the soil in the trench, a seed mixture (Table 10) consisting of annual and native species has been developed for the dormant period. The application rate for the BG mode using the proposed seed mix would be 43 pounds of PLS per acre or approximately 1 pound per 1,000 square feet. Prior to seeding re-shaping of the ditch spoil after initial thawing would be done to prevent any ponding due to thaw slump. The seed mixture would be applied on a case-by-case basis to areas along the pipeline exhibiting erosion and slumping. Revegetating the first summer after construction would help stabilize the soil and replace a vegetative covering as soon as possible. Trench stabilization of the backfilled ditch may be a multi-year process in some areas, particularly areas with fine-grained, ice-rich soils. Achieving habitat stability may require trench maintenance and long-term stabilization activities. Seeding is just one of many soil stabilization procedures and may not be the solution

for all areas. Other procedures (special design area engineering, armoring, terrain contouring, etc.) may be used in combination with or as a replacement altogether to revegetation.

Table 8. Proposed North Slope Dormant Period Seed Mixture: Belowground Pipeline

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Arctared' Red fescue	<i>Festuca rubra</i>	30	19.35
'Nortran' Tufted hairgrass	<i>Deschampsia caespitosa</i>	30	10.75
Annual ryegrass	<i>Lolium multiflorum</i>	25	8.6
'Tundra' Glaucous bluegrass	<i>Poa glauca</i>	15	4.3

3.2.2 Erosion Control

The Erosion and Sedimentation Control Plan outlines erosion control procedures for areas along the pipeline ROW. Best management practices to prevent degradation of land and water resources would be incorporated into this plan and used throughout the life of the pipeline project, including final revegetation at termination of the pipeline project. New and innovative BMP Measures would be evaluated over the term of the pipelines life and may be applied to revegetation actions over the long term.

Erosion and sediment control and drainage controls will occur through the establishment of permanent and temporary Best Management Practices (BMPs), including site adapted vegetation cover that emulates existing landscape conditions. Mulch, erosion control blankets, biodegradable jute matting, hydroseeding, silt fence, and water bars (slope breakers) are a form of BMPs and may be used as appropriate across the ROW. Removal of temporary BMPs would occur when permanent BMPs are installed or reclamation is successful.

Erosion control measures for ditch excavations performed through stream beds and banks will be applied as soon as the backfill is placed into the ditch to complete pipe coverage. Specific materials to use for erosion control of the bed and banks will be determined on a case-by-case basis and identified in the construction plans for each crossing.

Continued ground surveillance and monitoring and corrective erosion control and vegetation maintenance would be employed throughout construction of the project. Normal drainage patterns would be maintained where practical. Additional erosion and sedimentation control measures are described in the *ASAP Plan of Development (POD)* (AGDC 2014, 2016b).

Revegetation Guideline W: Erosion Control

For summer construction, the following erosion control measures would be employed:

- Barriers (for example, brush berms or silt fences) and temporary slope breakers would be installed as needed to contain disturbed soils on the construction ROW and to minimize the potential for soil to enter wetlands or waterbodies.
- After installation, temporary erosion control measures would be regularly inspected and maintained throughout the duration of construction, until permanent erosion control measures have been installed and revegetation is complete.

- Trench plugs would be used in the trench in hilly terrain to prevent water from eroding the trench bottom. They would also be used on each side of waterbody crossings to prevent trench water from entering the stream, river, or wetland.
- Temporary slope breakers on summer graded ROW or workpad would be constructed of soil, brush berms, straw bales, or sandbags. Sediment barriers would be constructed of brush berms, sandbags or silt fences. They would be installed along wetlands, drainages, and streams to prevent sediment-laden water from leaving the ROW. They can also be used at outlets of slope breakers to control sedimentation off the ROW.

The effectiveness of erosion control measures and BMPs would be indicated by site conditions lacking rills, gullies, surface litter movement, exposed root systems, etc. If these indicators are present than project related erosion is occurring, and options for remedial measures would be evaluated and implemented as needed.

Adaptive management may be necessary to determine appropriate remedial erosion control measures for sites that have not demonstrated a trend toward success and stabilization. If required, implementation of remedial measures would be determined in coordination with the appropriate agency or land owner based on monitoring data and annual reports.

3.2.3 Thermal Erosion

Construction activities would disturb the natural ground surface through removal or disturbance of the vegetative cover along the pipe trench and ROW. The ROW may also require cut slopes to improve trafficability. This disturbance may result in accelerated thermal erosion, with potential adverse effects to the pipeline, ROW, and any facilities unless mitigative measures are employed. Design and implementation of thermal erosion control measures and site stabilization thru revegetation would generally be on a site-specific basis and made by the construction engineer. The region and landform type exhibiting thermal erosion will indicate the appropriate seed mixture to use (guideline 13.5-8D: Seed Mixtures, above).

Thermal erosion is generally associated with rapid thawing of ice-rich, fine-grained permafrost soils that occurs as a result of alterations in surface drainage patterns, removal of insulating vegetation blankets, or excavation. On the pipeline route, the most dramatic thermal erosion would occur in areas where ice-rich soils are exposed in cut slopes. On these slopes, fine-grained soils are mostly likely to undergo thaw flow slide activity that could result in siltation of streams if not properly addressed.

Revegetation Guideline X: Thermal Erosion

Thermal erosion, the thawing of ice-rich permafrost soils, would occur in response to alterations in surface drainage patterns, removal of insulation vegetative cover, or excavation on slopes. The most dramatic thermal erosion along the pipeline ROW would be in areas where ice-rich soils are exposed in cut slopes, resulting in thaw flow slides, gullyng, and possible siltation of nearby streams. Another potential effect is ground subsidence resulting in water ponding and changes in drainage patterns. Revegetation measures would be required to provide long-term protection against erosion. Revegetation of affected areas would be implemented on a site-specific basis to include:

1. Slope cuts in ice-rich, fine-grained soils would be made near-vertical with a widened ditch section to accommodate sloughing (ablation method), hand-cleared of brush and trees

above the slope and allowed to self-stabilize. As the cut slope recedes, accumulation of sloughed material at the toe provides stability, and the vegetative mat at the cut face would slump over the exposed soil, thereby insulating and stabilizing the soil.

2. The organic mat may be reinforced with biodegradable netting to minimize tearing of the natural mat. Sloped cuts, if required, would need to be stabilized with a combination of granular soil blankets, wood chips, manufactured organic mats (erosion blankets), and board insulation to reduce the rate of thaw and facilitate slope drainage and soil consolidation.

4. REVEGETATION MONITORING

4.1 MONITORING

Monitoring would be conducted to evaluate soil stability, vegetative cover and/or density, presence of invasive species, and damage as a result of human or animal use in the ROW. Monitoring would consist of both qualitative and quantitative analyses.

The primary goals and objectives of monitoring are:

- Monitor and through quantitative analysis assess the performance success of natural revegetation or revegetation efforts during each growing season for those areas being reclaimed. A point-intercept method would be used to assess ground cover and other values.
- Monitor and assess invasive species in accordance with the ISPMP, to be developed before construction.
- Monitor and identify other natural or human disturbances that may impact revegetation success, such as excessive ATV public use.
- Monitor vegetation growth in the permanent ROW during the life of the pipeline project and initiate clearing of brush and shrubs every ten years or as required to allow continued surveillance, monitoring, and inspection access.

The first year's monitoring would focus on qualitative analysis of the ROW. This includes documenting site conditions through visual observations and photographs. Photographs are a good way to monitor general habitat conditions, disturbances and cover. Qualitative analysis would also be incorporated at established evaluation sites to provide digital-photo documentation of all quantitative data. Locations where remedial work may be required should be apparent and would be identified by milepost (MP), location or location identifier and site name, in the case of campsites, access roads, airfields, etc. unless a MP and description is sufficient.

4.2 REFERENCE SITES

A reference site is a geographic area that serves as a model for defining reclamation objectives on a disturbed site with similar soil, aspect, slope and site characteristics. Monitoring plots would be established within the ROW and local reference sites on adjacent undisturbed land. The local reference site must be naturally vegetated, not in a state of recent disturbance, and it must represent the same ecological site / potential vegetative community as the reclaimed site prior to disturbance. Multiple reference sites approximately an acre in size would be established adjacent to the monitoring plots to account for a site that may be biased. Reference sites should not be within the area to be disturbed. All reference sites would be approved by the appropriate agencies prior to them being used to meet the success standards.

4.3 REVEGETATION PERFORMANCE CRITERIA

Revegetation sites would be monitored in terms of native species progression and revegetation cover and/or density. Revegetation of Representative Monitoring Evaluation Sites (RMES) would

be considered successful when vegetation within the reclaimed ROW supports plants that are similar in cover and/or density to those growing on adjacent undisturbed reference sites that will be determined later.

The erosion control standard, amount of canopy (or aerial) cover, and density standard would be based on the quantitative information collected from adjacent reference or control sites. A quantitative vegetative monitoring program would document the revegetation progress. RMES would be established approximately every 10 miles (16 km) along the ROW, or as agreed upon with the landowner to reflect various conditions, in addition to specific sites used for temporary support purposes.

The responsibility for meeting the performance success standards begins after the last application of seed and fertilizer, or other work excluding maintenance work and cultural practices that can be expected to continue as part of land use. The period of responsibility is at least five years and additional or supplemental seeding or fertilizer application after the initial seeding and fertilizer applications can take place within a 3-year period. The additional two years watch period of the five-year period with no additional or supplemental action would provide a good buffer to determine long-term standards success.

Performance standards do not need to be regionally-specific to account for the varying environments traversed by the pipeline. Vegetation types and their growing conditions vary widely, from the dwarf-shrubs and sedges found in tundra north of the Brooks Range to the spruce-hardwood forests in the Interior, to the coastal spruce-hemlock forests in southcentral Alaska. This Revegetation Plan includes flexibility in its implementation to address site-specific conditions or circumstances that will facilitate an acceptable success standard tailored for a given site:

- A typical erosion control standard of at least 70 percent pre-disturbance canopy (or aerial) cover, which includes live vegetation that will resist erosion (see Section 4.3.1, below).
- If documented reference site conditions show a lesser percent cover, achievement of that cover level as an adaptive management level prior to requesting site release and/or termination of a reclaimed project site or area would be needed.
- ASAP may request from the appropriate agency that a lower standard than 70 percent be allowed in those areas where a lesser cover will control erosion and allow faster revegetation of species.
- Species density would be evaluated by comparing the total number of species in the evaluation site to that of the adjacent reference sites.

It is possible that some sites would be incapable of supporting adequate vegetation to progress towards the success standards because of project-caused conditions or environmental limitations not associated with the project. For instance, revegetation may fail or be severely disrupted in areas with unmanaged ATV access, natural disasters such as fire or flooding, and construction of other projects. This is discussed in greater detail in Section 6. Adaptive Management, below.

4.3.1 Cover (canopy) Standard

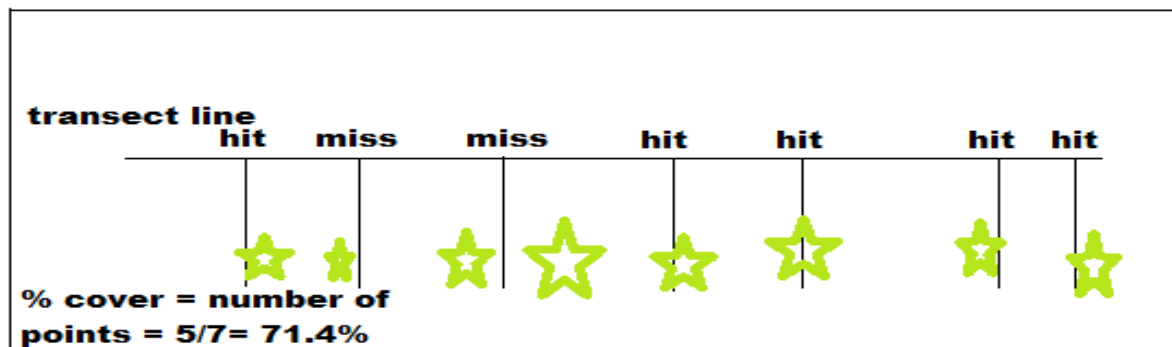
Canopy cover is the percentage of the ground obscured by vegetation (not to be confused with basal cover, which is a covering in which plants intersect the ground, such as at the base or trunk of a plant). The canopy can be visualized by considering a bird's-eye view of the vegetation. A typical

erosion control standard of at least 70 percent pre-disturbance canopy (or aerial) cover, which includes live vegetation that will resist erosion, would be achieved for ASAP. Dead vegetative mat, incidental woody debris, stones or gravel and litter are excluded from making up the 70% cover. If documented reference site conditions show a lesser percent cover, achievement of that cover level as an adaptive management level prior to requesting site release and/or termination of a reclaimed project site or area would be needed. ASAP may request, with the appropriate agency, that a lower standard than the 70 percent be allowed in those areas where a lesser cover will control erosion and allow faster revegetation of species.

The reclamation standard of at least 30 percent vegetative cover over a three-year period (not including seeding year) would be an interim action level criterion, which would indicate to ASAP whether additional revegetation action would need to be taken to ensure that a viable vegetative cover is established and that natural succession of plant species would continue, unless documented adjacent reference site conditions show a lesser percent cover for the surrounding area. Remedial action could include seeding or reseeding an area, additional application of soil amendments, and/or incorporation of additional growth media on a particular site. ASAP would be responsible for determining the cause and resolution of the substandard revegetation cover, and if appropriate, to seek approval for an adaptive management solution. The cover standard should be achieved without the use of fertilizer or reseeding for the last two growing seasons in the 5-year period.

Point intercept will be the method used to measure canopy cover with transects forming the sampling unit. Cover should be measured during the same time period each season from August 1-31. This time period will be indicative of the peak growing season when species are at their potential for vigor and biomass. Points will be placed systematically along transects at one foot intervals. Two permanent transects will be installed at each evaluation site for quantitative measures of plant cover. Each transect is 300 feet long with observations (hits) recorded on canopy cover of species recorded at one foot intervals resulting in a total of 300 points per transect. The estimate of cover along each transect is then this number of hits divided by the total number of possible hits (Figure 6). Points are measured either with pins that touch the vegetation or with a cross hair optical sighting device. It is important to use the same diameter of pin for successive measurements. Transects should be long enough to account for variability in the vegetation being sampled and have enough points so that you will intersect at least some individuals of the species of interest along each transect line. The transects will have permanent markers such as t-post or rebar marking the beginning, middle, and end points so they can be located in the field.

Figure 6. Example of Point Intercept Method of Measuring Cover



4.3.2 Density Standard

A density count of individuals or stems (counting unit) per unit area would indicate whether natural revegetation through species recruitment is occurring at a rate that will produce a permanent native vegetation community over time. During seeding, density can be used to evaluate seedling emergence and survival. Density is most sensitive to changes caused by mortality or recruitment.

Species density would be evaluated by comparing the total number of species in the evaluation site to that of the adjacent reference sites. Quadrants would be the sampling unit used for measuring density with herbaceous plant stems and individuals counted within the boundaries of a quadrat. Design and field considerations are of great importance in density measurements, and individuals or stems 'number' indicating density success would be determined at time of monitoring. Quadrat design, counting unit, and boundary decisions are all key monitoring design decisions. A thorough resource on this topic is from Elzinga et al. (1998).

Density design and measurements will be made on a case-by-case basis to fit the site area to be monitored.

4.4 MONITORING METHODS

As currently anticipated, three types of monitoring would be conducted in order to meet the primary goals and objectives of monitoring as stated above:

1. General Route Monitoring (GRM) – General route reconnaissance and reporting of revegetation conditions along the entire length of the pipeline right-of-way including the temporary use areas as necessary. Qualitative monitoring would be conducted annually along the entire pipeline ROW.
2. Representative Monitoring Evaluation Site (RMES) Monitoring– Detailed field reconnaissance and reporting at the designated RMES along the pipeline right-of-way including temporary use areas. Qualitative as well as quantitative monitoring would be taken. These sites progress and success would be compared to baseline data taken from adjacent reference sites. Monitoring would begin the second growing season and occur annually for a period of at least five years.
3. Specific Site Monitoring (SSM) – Detailed field monitoring at specific sites where needed to monitor revegetation progress. Qualitative and quantitative monitoring would be required at least annually.

4.4.1 General Route Monitoring

A general route reconnaissance of the entire ROW project would be conducted annually. The intent of this reconnaissance is to inspect and document overall recovery conditions. Conditions to be observed may include areas of dead plants, establishment of invasive species within the right-of-way, significantly eroded soils, deteriorating conditions or subsidence, unstable streambanks at crossings, and damage caused by ATVs. Documentation would include establishing photo points at specific locations, estimating area or revegetation affected, and/or recording the apparent cause or remediation efforts required. Site locations may be documented by MP, global positioning system coordinates, or by name. Adaptive management actions may be implemented based on findings from route monitoring. Each annual visit would assess designated RMES sites and document new locations where appropriate.

4.4.1.1 Representative Monitoring Evaluation Sites

Representative monitoring evaluation sites would be established approximately every 10 miles along the right-of-way in coordination with the applicable landowner and/or the Alaska Plant Materials Center, and as appropriate for other specific sites needing extra attention, where maintenance has occurred or for specific actions during termination. The establishment of these specified RMES would allow ASAP and the landowner/appropriate agency to evaluate whether or not the cover and density standards are being achieved on the particular area or segment of the ROW over a period of time (5 years). There would be approximately 73 RMES. Even though specific sites would be monitored the pipeline would generally be visually monitored for areas where revegetation may need further attention or where damage to revegetation efforts may require attention.

The specific location of RMES and undisturbed adjacent reference sites would be identified, reviewed, and approved by the landowner and/or agencies prior to initiation of monitoring activities. Specific RMES would be located and mapped according to global positioning system coordinates. The location of evaluation sites would avoid, to the extent possible, areas that may be susceptible to future human disturbance (ATV use) to preserve the integrity of each site for the duration of the monitoring period. Where possible, RMES locations would provide a good representation of the overall ROW revegetation effort. Once initial monitoring evaluation site locations are finalized, photographs would be taken;

1. Prior to any construction/maintenance/termination-related disturbance,
2. When initial revegetation efforts have been completed and,
3. During each yearly monitoring evaluation site visit.

RMES would be examined at least annually beginning in year two, and a variety of vegetation information would be collected, including quantitative and qualitative information. RMES would also assess invasive and noxious plant species presence that may require remedial action consistent with the ISPMP. However, monitoring for known invasive and noxious plant species may occur independently of revegetation monitoring. Revegetation monitoring would also include the consideration of erosion control as a key indicator to measure the trend toward revegetation success (where applicable), and remedial actions may be taken in conjunction with monitoring efforts to control erosion.

4.4.1.2 Specific Site Monitoring

Specific site monitoring would be required at least annually, and a variety of information would be collected depending on the site conditions and the revegetation action involved. This type of monitoring may be found along riverbanks or steep slopes. These types of sites are deemed sensitive because the integrity of the permanent ROW, pipeline, and associated facilities may be compromised if stabilization actions through revegetation and other erosion control measures are not performing as expected.

4.5 INFORMATION COLLECTION

Revegetation of RMES for the Project would use vegetation as the main indicator of recovery, but observations on soil conditions would be considered when assessing progress toward functionality. Measurements and descriptions would be accompanied by photographs that would be used to help

document the status of recovery at all monitoring sites. Photographic reference points would be the primary method of qualitative monitoring for the project.

A protocol for taking photographs and a standardized information-recording form would be used to ensure consistency of monitoring and a number of forms for recording data from monitoring studies can be found in Appendix 15 (pg., 421) from Elzinga, C.L., D. W. Salzer, and J.W. Willoughby. 1998. Measuring & Monitoring. Use these as examples and develop and refine your own data sheets specifically appropriate to your study. The example forms developed from the authors; Elzinga, C.L., D. W. Salzer, and J.W. Willoughby may also be photocopied and used for your monitoring objective (s).

Qualitative (descriptive) and quantitative (numerical) information that would be gathered during GRM and RMES monitoring are described in detail below.

4.5.1 Qualitative

Qualitative monitoring would detect the initiation of change and changes resulting from environmental conditions, such as precipitation, allowing for a record of change over time. Qualitative data collection would occur at least annually for both GRM and RMES monitoring. The goal of qualitative monitoring is to document site conditions and assess the need for remedial actions to ensure that sites are progressing toward the established success standard. Unpredictable weather patterns may affect revegetation success within the 5-year post-revegetation action monitoring timeframe. Qualitative evaluations that are conducted at designated GRM and RMES during monitoring would serve as representative indicators for similarly disturbed areas in the same general vegetation community or where the same seed mix may have been applied. These site evaluations would then serve as a baseline when conducting general overall route survey's for the remainder of the revegetation areas within that vegetation community. Any outstanding or non-project-related disturbances that had or could affect revegetation would also be generally described during the general route monitoring. Recovery from construction-disturbance activities in some locations may not occur in a short amount of time, and it is for this reason that the monitoring would assess the trend toward the revegetation success standards.

Revegetation success may be assessed by the presence or condition of certain site characteristics that encourage recruitment of native vegetation. Revegetation actions of a given site, if implemented successfully, are anticipated to contribute to the stabilization of soils, seedling or seedbank recruitment, and avoidance of noxious weeds. Lack of erosion at a site provides evidence that soils have been adequately stabilized, while natural recruitment and/or reproduction indicate that important functional processes are in place that initiate regeneration, such as pollination and seed dispersal. Noxious weeds could potentially compete with native perennial species, and relatively high abundances can have negative effects on site conditions. Evidence of animal use is also used as an indicator that habitat conditions have been or are being restored. Patterns of established vegetation help to determine whether large bare areas are indicative of site conditions or simply a result of the patchiness of surrounding vegetation. Such site characteristics would help determine trends that relate to revegetation success. Once recruitment conditions have been met, established vegetation is anticipated to contribute to the maintenance and functionality of the community to ensure continued success after monitoring has concluded.

4.5.2 Quantitative

Quantitative monitoring would document the trend and degree of change at each site. Success parameters would be numerically measured on those specified monitoring sites starting the second growing season to determine if there is a trend toward revegetation success. Quantitative assessment during the fifth year would provide enough time for vegetation establishment of the affected areas based on climatic trends for the area and as determined by the Alaska Plant Materials Center. Trends toward revegetation success as well as remedial actions (if necessary) would be identified during the third year. Quantitative monitoring in year seven would allow any remedial actions or climatic events to discernibly affect treated areas.

Monitoring sites that include salvaged plants or plants that have been preserved in place would also be counted and assessed for mortality, where present. The preservation or salvage of plants is primarily a visual mitigation measure and structural contribution to the long-term maintenance and functionality of the vegetation community. Salvage-plant mortality should not be considered a principal indicator of overall restoration failure.

5. REMEDIATION – ACTION AND MAINTENANCE

To ensure revegetation activities accomplish their intended purpose follow-up actions may be required and would be identified through monitoring. Performance success of revegetation would be monitored in two ways. Physical revegetation such as earthwork and spoil application would be assessed for excess erosion periodically and immediately following major rainstorms and after spring breakup. Remedial action to correct instability would be taken as soon as feasible following detection of substantial erosion or loss of spoils material. Vegetative success would be monitored qualitatively by visual inspection and photo points on an ongoing basis by ASAP as well as appropriate agency staff, and quantitatively once per year at the end of the growing season.

ASAP would address identified erosion problems as soon as practical based on evaluation of site conditions as well as conditions outside the ROW against the original erosion control work. Additional, erosion control work would be performed by applying the BMP's and erosion control measures identified in the Erosion and Sediment Control Plan as well as the SWPPP plan. It is also noted that temporary erosion control structures, such as straw bale or sediment barriers, would be removed when sites are deemed stable and revegetation is determined to be successful.

Any reseeding efforts, including supplemental mulching if necessary, would occur, with the agreement of the landowner in any area where monitoring during the third year or growing season identifies a revegetation failure, particularly where accompanied by observed increases in erosion or excessive ATV use. Invasive and noxious plant species control also would be included in maintenance and would be performed in accordance with the approved ISPMP.

6. ADAPTIVE MANAGEMENT

An adaptive management approach is designed to allow revegetation implementation flexibility in addressing site conditions or circumstances to facilitate an acceptable alternative success standard tailored for the site. Adaptive management would increase the potential for revegetation success by providing early detection of problems and the opportunity to implement remedial actions to address a specific situation based on existing conditions and circumstances. Adaptive management actions may be recommended on a case by case base where feasible.

When determined that adaptive measures are necessary, monitoring information would assist in identifying deficiencies, such as vegetation cover, soil compaction, or other contributing factors. Based on this information, appropriate revegetation actions may be proposed, approved and implemented.

All adaptive management actions would be subject to the review and approval of the appropriate agency or landowner prior to implementation. The plan shall describe the specific location or area, the situation including environmental conditions, the adaptation proposed, and the anticipated result. Proper documentation of the approved approach and site specific monitoring and standards would be followed to measure progress.

Again, ASAP would use all reasonable methods to help ensure that revegetation is progressing toward the success performance standards. It is possible that some sites would be incapable of supporting adequate vegetation to progress towards the success standards because of project-caused conditions, or environmental limitations not associated with the project. For instance, revegetation may fail or be severely disrupted in areas with unmanaged ATV access, natural disasters such as fire or flooding, and construction of other projects. If revegetation failure is determined to be caused by conditions beyond ASAPs control, ASAP would work with the appropriate landowner to resolve the situation.

7. REPORTING

Revegetation performance success standards (4.2.1 Cover Standard and 4.2.2 Density Standard) would be used to achieve the goals outlined for revegetation, with consideration of local site conditions. The erosion control standard, amount of canopy (or aerial) cover, and density standard would be based on the quantitative information collected from adjacent reference or control sites. Specific monitoring requirements would be developed by ASAP in cooperation with the landowners prior to start of pre-construction activities. Revegetation sites would be monitored in terms of native species progression and revegetation success or density. Revegetation of an RMES would be considered successful when vegetation within the reclaimed ROW supports plants that are similar in cover and/or density to those growing on adjacent undisturbed reference sites.

ASAP would document its monitoring observations of revegetation performance following field inspections and provide summary reports to required agencies. Post construction annual monitoring and collection of information would be conducted during spring or fall after construction and revegetation actions are completed. Areas that need maintenance or remedial action would be identified by MP or by location and site name in the case of campsites, access roads, airfields, etc. and would include a description of completed or additional revegetation work anticipated. Reports including a summary of corrective actions taken or proposed would be submitted within three months of identifying these actions or upon agencies request. Any areas where control applications for invasive plants were taken or are needed would also be reported consistent with the reporting requirements of the ISPMP.

The annual report will give an updated summary of ASAPs revegetation efforts. The report would be provided to the appropriate agencies and landowners, or otherwise required, for review and discussion of revegetation conditions and progress.

AGDC O&M records and would be provided to the appropriate agencies and landowners, or otherwise required, for review and discussion of revegetation conditions and progress. Reporting would include site specific reports for RMES and a report for the GRM of the entire ROW project conducted annually. Site specific reports for RMES would include both quantitative monitoring information (the trend and degree of change at each site) and qualitative monitoring information (initiation of change and changes resulting from environmental and site conditions). All reports would include photo documentation.

Reclamation monitoring would occur for 5 years, after which time a summary of observations and site performance success rates would be assessed by AGDC to determine where additional monitoring or revegetative efforts would be required. ASAP would seek termination from further revegetation actions and monitoring after the final report and annual monitoring data are submitted and have gained approval from the appropriate agencies and landowners.

The RMES reports would be submitted to requesting agencies by December 31st of the monitoring year. The GRM Report would be submitted to requesting agencies by December 31st of the monitoring year.

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ATTACHMENT 1: STATE OF ALASKA SEED REGULATIONS

Alaska Administrative Code (AAC) Title 11, Chapter 34

State of Alaska Seed Regulations



Alaska Administrative Code:
Title 11, Chapter 34

Title 11, Alaska Administrative Code,

Chapter 34: ***Plant Health and Quarantine***



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SEED REGULATIONS: 11 AAC 34.010

11 AAC 34.010.

Labeling

(a) Each lot or package of agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

- (1) the commonly accepted name of the kind and variety of the seed;
- (2) the country or state where the seed was grown;
- (3) the total percentage by weight of pure seed;
- (4) the total percentage by weight of all weed seed;

- (5) the total percentage by weight of inert matter;
- (6) the total percentage by weight of other crop seed;
- (7) the name and approximate number per pound of each kind of restricted noxious weed seed, as listed in 11 AAC [34.020](#);
- (8) the percentage of germination of the agricultural seed, together with the month and year the seed was tested;
- (9) the percentage of hard seed, if any is present;
- (10) the name and address of the person labeling the seed or selling, offering, or exposing the seed for sale within the state; and
- (11) the lot number or other lot identification.

(b) Each lot of mixed agricultural seed sold or offered for sale within the state must bear on it or have attached to it in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

- (1) that the seed is a mixture;
- (2) the name and variety and total percentage by weight of each kind of agricultural seed present in order of predominance;
- (3) the total percentage by weight of other crop seed less than five percent of the mixture; and
- (4) the information listed in (a)(4), (a)(5), (a)(7), (a)(8), (a)(10), and (a)(11) of this section.

(c) Vegetable seed in a container of one-half pound or more sold or offered for sale within the state must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

- (1) the name of the kind and the variety and total percentage by weight; and
- (2) the information listed in (a)(4) - (a)(8), (a)(10), and (a)(11) of this section.

(d) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which meets the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must bear on the container or have attached to the container in a conspicuous place, a legibly written or printed label or tag, in English, providing the following information:

- (1) the name of the kind and variety of the seed;
- (2) the name and address of the person or firm labeling the seed, or selling, offering, or exposing the seed for sale within the state;
- (3) the year the seed was packed; and
- (4) the lot number or other identification.

(e) Vegetable seed in a container of less than one-half pound sold or offered for sale within the state and which does not meet the germination standards and tolerances in 7 U.S.C. 1551 - 1611 (Federal Seed Act) must be labeled, in English,

to provide the information required by (d) of this section and the following:

- (1) percentage of germination;
- (2) percentage of hard seed, if applicable; and
- (3) the phrase “substandard germination” in not less than eight-point type.

(f) Any agricultural or vegetable seed treated with toxic substances must be labeled to provide the information required by (a) - (e) of this section and the following:

- (1) a word or statement, in type no less than eight points, that the seed has been treated;
- (2) the commonly accepted coined or chemical name of the applied substances; and
- (3) a caution statement and appropriate poison symbol if the applied substance presents a hazard to human or animal health.

(g) Seed packed in hermetically sealed containers must be labeled to provide the information required by (a) - (f) of this section and the following:

- (1) that the container is hermetically sealed;
- (2) that the seed has been preconditioned as to moisture content;
- (3) that the germination test is valid for a period of not more than 24 months from the date of germination test for seed offered for sale on a wholesale basis, and for a period of not more than 36 months for seed offered for sale at retail; and
- (4) that the germination of seeds at the time of packaging was equal to or above standards and tolerances prescribed in the 7 U.S.C. 1551 - 1611 (Federal Seed Act).

(h) Agricultural seeds, mixed agricultural seeds, or bulk vegetable seeds, are exempt from the provisions of this section when

- (1) the seeds are grown in or sold within the state to be recleaned before being sold, exposed, or offered for sale for seeding purposes;
- (2) the seeds are held for purposes of recleaning; or
- (3) the seeds are held or sold for milling for food or for feeding purposes only.

(i) Tetrazolium viability test results are not considered valid germination tests for the purposes of labeling as required by this section.

(j) Hybrid seed, as defined in 7 C.F.R. 201.2(y), must be labeled in accordance with provisions of 7 C.F.R. 201.11(a).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.020.

Prohibited and restricted noxious weeds

(a) The following are prohibited noxious weeds:

- (1) **Bindweed, field** (*Convolvulus arvensis*);
- (2) **Fieldcress, Austrian** (*Rorippa austriaca*);
- (3) **Galensoga** (*Galensoga parviflora*);
- (4) **Hempnettle** (*Galeopsis tetrahit*);
- (5) **Horsenettle** (*Solanum carolinense*);
- (6) **Knapweed, Russian** (*Centaurea repens*);
- (7) **Lettuce, blue-flowering** (*Lactuca puichella*);
- (8) **Orange Hawkweed** (*Hieracium aurantiacum*);
- (9) **Purple Loosestrife** (*Lythrum salicaria*);
- (10) **Quackgrass** (*Agropyron repens*);
- (11) **Sowthistle, perennial** (*Sonchus arvensis*);
- (12) **Spurge, leafy** (*Euphorbia esula*);
- (13) **Thistle, Canada** (*Cirsium arvense*);
- (14) **Whitetops** and its varieties (*Cardaria drabe*, *C. pubescens*, *Lepidium latifolium*).

(b) The following are restricted noxious weeds, with their maximum allowable tolerances:

- (1) **Annual bluegrass** (*Poa annua*), 90 seeds per pound;
- (2) **Blue burr** (*Lappula echinatat*), 18 seeds per pound;
- (3) **Mustard** (*Brassica kaber, juncea*), 36 seeds per pound;
- (4) **Oats wild** (*Avena fatua*), seven seeds per pound;
- (5) **Plantain, buckhorn** (*Plantago sp.*), 90 seeds per pound;
- (6) **Radish** (*Raphanus raphanistrum*), 27 seeds per pound;
- (7) **Toadflax, yellow** (*Linaria vulgaris*), one seed per pound;
- (8) **Vetch, tufted** (*Vicia cracca*), two seeds per pound;
- (9) **Wild Buckwheat** (*Polygonum convovulus*), two seeds per pound.

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88;
am 7/28/2007, Register 183

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.030.

Weed seed as agricultural seed

The following seeds, when occurring incidentally in agricultural and vegetable seeds, are classed as weed seeds, except when sold alone or as a specific constituent of a definite seed mixture:

- Black Medic (*Medicago lupulina*);
- Cardoon (*Cynara cardunculus*);
- Dandelion (*Taraxacum* species);
- Lupine (*Lupinus* species);
- Pigweed (*Amaranthus* species);
- Radish (*Raphanus sativus*);
- Rape (*Brassica campestris* and *napus*);
- Sunflower (*Helianthus annuus*);
- Yarrow (*Achillea millefolium*); and
- Tufted Vetch (*Vicia cracca*).

History: In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.040.

Sampling procedure for purity and germination tests

(a) A sample of seed chosen by an authorized agent of the division of agriculture for the purpose of determining whether or not the seed meets the requirements of this chapter is known as an “official sample,” and must be drawn in a manner to represent as nearly as possible the entire lot from which it is taken.

(b) Official samples of seed shall be taken according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.39 - 201.44.

History: In effect before 7/28/59;
am 3/2/78, Register 65

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.045.

Duties and authority of the director

(a) The duty of enforcing this chapter and of carrying out its provisions and requirements is vested in the director. The duties and authority of the director include the following:

- (1) to sample, inspect, make analyses of, and test any agricultural or vegetable seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and to the extent the director finds necessary to determine whether the seed is in compliance with this chapter;
 - (2) to sample, inspect, make analyses of any tree, shrub, or flower seed held, transported, sold, offered, or exposed for sale within the state for planting purposes, at the time, place, and the extent as the director may find necessary to determine whether the seed is in compliance with this chapter;
 - (3) to issue and enforce a written stop sale order or to issue a violation notice, whichever the director determines applicable, to the possessor or owner of any lot of agricultural, vegetable, tree, shrub, or flower seed which is found to be in violation of this chapter; and
 - (4) to prohibit the further sale, processing, or movement of seed, except on approval of the director, until evidence is obtained that shows that the requirements of this chapter have been complied with and a release from the stop sale order has been issued for the seed.
- (b)** When seed is denied further sale, processing, or movement under (a)(3) and (a)(4) of this section, the owner or processor of the seed has the right to appeal to a court of competent jurisdiction in the locality in which the seeds were found in violation, asking for a judgment as to the justification of the order and for the discharge of the seed from the order prohibiting the sale, processing, or movement, in accordance with the findings of the court.
- (c)** The provisions of (a)(3) and (a)(4) of this section do not limit the right of the director to proceed as authorized by other sections of this chapter.
- (d)** For the purpose of carrying out the provisions of this chapter, the director or his authorized agents, may
- (1) enter upon any public or private premises during regular business hours in order to access seeds and associated records maintained under this chapter, and any truck or other conveyer by land, water, or air at any time when the conveyer is accessible, for the same purposes; and
 - (2) either alone or in the presence of a representative or employee of the person whose premises are entered, examine and inspect any agricultural, vegetable, tree, shrub, or flower seed in possession, offered, or exposed for sale for planting purposes in this state, for compliance with this chapter.
- (e)** A sample taken under this section, and the report showing the results of the official test made on a sample, is prima facie evidence of the true condition of the entire lot from which the sample was taken.
- (f)** A copy of the results of any seed test from a sample taken under this section may be mailed to any person or his authorized representative, known to own, possess, or hold the seed from which the sample was taken.

History: Eff. 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 03.05.040](#) , [AS 03.05.050](#) , [AS 44.37.030](#)

11 AAC 34.050.

Germination and purity tests

Germination and purity tests of seeds must be conducted according to procedures which conform as nearly as practicable to those used by the United States Department of Agriculture pursuant to 7 C.F.R. 201.59 - 201.66.

Authority: [AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.060.

Laboratory fees and schedule

(a) Germination and purity tests are performed at the Alaska Seed Testing Laboratory.

(b) State residents may submit seed samples for routine testing free of charge if the samples are limited to three per year per person and are submitted before April 15 of the year.

(c) Samples submitted by residents in excess of three per year or after April 15, or submitted by nonresidents will be charged a service fee as determined by the director.

(d) Samples submitted by residents and nonresidents for germination tests requiring tetrazolium procedures will be charged a service fee to be determined by the director according to a fee schedule based upon the difficulty of the species being tested.

History: Eff. 3/2/78, Register 65

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.070.

Code of Federal Regulations

Except where in conflict with specific provisions of this chapter, the rules, regulations and recommendations pertaining to sampling procedures and germination and purity testing procedures and standards contained in 7 C.F.R. 201.39 - 201.44 and 201.59 - 201.66 are adopted by reference and made part of this chapter. Copies of these provisions may be obtained from the U.S. Government Printing Office, Washington, D.C. 20250. Any reference in these provisions to U.S. Government officials and agencies shall be construed to refer to the corresponding officials and agencies of the State of Alaska.

History: Eff. 3/2/78, Register 65

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

Editor's note: These regulations are adopted by reference. The official Rules and Regulations under the Federal Seed Act are published by the U.S. Department of Agriculture and are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20250

11 AAC 34.075.

Prohibited acts

(a) No person may sell, offer for sale, expose for sale, or transport for use in planting in the state any agricultural or vegetable seed that

(1) unless exempt under 11 AAC [34.010\(h\)](#), has not been labeled as required by 11 AAC [34.010](#);

(2) bears a false or misleading label;

(3) contains any prohibited noxious weed seed, except as allowed in (g) of this section;

(4) contains any restricted noxious weed seed in excess of the permissible tolerance per pound established under 11 AAC [34.020\(b\)](#), except as allowed in (g) of this section; or

(5) has not been tested within the 18 months preceding the sale, offering, or exposure for sale, or transportation, not including the calendar month in which the test was completed, except for hermetically sealed containers under 11 AAC [34.010\(g\)](#) (3), and except that

(A) the director will, in his discretion, allow a shorter period for kinds of seed which he finds, under ordinary conditions of handling, will not maintain a germination within the established limits of tolerance during the prescribed time period, or a longer period for kinds of seed which are packaged in a container and under conditions the director determines will, during the longer period, maintain the viability of the seed under ordinary conditions of handling;

(B) a person in possession of seed shall keep on file, available for department inspection, the original or duplicate copy of the latest test made of the seed which must show, in addition to the information required by this chapter, the date and name of the person making the test.

(b) No person may substitute uncertified seed for certified seed.

(c) No person may use tags or seals indicating certification other than as prescribed by the authorized certification agency unless the tuber, horticultural, vegetable, tree, shrub, flower, or cereal grain seed has been produced, tested, examined, and labeled in accordance with this chapter or the official certification agency of another state, territory, or country. No person may

(1) sell, offer for sale, expose for sale, advertise, or transport any tuber, plant, or seed, falsely representing it to be certified; or

(2) use in connection with a tuber, plant, or seed any tags or seals similar to

those used in official certification as established by this chapter.

(d) No person may hinder or obstruct in any way, any authorized person in the performance of his duties under this chapter.

(e) No person may sell, offer, or expose for sale, plant, transport or process any seed that is under a stop sale order issued under 11 AAC [34.045\(a\)](#) (3) or that is in violation of this chapter, without express approval of the director.

(f) No person may plant in this state any agricultural, vegetable, tree, shrub, or flower seed containing any prohibited noxious weeds listed in 11 AAC [34.020\(a\)](#) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC [34.020\(b\)](#) , except as provided in 11 AAC [34.030](#), without express written approval of the director, or as provided in (g) of this section.

(g) No person may use, sell, offer, expose for sale, give away, or transport for feeding, seeding, or mulching purposes any seed or grain screenings containing any prohibited noxious weed seed listed in 11 AAC [34.020\(a\)](#) or any restricted noxious weeds in excess of the maximum allowable tolerances listed in 11 AAC [34.020\(b\)](#), except as provided in 11 AAC [34.030](#), and except that the director may allow sale or transport of screenings for

(1) complete destruction;

(2) removal outside of the boundaries of the state;

(3) recleaning to the point of being in compliance with 11 AAC [34.020\(a\)](#) and (b); or

(4) processing to make the weed seed nonviable.

(h) No person may sell, offer, or expose for sale for seeding purposes, seed containing more than one and one-half percent by weight of all weed seed.

(i) No person may sell, offer, expose for sale or transportation, or transport a container or package of seed within this state unless the container or package of seed is labeled with a net contents statement, expressed by either weight, volume, or numerical count, except for seed being transported from an owner's field to a warehouse for storage, cleaning, or processing.

(j) No person may sell, offer for sale, or represent potatoes as seed potatoes unless the potatoes have been certified by the official seed certifying agency of the state or country of origin.

History: Eff. 10/28/83, Register 88;
am 10/28/87, Register 104

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.077.

Weed seeds in shipment

Whenever anything brought into a part of the state from another part of the state

or from any other state or foreign country is found to be infested with the seed of any prohibited noxious weed, the director will notify the owner or bailee of the shipment to return it to the point of shipment within 48 hours, and the owner or bailee of the shipment shall return it. If the director determines that the seeds can be destroyed by treatment, the shipment may, at the option and expense of the owner or bailee, be treated under the supervision of the director, and may be released after treatment.

History: Eff. 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.080.

Penalties

Penalties for violation of this chapter are as provided in [AS 03.05.090](#).

Authority: [AS 03.05.010](#) , [AS 03.05.030](#) , [AS 03.05.090](#)

11 AAC 34.085.

When penalties not applicable

No person may be subjected to the penalties of [AS 03.05.090](#) for selling, offering, exposing for sale, or transporting in this state any agricultural or vegetable seed that;

(1) is incorrectly labeled or represented as to kind and variety or origin, and which cannot be identified except by a field test, when that person

(A) obtains an invoice or grower's declaration stating the kind, or kind and variety, and origin, if required;

(B) takes the invoice or grower's declaration in good faith; and

(C) takes other precautions as are reasonable to insure the identity of the seeds to be as stated;

(2) does not conform to the label on the container, but is within the tolerances authorized by the director under this chapter; or

(3) is in violation of this chapter, but is allowed sale or movement under specific written permission of the director.

History: Eff. 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.090.

Records

Each person whose name appears on the label as handling agricultural or vegetable seed subject to this chapter shall keep for two years a complete record of each lot of agricultural or vegetable seed handled, and shall keep for two years a file sample of each lot of seed after final disposition of the lot. All records and samples pertaining to the shipment or shipments involved must be accessible for inspections by the director or his designated agent during customary business hours.

History: Eff. 10/28/83, Register 88

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.100.

Expense of treatments

Any treatment which may be required under the provisions of this chapter shall be at the risk and at the expense of the owner or persons in charge or in possession thereof at the time of treatment unless otherwise provided.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

ARTICLE 2

11 AAC 34.105.

Quarantine officers

(a) The director is an enforcing officer of all laws, rules and regulations relative to the prevention of the introduction into, or the spread within the state of pests.

(b) The director and such inspectors as he may appoint, holding valid certificates of eligibility for the office to which they have been appointed, are hereby designated State Plant Quarantine officers for the purpose of certifying to the pest condition or pest treatment of shipments, when certification as a condition of movement is officially required, and for the purpose of enforcing of laws, rules and regulations, relative to plant quarantine.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.110.

Pest certificate fees

The director may establish a schedule of fees for any or all classes of certificates to be paid by shippers requesting such certificates. Upon receipt of such scheduled fee, or in the event no schedule has been established, then upon request of the shipper it is the duty of the director to make such inspection as may be necessary to determine the facts required by the state or country of intended destination and to issue a certificate stating the facts determined; provided, that no fee shall be charged for certification required by any law, regulation, or requirement of the United States or of this state. The schedule of fees established for such certificates shall be based upon the approximate cost of the inspection made therefor.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.115.

Appeals from director's decision

(a) In cases relative to the prevention of the introduction into, or the dissemination within the state of pests, any interested person aggrieved by any action or order of the director may appeal in writing to the office of the director within five days after notice of action or order where there is no time limit upon such action or order, and in cases where a time limit is fixed, within such time limit. In cases where the director is empowered to, and does take summary action, no appeal may be taken.

(b) Appeals will be heard by the director within 10 days after receipt thereof upon notice to all interested parties and his decision shall be final.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.120.

Federal-state cooperation

Whenever quarantine regulations are established under this chapter, if there are any authorities or officers of the United States having authority to act in such matter, or any part thereof, the director shall notify such authorities or officers and seek their cooperation as far as possible. When any article is found to have been transported into this state from any other state, or district of the United States, in violation of the provisions of a quarantine established by the Secretary of Agriculture of the United States, such article shall be subject to seizure, destruction or other disposition to the same extent and in the same manner as if such article had originated in this state and was in violation of a provision of this chapter.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.125.

Inspection stations

To prevent the introduction into, or the spread within this state, of pests, the director may maintain at such places within this state as he deems necessary quarantine inspection stations for the purpose of inspecting all conveyances which might carry plants or other things which are or are liable to be infested or infected with pests.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.130.

Quarantine regulations: inspections

(a) The director may establish, maintain and enforce such quarantine regulations as he deems necessary to protect the agricultural industry of this state from pests, by establishing quarantine at the boundaries of this state or elsewhere within the state. He may make and enforce such rules and regulations as are necessary to prevent any plant or thing which is or is liable to be infested or infected by or which might act as a carrier of any pest, from passing over any quarantine line established and proclaimed pursuant to this chapter. The person conducting the inspection shall not permit any such plant or thing to pass over the quarantine line during quarantine, except upon a certificate of inspection and release signed by him.

(b) No person shall conceal from plant quarantine officers any plant or fail to present the same or any quarantined article for inspection at the request of such officer.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.135.

Form of certain regulations

All quarantine regulations involving another state, district, or foreign country will be adopted by the commissioner and will be approved and proclaimed by the

SEED REGULATIONS: 11 AAC 34.135 - 34.150

governor. A proclamation will be signed in duplicate. The original proclamation will be filed in the office of the lieutenant governor and a copy in the office of the director before it takes effect.

History: In effect before 7/28/59;
am 10/28/83, Register 88

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.140.

New pests

Upon information received by the director of the existence of any pest not generally distributed within this state he shall thoroughly investigate the existence and probability of the spread thereof. He may also establish, maintain and enforce quarantine and such other regulations as are in his opinion necessary to circumscribe and exterminate or prevent the spread of such pest. The director may disinfect, or take such other action with reference to, any plants or things infested or infected with, or which in his opinion may have been exposed to infection or infestation by, any such pest, as in his discretion shall seem necessary.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.145.

Permits for pest shipment

No pest, live insect or disease may be imported into or shipped or transported within the state except for the purpose of identification, unless such shipment or transportation is authorized under written permit and the regulations of the director or the United States Department of Agriculture. Any unauthorized shipment shall be returned to the point of origin, shipped out of the state, or destroyed within 48 hours at the expense of the owner or bailee.

History: In effect before 7/28/59

Authority:

[AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.150.

Notification of quarantined articles

Any person who transports, receives or imports into the state any things, or any

SEED REGULATIONS: 11 AAC 34.150 - 34.165

plants against which quarantine has been established and who fails immediately after the arrival thereof to notify the director of their arrival, and to hold them for immediate inspection by the director, without unnecessarily moving them, or placing them where they may be harmful, is in violation of this section.

History: In effect before 7/28/59

Authority: [AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.155.

Release from inspection

The director may designate certain plants arriving from certain areas not for planting, propagation or ornamental purposes within this State which may be released without inspection, if he finds upon investigation that such plants from such areas are not liable to cause the introduction of pests into the state.

History: In effect before 7/28/59

Authority: [AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.160.

Right to inspect

The officer making the inspection may enter at any time into any conveyance or place within the state where the said plants or things are located, to ascertain whether they are or are liable to be infested or infected with any pest.

History: In effect before 7/28/59

Authority: [AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.165.

Labeling and certificates

Each shipment of plants, brought into this state, shall have legibly marked thereon in a conspicuous manner and place the name and address of the shipper or owner, the name of the person to whom the same is forwarded or shipped, or his agents, the name of the country or state where the contents were grown, and a statement of the contents therein. Also each shipment of plants, grown in a country or state which maintains inspection of plants, shall be accompanied by a copy of a current inspection certificate from such country or state.

History: In effect before 7/28/59

Authority: [AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

11 AAC 34.170.

Destruction or treatment of pests

When any shipment of plants brought into this state is found infested or infected or there is reasonable cause to presume that it may be so infested or infected with any pest, the shipment shall be immediately destroyed by, or under the such pest may be exterminated by treatment or processing prescribed by the director, and it is determined by the inspecting officer that the nature of the pest is such that no damage can be caused to agriculture in this state through such treatment or processing, or procedure incidental thereto. In such case, the shipment may be so treated or processed at the expense of the owner or bailee in the manner, and within the time specified by the inspecting officer, under his supervision, and if so treated or processed, upon determination by the enforcing officer that the pest has been exterminated, the shipment may be released.

History: In effect before 7/28/59

Authority: [AS 03.05.010](#) , [AS 03.05.030](#) , [AS 44.37.030](#)

11 AAC 34.180.

Treatment of appliances

(a) To prevent the dissemination of pests through the agency of appliances, the director will, in his discretion, publish a list of pests that can be carried that way and designating the appropriate treatment for appliances.

(b) No person may ship or move any used appliances unless he furnishes to the director proof satisfactory to the director that the appliances have not been exposed to infestation or infection by any pests, or that the appliances have been treated immediately before shipment or movement in the manner designated by the director.

History: In effect before 7/28/59;
am 10/28/83, Register 88

Authority: [AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

Definitions

11 AAC 34.400.

Definitions

The terms used in this chapter are construed to conform insofar as possible with the terms used in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations issued under that Act. Unless the context indicates otherwise, in this chapter

(1) “*advertisement*” means representation other than on labels, disseminated in

any manner or by any means relating to seed within the scope of these regulations;

(2) “*agricultural seeds*” means the seeds of all domesticated grasses and cereals, and of all legumes and other plants grown as turf, cover crops, forage crops, fiber crops or field crops and mixtures of the seeds;

(3) “*appliance*” means box, tray, container, ladder, tent, vehicle, implement, or any other article which is or may be used in connection with the planting, growing, harvesting, handling, or transportation of an agricultural commodity;

(4) “*bailee*” means a person who, by warehouse receipt, bill of lading, or other document of title, acknowledges possession of goods and contracts to deliver them;

(5) “*certified*,” as applied to bulblets, tuber, or horticultural plants or to agricultural, vegetable, tree, shrub, flower, or cereal grain seed, means inspected and labeled by and in accordance with the standards and rules and regulations of the official certification agency or in accordance with similar standards established by a similar authority in another state, country, or territory;

(6) “*certified seed potatoes*” means potatoes used for planting a crop, that have been officially certified as “foundation seed” or “certified seed” by an authorized inspector, in a manner approved by the director, or, in the case of seed imported into the state, meets the certification standards of the Association of Official Seed Certifying Agencies;

(7) “*commercial production*” means products not grown exclusively for use or consumption by the producer;

(8) “*director*” means the director of the division of agriculture, Department of Natural Resources, or the director’s authorized agent;

(9) “*flower seed*” includes seed of herbaceous plants grown for their blooms, ornamental foliage, or other ornamental parts which is commonly sold under the name of flower seed in the state;

(10) “*labeling*” means all labels and other written, printed, or graphic representations in any form whatsoever, whether attached to, or accompanying and pertaining to any seed, whether in bulk or in containers and includes invoices;

(11) “*lot*” means a definite quantity of seed identified by a lot number or other mark, every portion of which is uniform within the recognized tolerances for the factors which appear in the labeling;

(12) “*mixed agricultural seeds*” means any lot of seeds that contains five percent or more by weight of each of two or more kinds of agricultural seeds;

(13) “*noxious weed*” means any species of plants, either annual, biennial, or perennial, reproduced by seed, root, underground stem, or bulblet, which when established is or may become destructive and difficult to control by ordinary means of cultivation or other farm practices; or seed of such weeds that is considered commercially inseparable from agricultural or vegetable seed;

(14) “*nursery stock*” means any plant for planting, propagation or ornamental use;

(15) “*other crop seed*” means that part of a lot or sample of seed that consists of the seed of cereal grain and agricultural and vegetable seeds other than those named on the label;

(16) “*packer*” means the person or firm putting the seed into its final container in preparation for sale as seed;

(17) “*person*” means a individual, partnership, corporation, company, society, association, or cooperative;

(18) “*pest*” means a form of animal life, plant life, or infectious, transmissible, or contagious disease of plants, that is or is liable to be dangerous or detrimental to the agricultural industry of the state;

(19) “*plant*” means a whole or part of a plant, tree, shrub, vine, fruit, vegetable, seed, bulb, stolon, tuber, corm, pip, cutting, scion, bud, graft, or fruit pip, and includes an article made from a plant;

(20) “*pure seed*,” “*germination*,” and other seed labeling and testing terms in common use are defined as the terms are defined in the Rules for Seed Testing (Volume 6, #2, 1981) published by the Association of Official Seed Analysts, Stone Printing Company, Lansing, Michigan, and in the Federal Seed Act (7 U.S.C. 1551 et seq.) and the regulations promulgated under it (7 C.F.R. 201 et seq.);

(21) “*restricted noxious weed seed*” means the seed of weeds which are very objectionable in fields, lawns, and gardens of this state, but which can be controlled by good cultural practices;

(22) “*shipment*” means an article or thing, which may be, is being, or has been transported from one place to another place;

(23) “*tree and shrub seed*” means seed of woody plants commonly known and sold as tree and shrub seeds in this state;

(24) “*vegetable seeds*” means the seeds of all crops which are being grown or which may be grown in gardens, privately or commercially, and which are generally known and sold under the name of vegetable seeds; and

(25) “*weed seed*” means a restricted noxious weed seed and any seed not included in the definition of agricultural seed when it occurs incidentally in agricultural or vegetable seeds.

History:

In effect before 7/28/59;
am 3/2/78, Register 65;
am 10/28/83, Register 88

Authority: [AS 03.05.010](#), [AS 03.05.030](#), [AS 44.37.030](#)

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ALASKA STAND ALONE PIPELINE/ASAP PROJECT

Analysis of Potential Indirect Impacts to Wetlands Related to Buried Pipeline Construction

ASAP-22-RTA-ENV-DOC-00002
April 12, 2018

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REVISION HISTORY

REV. NO.	APPROVED DATE	REVISION DESCRIPTION	FUNCTIONAL OR PROJECT MANAGER APPROVAL
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B	2/17/2017		KS
B1	3/10/2017	Minor tech edits	KS
C	4/12/2018	Updated with Revised Footprint and PJD Wetlands	KS

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ACRONYMS AND ABBREVIATIONS

ACP	Arctic Coastal Plain
AGDC	Alaska Gasline Development Corporation
ASAP	Alaska Stand Alone Pipeline
bgs	Below ground surface
CRREL	Cold Regions Research and Engineering Laboratory
ft	feet / foot
GIS	Geographic Information System
HDD	horizontal directionally drilled
HGM	hydrogeomorphic
in	inch
m	meters
MAGT	mean annual ground temperature
MP	milepost
PHMSA	Pipeline Hazardous Material Safety Administration
PJD	Preliminary Jurisdictional Determination
ROW	right-of-way
RSP	Revegetation and Stabilization Plan
SEB	surface energy balance
SEIS	Supplemental Environmental Impact Statement
SPCO	State Pipeline Coordinator's Office
TAPS	Trans-Alaska Pipeline System
TAZ	Thaw Affected Zone

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USACE U.S. Army Corps of Engineers

USDOT U.S. Department of Transportation

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Attachment 2 – Thaw Affected Zone GIS Methodology Overview

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1. INTRODUCTION

1.1 PURPOSE

The USACE Alaska District, in coordination with the USACE Cold Regions Research and Engineering Laboratory (CRREL), has requested that AGDC provide an analysis of whether abutting or adjacent wetlands outside the construction ROW would be impacted by indirect thaw to permafrost in undisturbed areas over the life of the project. This report provides an analysis and additional modeling to address this question.

1.2 CONSTRUCTION OF ASAP THROUGH PERMAFROST REGIONS

The Alaska Gasline Development Corporation (AGDC) has proposed to construct and operate the Alaska Stand Alone Pipeline (ASAP) as a means to transport natural gas from Prudhoe Bay to Southcentral Alaska. ASAP will require the construction of a 733-mile long, 36-inch diameter pipeline that will be buried, except at select fault crossings, bridged stream crossings, and block valve locations. The pipeline will be constructed in different permafrost regions, as generally noted in Jorgenson et al. (2008). A review of literature and geotechnical data helped to determine mainline milepost ranges for three permafrost zones, as follows:

- Continuous Permafrost: MP 0 – MP 168
- Discontinuous Permafrost: MP 168 – MP 634
- Sporadic Permafrost: MP 634 – MP 733

AGDC provided the USACE with a *Joint Application for Permit – Revised* that included typical drawings depicting pipeline engineering for different modes, seasons, and regions (AGDC 2015). The pipeline construction right-of-way (ROW) width has been proposed as a nominal 120ft-wide corridor that will also include wider areas for special design, side slope cut-and-fill, and temporary workspace. The pipeline will be revegetated following construction and maintained during the operational phase (AGDC 2016a,b). The permanent ROW has been proposed as a nominal 53ft-wide corridor that will also include wider areas for maintaining the stability of the ROW that is impacted during construction.

1.3 DIRECT IMPACTS TO WETLANDS AND UPLANDS

ASAP's direct impacts to wetlands were originally reported to the USACE in the December 2015 *Joint Application for Permit – Revised* (AGDC 2015) and in AGDC's *Environmental Evaluation Document* (AGDC 2016a). Direct impacts to wetlands were avoided and minimized to the extent practicable and will be mitigated through procedures described in the application and in AGDC's

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forthcoming final *Wetlands Compensatory Mitigation Plan*. Potential indirect impacts were originally reported in early 2017. In Fall 2017, approximately a dozen changes to the ASAP project footprint were documented by AGDC, most of which were in response to public comment. Following receipt of a preliminary jurisdictional determination (PJD) from the USACE for wetlands on March 30, 2018, AGDC overlayed the new project footprint with wetlands data contained within the PJD database.

Following these procedures, AGDC reports direct impacts to wetlands totaling approximately 9,704.83 acres, of which 8,014.86 acres will be attributed to permanent impacts to freshwater wetlands, when temporary impacts to freshwater wetlands and any impacts to intertidal / subtidal wetlands are tabulated separately. The Project will also directly impact 11,788.20 acres of uplands. The ASAP project footprint comprising all permanent and temporary direct impacts to wetlands and uplands will be 21,493.04 acres.

1.4 THE POTENTIAL FOR INDIRECT IMPACTS TO WETLANDS THROUGH PERMAFROST THAW

As noted above, the USACE Alaska District, in coordination with the USACE Cold Regions Research and Engineering Laboratory (CRREL), has requested that AGDC provide an analysis of whether abutting or adjacent wetlands outside the construction ROW would be impacted by indirect thaw to permafrost in undisturbed areas over the life of the project. During pipeline construction, ground disturbing activities within the ROW that would impact the organic layer, such as clearing, grading, grubbing, compression, or the use of a gravel work pad, can affect surface albedo, vertical and lateral heat flux or transfer, and subsequently, thaw of permafrost. Roads and facility pads are of lesser concern because thicker gravel pads required for these facilities have insulative properties that mitigate against thaw.

The buried ASAP pipeline was designed to receive gas from a conditioning facility at 30°F and operate at ambient ground temperatures that would range from 8°F to 30°F on the North Slope within the continuous permafrost zone (AGDC 2016a). The pipeline will operate at slightly warmer ground temperatures in the more southerly discontinuous and sporadic permafrost regions. Indirect thaw of permafrost outside the area of direct impact has the potential to occur. The driver for this indirect thaw is a change in heat balance that could result from disturbance of the organic layer within the ROW during construction (e.g., damage to or compression of the organic layer, vegetative clearing, and gravel pad placement, if applicable).

AGDC intends to institute a comprehensive monitoring program and will employ several mitigative measures to offset and minimize indirect impacts to wetlands, including a revegetation program that allows for the recolonization of the ROW by native species in non-sensitive areas and the immediate revegetation of the ROW through re-seeding in sensitive areas (AGDC 2016e). The program will employ continual detection and field maintenance activities (AGDC 2016b,e) and the use of thermosyphons or additional ditch plugs (described in AGDC 2016b) in select areas (AGDC

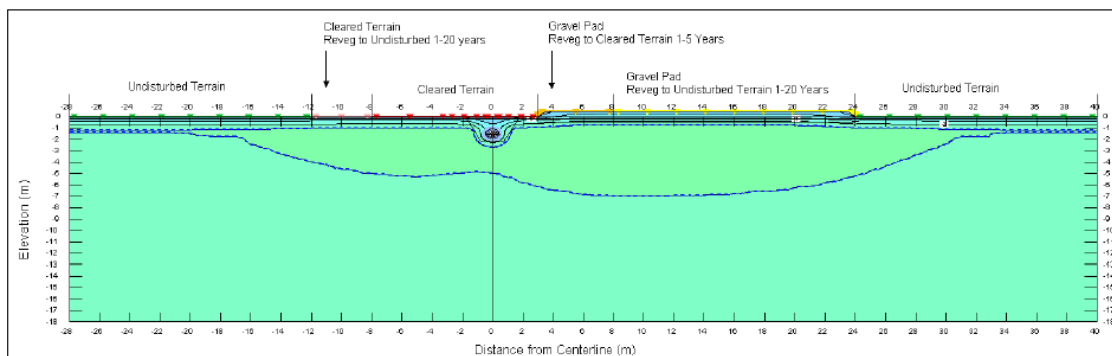
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2016c; see also Section 7, below). Thermosyphons would be used in select areas of discontinuous permafrost where greater permafrost stability near the surface is required; field monitoring crews observing issues such as slumping or reports of suspected thaw by in-line inspection may lead to thermosyphon placement. Thermosyphons have been used historically for areas along the TAPS ROW and for other projects, such as the Alpine horizontal directionally drilled (HDD) crossing of the Colville River. Additional ditch plugs could be used where newly identified water management efforts are required. In rare instances, where thaw or slumping are identified around permanent facilities that cannot be moved (e.g., block valves) and where a power supply is available, a stationary active refrigeration unit may be employed.

AGDC's initial geothermal modeling shows that with revegetating the ROW in discontinuous permafrost terrain, the indirect permafrost thaw affected zone (TAZ) over a period of 30 years will be limited to less than 10m (35ft) beyond the directly impacted area (AGDC 2016c; Figure 1). USACE CRREL have agreed that these modeling procedures are sound and have generally agreed with the approach and results (personal communication with Kevin Bjella, USACE CRREL, as noted in Meeting Minutes from a USACE / AGDC Supplemental Environmental Impact Statement (SEIS) Progress Meeting on November 29, 2016). A robust monitoring program and other mitigative options and monitoring could further limit indirect thaw (see Section 7 for mitigative options and AGDC 2016b for monitoring program details). It is important to note, therefore, that limited indirect thaw to permafrost beneath a wetland will not necessarily result in an indirect impact to that wetland's function or value (i.e., limited, acute permafrost impact does not necessarily equate to wetland impact).

The mechanism by which indirect wetlands impacts could potentially occur would be through thaw settlement (vertical subsidence) of lands that would create a slight downward vertical ground surface displacement and a possible avenue for drainage of surface water from perennially or intermittently saturated soils. An approximately 1m thaw settlement estimate was based on approximately 5m of thaw depth below the undisturbed active layer in discontinuous permafrost terrain with an assumed 20% thaw strain. A 20% thaw strain (thaw settlement per thaw depth) of maximum subsidence is a reasonable expectation as to what would actually be observed in the field (as noted in personal communication with Kevin Bjella, USACE CRREL, as noted in Meeting Minutes from a USACE / AGDC SEIS Progress Meeting on November 29, 2016). This estimate is based on geotechnical data, permafrost modeling, knowledge of soil, hydrologic, and vegetative characteristics along the ROW, experience and engineering judgment. The potential for wetlands to be indirectly impacted due to subsidence and subsequent drainage of saturated soils varies according to region and permafrost type.

Figure 1. ROW Thaw Depth for Discontinuous Permafrost (in meters)



Notes: The Construction ROW having a nominal width of 120ft (approximately 36m, as 1m = 3.281ft) exists from approximately -12m to 24m on the lateral plane, above.

1.4.1 Continuous Permafrost (MP 0 to MP 168)

The area of continuous permafrost traversed by the pipeline (MP 0 to MP 168), is of smaller concern for indirect impacts to wetlands than in discontinuous permafrost for several reasons. First, the direct impact width will be much smaller on Alaska's Arctic Coastal Plain (ACP) (MP 0 to MP 62) due to mitigative measures that can be implemented in this region, such as the use of ice roads and ice workpads. The main impact from MP 0 to MP 62 will be through burying the pipe in a 5ft wide ditch, with an additional two feet of approximate cover on either side to account for the toe of the slope of the mound over the ditch, which would settle in spring. Trench spoils and refill would therefore result in a 9ft wide corridor of direct impact to wetlands for the first 62 miles, a much narrower direct impact corridor than in discontinuous regions. South of MP 62, the route enters the foothills of the Brooks Range, with sloped terrain that requires a different construction mode and working to construct the pipeline off gravel, but which still allows for ice access roads to be used.

The continuous permafrost area is characterized as having an active layer thickness of around 2ft (24 inches) (AGDC 2016b). Since the sub-freezing pipe will be surrounded by perennially frozen soils, the cold ground temperature will limit lateral thaw. Where the pipe is relatively warm (30°F at MP 0) the active layer depth near the trench would increase somewhat. Geothermal modeling shows that this increased active layer depth would diminish rapidly within 20ft laterally from the trench centerline (see Section 2.3.1 and Figure 6, below). The pipe would become cooler with increased distance from MP 0. The soils in the impacted area adjacent to the trench will re-freeze in winter and will remain frozen for approximately three-quarters of the year. The soils directly around the sub-freezing pipe will remain frozen throughout the year.

Third, being surrounded by perennially frozen soils and, in the case of the ACP, relatively flat terrain means that even if thaw and subsidence did occur, saturated soils would not necessarily be able to drain, especially if in a flatter area. Drainage of wetlands would be hindered by surrounding permafrost. To keep water from flowing into and along the area where the pipe is buried, pipeline

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engineers intend to use common engineering practices for buried pipelines in wet areas, including ditch plugs and surface crowning, as needed (AGDC 2016 a,b,d). These practices will limit the flow of water along the pipe and help to maintain wetlands adjacent to directly impacted areas.

1.4.2 Discontinuous Permafrost (MP 168 to MP 634)

The area of discontinuous permafrost traversed by the pipeline (MP 168 to MP 634) is characterized by wide variability in the physical environment, including permafrost presence and active layer depth. Similar to the other permafrost regions, the variability in terrain unit classification also varies widely. Terrain units are subsets of land area classified by soil types that can often be characterized as either thaw-stable or thaw-unstable material. For most of this region, the pipe would cool to ambient ground temperature or cooler due to Joule-Thomson cooling.

The area of discontinuous permafrost is variable in elevation, slope, ground temperature, and wetlands type. Certain wetland types are also often associated with permafrost presence or absence. Delineated wetlands can be classified as low, medium, or high potential for permafrost to be present beneath them. Thus, the potential for indirect impacts to permafrost, thaw settlement, and subsurface drainage of wetlands is also highly variable in this region. Several years after construction, the area beneath vegetation in the indirect TAZ would be able to hold more water than before construction, but this would not necessarily impact wetland functions or values in the TAZ.

1.4.3 Sporadic Permafrost (MP 634 to MP 733 and FLMP 0 to FLMP 30)

The area of sporadic permafrost (often referred to as a ‘no permafrost’ area) traversed by the mainline (MP 634 to MP 733) is characterized by a general lack of permafrost or by sporadic, patchy permafrost areas. There is a very low probability of permafrost occurring in this region and therefore indirect impacts to wetlands due to permafrost thaw, thaw settlement, and drainage are not likely to occur. The Fairbanks Lateral traverses approximately 99% uplands, further reducing the possibility for indirect impacts to wetlands.

1.5 OVERALL APPROACH

The USACE has requested that AGDC report where indirect impacts to wetlands could potentially occur outside of the pipeline ROW. AGDC has developed methodology to provide this information to the USACE. AGDC will use a screening approach to eliminate areas where there is a low likelihood for impacts to occur to wetlands outside the Project ROW (Figure 2). AGDC has applied these screens, or filters, through a GIS-based approach (Attachment 2) that will remove areas where wetlands have a low likelihood of being directly impacted. The resulting areas not eliminated through this process are a subset of potentially susceptible pipeline segments within which wetlands could be indirectly impacted by additional permafrost thaw.

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Figure 2. Route Application Methodology

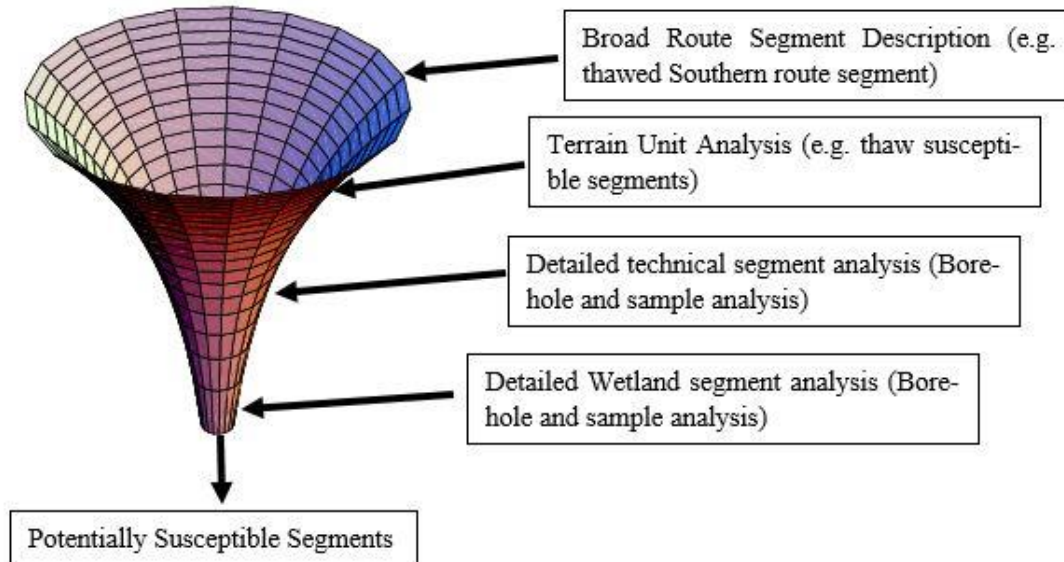
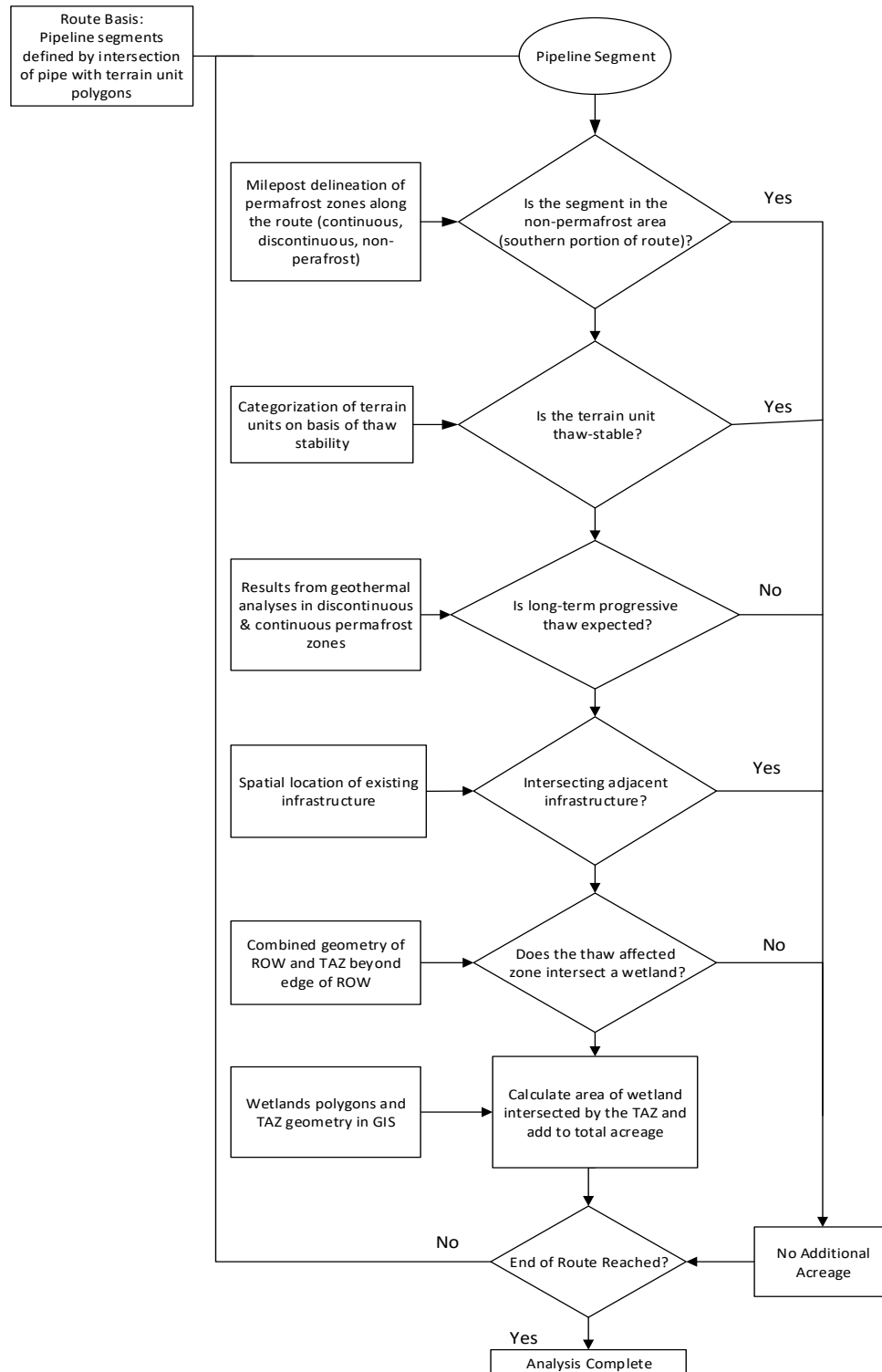


Figure 3 shows a detailed Route Assessment Methodology Flowchart used to determine the areas in which wetlands outside of the pipeline ROW could be impacted indirectly by construction over a 30-year period. It is discussed generally in this section, but in greater detail in Section 3.

The methodology begins by determining whether the route segment is in an area characterized by continuous, discontinuous, or sporadic permafrost. It then categorizes terrain unit data within the ROW on the basis of thaw-stability. Results from geothermal analysis determine whether long-term thaw is expected. The spatial location of existing infrastructure (roads, railroads, powerline, TAPS Crossings, etc.) bisecting the pipeline ROW and the indirect TAZ is then assessed to determine where permafrost is already thawed by existing infrastructure or where the permafrost is preserved with thick, insulative gravel pads near existing infrastructure.

Next, the methodology explores whether the defined TAZ could indirectly impact a wetland. The area of wetlands potentially affected are then assessed to tabulate a total wetlands impact acreage. This resulting acreage of potential indirect wetland impacts is then be categorized by wetland type to provide greater detail to the reader.

Figure 3. Route Assessment Methodology Flowchart



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2. GEOTHERMAL ANALYSIS OF ROW

Geothermal analysis has been used to evaluate the effect of thermal disturbance from construction and operations on long-term thaw depths along the ASAP ROW (AGDC 2016c; Attachment 1). Geothermal analysis accounts for several important variables affecting soil temperatures including, soil material properties (such as thermal conductivity, soil moisture content, and latent heat), thermal boundary conditions (such as energy exchange at the ground surface and heat transfer between the operating pipe and the surrounding soil), and phase change and the associated latent heat of soil moisture.

In the context of route thaw settlement, geothermal analysis provides a quantitative method to determine long-term thaw depths both below the disturbed ROW and below the pipe, if any. For the pipe, the resultant thaw depth allows further analyses to evaluate potential pipe thaw settlement as required for assessing pipeline integrity. For the ROW, the geothermal analyses enable evaluation of thermal disturbance effects from construction and operations along the route and, of particular focus, the potential effect on route wetlands. It is this latter effect that is the focus of the current study with respect to wetlands outside the ROW.

The principal tool for geothermal analysis on the Project is TEMP/W, a commercial finite element program for heat transfer with the ability to evaluate the effects of phase change in the soils. It simulates the heat transfer within the ROW cross-section to determine long-term thaw depth. The modeled domain is discretized into small areal extents (finite elements) which individually evaluate the localized heat transfer within this area. When assembled, the individual elements collectively can model extensive regimes with varying constraints and conditions. Input data, simulation methodology, and results for thaw depth and ROW settlements for these finite element analyses are described in this chapter.

2.1 ROW CONSTRUCTION MODES

The ASAP report entitled *Design Basis - Pipeline* (AGDC 2016d) describes considerations given to the varying terrain and climatic conditions along the ROW, as well as additional considerations such as seasonal constraints and construction scheduling. Several ditch and ROW configurations or ‘modes’ were defined to accommodate these anticipated conditions along the proposed alignment. These construction modes were developed and intended to ensure long-term integrity of the pipeline and to protect nearby foreign structures and the environment.

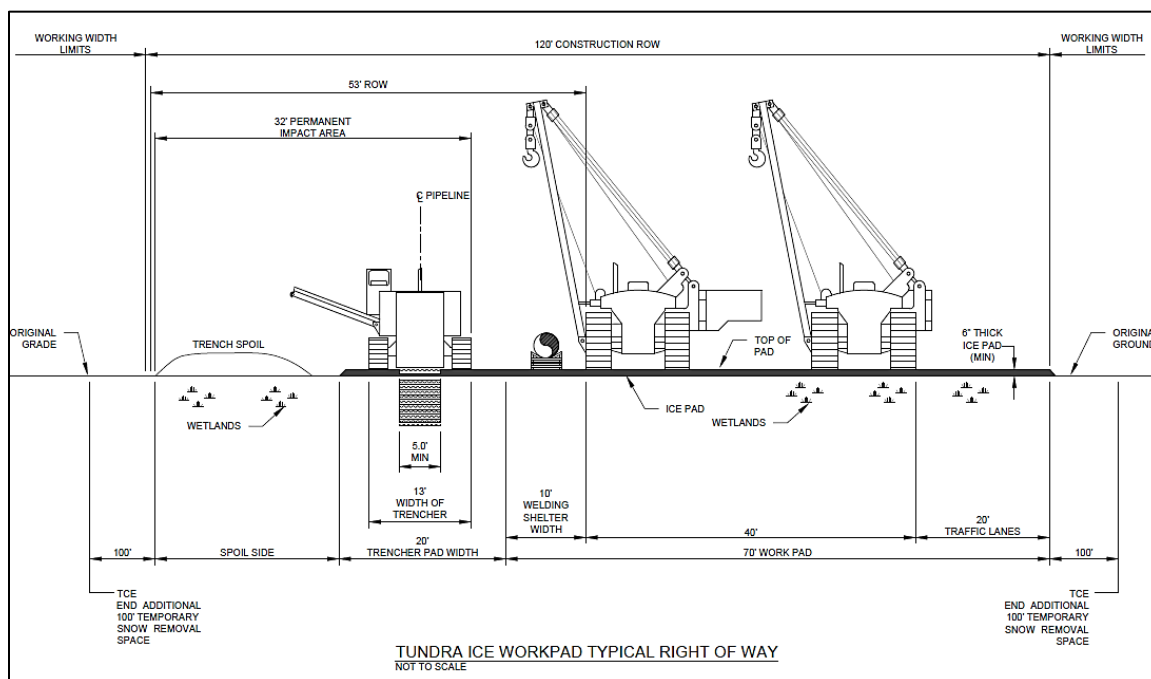
2.1.1 Continuous Permafrost

For the ACP, which is underlain by continuous permafrost, an ice pad will be used in lieu of a gravel pad, which is typical for North Slope construction. The pipeline ROW configuration is

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planned to be 120ft wide (Figure 4), nominally, although the direct impact to wetlands will be defined by a 9ft-wide impact corridor for the first 62 miles (. Construction will require a 90ft wide ice pad thick enough to support construction traffic on one side of the pipe centerline, and an adjacent area for trench spoil. After the construction season, the ice road will naturally thaw and, as is typical, a negligible effect on the tundra is expected. South of MP 62, construction will require equipment to work from a gravel workpad (AGDC 2015), similar to Figure 5.

Figure 4. Construction ROW for Continuous Permafrost on ACP



(WBaker USACE_ROW-22 08/May/2015)

2.1.2 Discontinuous Permafrost

The typical pipeline ROW configuration in discontinuous permafrost is planned to be 120ft wide, nominally, as depicted in AGDC 2015 and in Figure 5. This includes an 18in thick, 70ft wide gravel pad on one side of the pipe centerline, and a 30ft wide cleared area for trench spoil, each setback 10ft from either side of the pipe centerline. After one construction season, the permanent ROW is planned to be 53ft wide and centered over the pipe. The remainder of the pad outside of the permanent ROW will be scarified by ripping (i.e., cultivation), which will aerate the surface of the land and prepare it as a seedbed for natural colonization of vegetation (AGDC 2016e). With time, grasses and shrubs and eventually trees (in originally treed areas along the route) will revegetate the ROW. After three years, re-seeding with a prescribed seed mix will be considered if minimum ground cover standards are not met, per the ASAP Revegetation Plan (AGDC 2017). Any young trees colonizing the permanent 53ft Mainline ROW would be cleared during operations, while those beyond the 53ft ROW to the edge of the 120ft temporary construction ROW would be allowed to

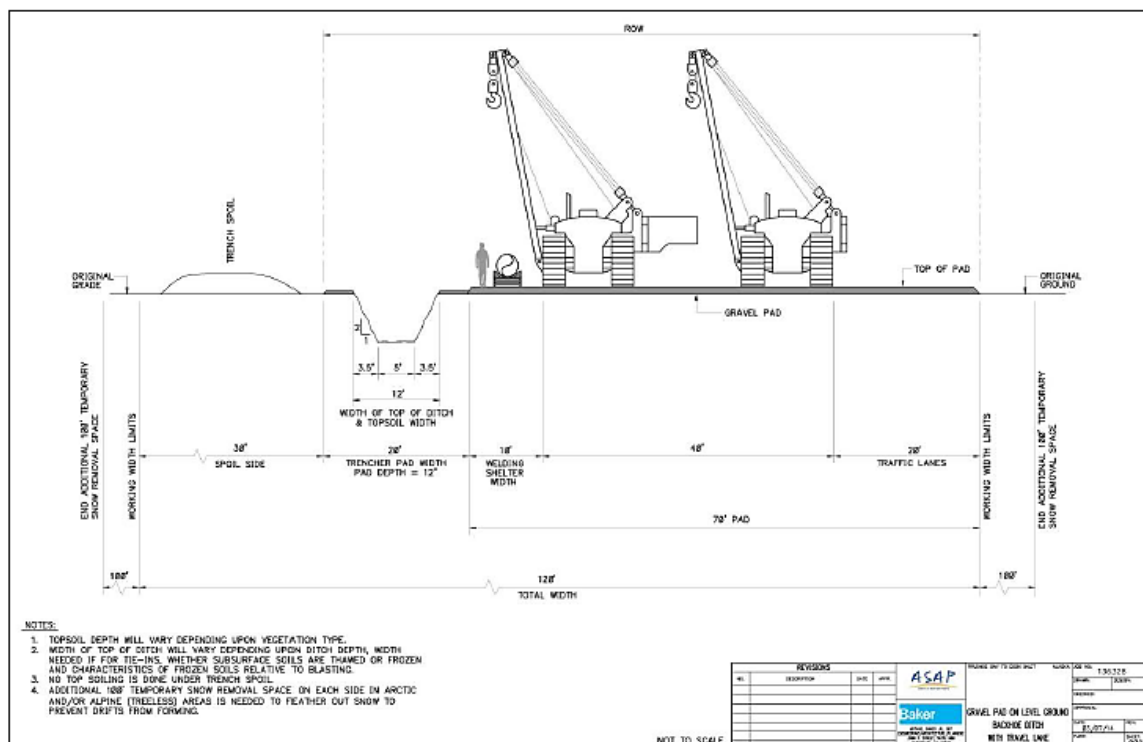
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grow unhindered. This process of scarifying and revegetating would maintain the integrity of the land and would be less damaging than gravel removal.

Figure 5. Construction ROW for Discontinuous Permafrost



2.1.3 Sporadic Permafrost

In areas of sporadic or no permafrost in upland areas, the typical construction ROW configuration is to grade the surface. The working surface is 120ft wide and is configured similar to Figure 5 without the addition of the gravel pad.

2.2 DEVELOPMENT OF THE GEOTHERMAL MODEL

Modeling subsurface geothermal conditions requires establishment of an overall geothermal modeling approach, definition of the domain geometry, assembly of several material properties and boundary conditions, and proper model calibration. Geothermal modeling was undertaken to answer specific questions that arose as a result of an engineering design and/or a change to thermal conditions such as construction disturbance and operational conditions. Once the main objective of a geothermal analysis was established, it was necessary to undertake the modeling effort to meet the specified objectives.

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The modeling procedure to determine the effects of the construction disturbance and pipeline operating conditions on the subsurface through time during the design life was described in detail in Chapter 3.2 “Modeling Subsurface Geothermal Conditions” in *Identification and Evaluation of Time-Dependent Route GeoHazards* (AGDC 2016c). To accurately model the subsurface change for any segment along the pipeline, the report lists the data that must be assembled:

- Establish the domain geometry.
- Define soil material properties.
- Specify initial temperature conditions.
- Define thermal boundary conditions.
- Determine maximum simulation time.

Using these data, a further step is required to ensure that the model will accurately reflect the segment conditions:

- Calibrate the geothermal model to reproduce existing undisturbed conditions then apply variation to boundary conditions to simulate effects of construction and/or operations.

For this study, these same steps were followed for the two ROW models examined. The analysis for continuous permafrost was evaluated specifically for MP 0 because the gas treatment plant discharges gas continuously at 30°F, which represents the worst-case scenario for continuous permafrost. South of MP0, the pipe will lose heat to the soil and will have a temperature close to that of the ambient soil temperature, so deepening of active layer depth near the trench will be less south of MP0 than at MP0.

The models were not evaluated for any specific milepost route segment, but utilize reasonably conservative values for subsurface conditions susceptible to thaw settlement. Each step for this study is examined further:

- **Establish the Domain geometry** – the domain geometry is based on the construction mode assigned for the segment. The construction mode itself is determined by the nature of the surface features (rolling tundra, hilly, swampy...) as well as by the season designated for construction of the segment. The construction modes of interest for this report include the construction mode using only an ice road (typical on the North Slope and called the North Slope Model) and a mode using a gravel pad more typical in the area of discontinuous permafrost (termed the Discontinuous Model). The basis for the Discontinuous Model is detailed in AGDC 2016c - Appendix B, “Expected Long-Term Thaw Depths in Warm Permafrost on the ASAP ROW - Technical Memorandum” while the Basis for the North Slope Model is detailed in Attachment 1 of this report.
- **Define soil material properties** – the soil properties used for the analysis of the subsurface strata are generally developed using the route database. For the North Slope Model and

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Discontinuous Model, the subsurface soils were chosen as typical soils susceptible to thaw settlement. The subsurface soils were accordingly considered to be composed of a single stratum of this thaw susceptible material to depth.

- **Specify initial temperature conditions** – consistent with the soil material properties, the in situ thermal state of the subsurface is generally developed using the route database. For this analysis, since the focus was on potential settlement, the in situ condition of the subsurface was considered to be initially frozen to depth.
- **Define thermal boundary conditions** – the thermal boundary conditions employed a full surface energy balance (SEB) methodology, with the input definition of the various elements of the SEB (described in detail in Chapter 3.2.5 “Ground Surface Boundary Condition” of AGDC 2016c) consistent with the route region under investigation. The SEB datasets are defined to simulate an annual variation of the region based on available climatic data from adjacent climate and weather stations. The input conditions for the SEB models are not the same, therefore – those for the North Slope Model with a construction mode utilizing an ice pad, typical of the proposed construction on the arctic plain, utilized an SEB dataset consistent with the North Slope climate. The Discontinuous Model used an SEB dataset consistent with the discontinuous permafrost region in the Fairbanks area and is described further in Chapter 3.3 of Appendix B of AGDC 2016c, while the North Slope SEB model is described in detail in Attachment 1 of this report.
- **Determine maximum simulation time** – the simulations for both models were extended to 30 years after startup. As noted below, the startup of the simulations actually predates operational startup to more accurately reflect the in situ subsurface thermal conditions.
- **Calibrate the geothermal model** - to reproduce existing undisturbed conditions, some items of the SEB model can be varied so as to better reflect the in situ subsurface conditions, as described in Chapter 3.5 of AGDC 2016c. Typically, an SEB data element pertaining to the snow cover (i.e. snow conductivity) is varied within a typical range to match the mean annual ground temperature (MAGT) of the route segment being investigated. The calibration was separately carried out for the North Slope Model and Discontinuous Model to reflect the unique conditions of those regions. The calibration of the Discontinuous Model is described further in Chapter 3.4 and 3.5 of Appendix B of AGDC 2016c, while the North Slope calibration is described in detail in Attachment 1 of this report.

Each model with the calibrated SEB datasets for the in situ conditions were then run for a period of time before construction so as to establish the annual subsurface variation throughout the Domain that corresponds to the in situ condition. To model construction, the SEB dataset is changed accordingly to reflect changes in the surface albedo and vegetative cover and, as appropriate, additional infill material such as that for a gravel workpad.

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After the construction period, the pipe temperature is defined as an additional thermal boundary condition. The pipe temperature varies throughout the year, found through a separate pipeline hydraulic analysis. (For the current study, the pipe temperature has a minimal effect on the subsurface conditions at the edge of the ROW for the ASAP pipeline). Additionally, the effect of revegetation may be introduced during the operational period.

2.3 GEOTHERMAL MODEL RESULTS

2.3.1 Long-Term Thaw Depths in Continuous Permafrost

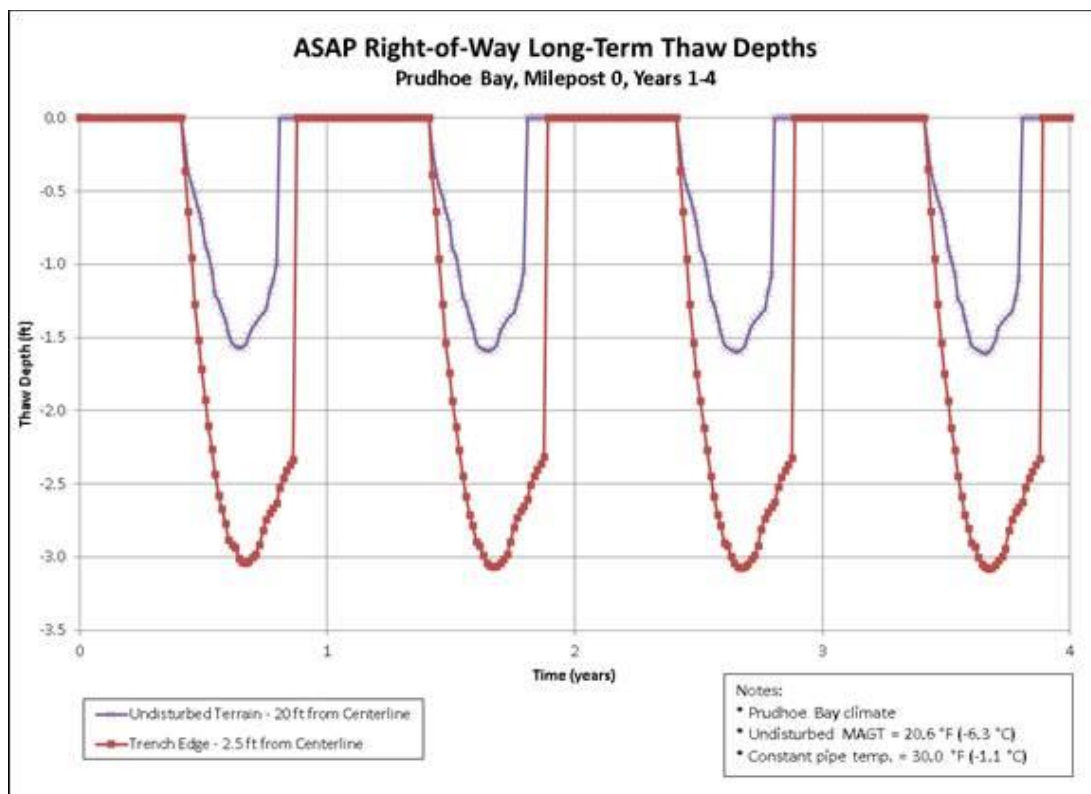
Geothermal modeling was completed to assess the long-term thaw depths in continuous permafrost where ground surface disturbance of the tundra terrain will be minimized by the use of ice workpads. With the tundra protected from construction disturbance, there is no expected change of the thermal regime on or adjacent to the ROW, with the exception of the ground disturbance at the pipeline trench. Additional ground warming will occur from the pipeline itself where the mean annual pipeline temperature (MAPT) is warmer than the mean annual ground temperature (MAGT) in undisturbed terrain. The gas treatment plant will supply gas into the pipeline at a constant temperature of 30 °F year-round causing the largest temperature contrast between MAPT and MAGT in continuous permafrost to occur at the pipeline inlet at milepost 0 (MP 0). For this reason, geothermal modeling to assess long-term thaw depths in continuous permafrost was performed at MP 0, details of which are provided in Attachment 1 of this report.

The geothermal modeling showed that at MP 0, deepening of the active layer in the undisturbed soils near the trench reaches maximum within a year or two after construction. Thereafter, the ground temperatures vary seasonally in periodic steady-state and progressive long-term thaw deepening does not occur. In addition, the active layer at the edge of the pipe trench is expected to be about 3.1ft deep as compared to an active layer depth of about 1.6ft in undisturbed tundra terrain. Beyond 20ft from the pipe centerline, modeling showed that the pipe and trench have practically no influence on the active layer depth.

Figure 6 shows the active layer depths from the geothermal modeling over the first four years of the simulation at the trench edge (2.5ft from pipe centerline) and at 20ft from the pipe centerline. This figure shows that the increase in active layer depth at the edge of the trench occurs in the first year and does not deepen in subsequent years. There is no long-term progressive thaw or ongoing active layer deepening beyond 20ft from the trench. In all areas (undisturbed and disturbed), summer warming causes thaw from the ground surface that deepens through the summer and into the early fall (Figure 6). During the fall when air temperatures descend below freezing, active layer freezeback occurs downward from the ground surface (not shown on Figure 6) and upward from the permafrost (as shown on Figure 6 by the decreasing thaw depth after a maximum thaw depth is reached). The final part of the active layer to refreeze is at a depth of about 1 foot in undisturbed terrain (as shown for the data at 20ft from the pipe centerline in Figure 6). At the trench edge, the expected active layer freezeback is at a depth of about 2.3ft.

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Figure 6. Expected Active Layer Depths Near-Pipe and in Undisturbed Terrain in Continuous Permafrost (MP 0)



2.3.2 Long-Term Thaw Depths in Discontinuous Permafrost

Geothermal modeling results to estimate long-term thaw depths in discontinuous permafrost are discussed further in Appendix B of AGDC 2016c. Figure 7 from that report (showing the expected 30-year thaw depth across the ROW in warm permafrost) is reproduced in this report as Figure 1 (note the figure axes are in meters). The thermal influence of the gravel pad extends beyond the edge of gravel pad by about 33ft in the case without an organic layer below the gravel pad which is the conservative case (the thermal influence extends beyond the edge of the gravel pad by about 26ft with an organic layer beneath the gravel pad). To be conservative in the route evaluation, an edge distance of 35ft on both sides of the ROW was used in the evaluation of all route segments that were determined to have a potential thaw settlement impact on wetlands.

2.4 ASSOCIATED THAW SETTLEMENT IN THE DISCONTINUOUS MODEL

The progression of the thaw depth for the Discontinuous Model is shown in Figure 9 of Appendix B of the *Time-Dependent Route Geohazards* report (AGDC 2016c) and is reproduced in Figure 1

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in this document, above, for the governing case of a gravel workpad without an organic layer beneath the gravel pad. As shown in Figure 1, the thaw depth at the end of the 30-year analysis for the gravel pad is 25ft below ground surface while the thaw depth for the cleared terrain (but without a gravel pad) is 18ft beneath the ground surface (note that diagrams may be in feet or meters). The active layer extends 6ft below the surface, so the depth of thaw below the active layer is 19ft and 12ft for the two sides, respectively. A value of 20% for the thaw strain is used as a reasonably conservative value, resulting in an estimate of 3.8ft and 2.4ft of thaw settlement for the two sides, respectively, at the end of the design life.

The thaw settlement builds gradually, *i.e.* the time progression of thaw settlement over the design life follows the thaw depth progression, multiplied by the thaw strain of 20%. (In the case of layered strata, the thaw strain would vary by a function of depth but in this homogeneous scenario the progression is straightforward). Thus, to evaluate the progression of thaw settlement with time, Figure 9 of Appendix B of the *Time-Dependent Route Geohazards* report (AGDC 2016c) is used with the vertical scale multiplied by 0.20. It can be seen that the thaw depth, and thus the thaw settlement, progresses over the design life with a diminishing slope as time progresses. As high ice contents are found in the upper level of the permafrost table, a high thaw strain is likely to be seen at the start of the Project. However, monitoring and mitigative actions during operations are designed to be effective in blocking consequential damages.

2.5 SECTION SUMMARY

To summarize, geothermal analyses were conducted to evaluate the effect of construction disturbance, and further operational conditions, on the ASAP ROW. The focus of this study was to define the lateral extent of the thermal change and, in particular, that extent beyond the established ROW. With the evaluation of the progression of the thermal effect with time, and using a reasonably conservative value of thaw strain, the amount of concomitant thaw settlement could also be estimated.

Two models were developed for this investigation. A model for the Discontinuous Permafrost region, using climatic conditions appropriate and calibrated for the Fairbanks region was previously developed and described in Appendix B of AGDC 2016c. An additional model for the North Slope, which utilizes an ice road instead of a gravel pad to support construction, was also developed and described in detail in Attachment 1 of this report. Both models followed identical approaches for data development, subsurface modeling, climatic definition, and model calibration.

The model for the Discontinuous Permafrost region results in a thermal impact outside the ROW of a maximum of 33ft for the case of the gravel pad without an organic layer beneath the pad. It is this evaluation that results in a conservative criterion of the use of 35ft on both sides of the ROW as the basis for further route evaluation, described further in Chapter 3.

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3. ROUTE APPLICATION

3.1 OVERVIEW

The geothermal evaluations that were conducted and reported in Chapter 2 utilized properties of the subsurface to find a conservative estimate of the thaw depth beneath the ROW and the associated thaw settlement. Subsurface properties can vary considerably along the ROW meaning that the conservative evaluation is not generally applicable. Some sections of the route are already thawed while other frozen sections have soils that are not susceptible to subsequent settlement upon thawing. As shown in Chapter 2, the very cold subsurface conditions of the arctic plain limit thaw settlement concerns even when thaw susceptible materials are present.

In the case of the identification of those route segments that may cause a detrimental thermal impact, ASAP used a stepped approach to identify those potentially problematic route segments. The approach, detailed below in Chapter 3.2, utilizes an increasingly fine screen to determine which route segments can be eliminated from the evaluation. The remaining route segments, i.e. those route segments that could not be eliminated based on any of the criteria for elimination, are then considered potentially problematic route segments. The process is depicted graphically in Figure 3, and described further in this Chapter. Note that the methodology allows for increasingly finer analysis of the route segments as they proceed down the funnel – such analysis depends, accordingly, on increasingly finer route segment data. The process both focuses further field determinations on those potentially problematic segments as well as determining the types of data that must be recovered. ASAP sees this as a continuing mission throughout design and continuing into Operations. Thus, the conservative evaluation discussed at this stage of ASAP design could be expected to be further refined as the project progresses and new data, whether from AGDC field investigations or incorporated from other relevant sources, is added to the project geodatabase and wetlands investigations.

3.1.1 Terrain Units

Terrain units are a mainstay of the technical route analysis and summarized further here – a more detailed description is contained in Chapter 7 of the *Time-Dependent Route Geohazards* report (AGDC 2016c).

Terrain units describe the morphology of a route area and consist of individual landforms that together, comprise the subsurface characterization. The depth or thickness of these landforms are generally described down to a prescribed distance below ground surface (bgs) although they can be extended, based on further borehole evaluations to the depth of the borehole. Two dimensional geological cross sections or 3D fence diagrams can then be created along the alignment.

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Engineering data, such visual soil descriptions, soils laboratory data, ground temperature measurements, and groundwater depth measurements are then related to specific landforms and terrain units. These are documented in the ASAP geotechnical database library for use in further engineering analysis. A GIS geospatial database is used to illustrate terrain units, borehole locations, LiDAR, orthoimagery, and other data pertinent to the pipeline corridor. The GIS forms an integral part of the geohazard identification, evaluation and avoidance of pipeline route hazards in the design process.

The data can be expected to be increasingly refined and detailed as the project matures. All data used for design and all analyses have been subjected to rigorous subject matter expert review. A typical Terrain Unit map is shown in Figure 7.

Figure 7. Terrain Unit Map Example



3.2 ROW EVALUATION METHODOLOGY

As described earlier, the ROW evaluation methodology employs a series of refinements that are designed to eliminate potentially non-susceptible segments. The remaining segments at the end of the analysis are considered potentially susceptible to thermal impact of wetlands.

The analysis starts with what are considered the easiest determinations to apply to the pipeline, such as the determination as to the route delineation in the discontinuous permafrost region, the

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consensus area of focus. With this determination, no further data is required to refine the deliberation concerning those deleted segments. The next step is based on the evaluation of the Terrain Units, which are described in Chapter 3.1.1. The route geotechnical evaluation concluded at this point. The summary of that evaluation is discussed further in Chapter 4. Results of this evaluation, again based solely on geotechnical evaluations, were then further analyzed for wetlands impacts.

The Terrain Unit Technical evaluation was based on a segment by segment breakdown of the route into those Terrain Units that intersected the ROW. The Project geodatabase provided the terrain unit takeoff with a series of pipeline segments defined by the intersection of the pipeline centerline with each terrain unit polygon along the route. For each of these pipeline segments the, “thaw settlement potential” was identified for each landform/physiographic region combination, (from the terrain unit properties table of June 28, 2014 in Attachment 1), to determine the worst case thaw settlement potential (low, moderate or high) for each pipeline segment.

The procedure is detailed below:

1. Physiographic regions
 - Each segment was assigned a number from 1 to 7 for each of the 7 physiographic regions encountered along the route.
2. Route Terrain Unit / Physiographic Region combinations
 - The Terrain Units were uniformly formatted for processing.
 - All unique physiographic region number and terrain unit combinations from the route were associated and tabulated.
3. Terrain Unit / Physiographic Region combinations
 - Terrain unit/physiographic region combinations were compared against the available combinations from the geotechnical summary.
 - The description to a category of low, moderate, or high were uniformly formatted
 - Example: “Low to Moderate (High if excess ice in voids and fractures)” would be “Moderate, i.e. the more conservative description is retained.
 - Terrain unit/physiographic region combinations that were not specifically covered in the ASAP terrain units spreadsheet were assigned assumed thaw settlement categories.
 - i. Terrain units were assumed to have similar thaw settlement categorization to terrain units in adjacent physiographic regions.
 - ii. Terrain units with similar descriptions were assumed to have similar thaw settlement categorization.
 - An expanded list of thaw settlement categories for terrain units and physiographic regions was compiled.
4. Apply Terrain Unit / Physiographic Region to Route

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- The thaw settlement category for each Landform of each terrain unit in each segment was selected based on the previously evaluated Terrain Unit/Physiographic value (1 = low, 2 = moderate, 3 = high).
- The thaw settlement category for each segment was assigned based on Landform (i.e. the worst subsurface layer regardless of strata thickness).

Terrain Unit determinations that were inconsistent with the other terrain unit conventions were evaluated separately.

3.3 POTENTIAL REFINEMENTS

As was noted earlier, there are a series of refinements that could be used as additional data, and analyses utilizing that data, are utilized. These refinements include:

- Additional borehole and soil sample data to refine the soil index properties that are used in the geothermal determination (esp. the soil moisture content).
- Additional geothermal analysis of climatic variations along the ROW.
- Additional geothermal analysis of varying vegetative cover along the ROW.
- Refinement of wetlands data in site specific locations.

Each of these effects could be expected to further eliminate those route segments which are potentially susceptible and/or to refine the extent of the thaw settlement effects, as determined by this analysis using the existing data.

4. RESULTS OF TERRAIN UNIT EVALUATION FOR THAW SUSCEPTIBILITY

4.1 EVALUATION METHODOLOGY

Following the flowchart presented in Figure 3, above, the route segments south of the discontinuous zone (i.e., south of MP 634), were screened out and excluded from the wetlands analysis since the subsurface is generally considered to be thawed and thus is not susceptible to thaw subsidence (Table 1). Similarly, route segments north of MP 168 were screened out and excluded from the study since the analysis in the areas of continuous permafrost conducted for this study and reported in AGDC 2016c, were found not to have a thermal impact outside of the ROW (Table 1). The remaining 466 miles were evaluated for potential thermal impact based on their Terrain Unit classification and the corresponding evaluation table of their thaw settlement potential (Table 1).

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4.2 EVALUATION RESULTS

The Project GIS is the repository for the information that is spatially linked to the route and facility areas. It includes a spatial description of the Terrain Units along the route and was queried to find the intersection of the route with those Terrain Units using the methodology described in this document.

The results showed that for the 466 miles of the pipeline within the discontinuous region, 191.4 miles possessed a high thaw susceptibility potential, 65.5 miles possessed a moderate thaw susceptibility potential, and 178.3 miles possessed a low thaw susceptibility potential. The remaining approximately 31 miles were uncategorized and thus were conservatively assumed to have a high thaw susceptibility potential. These results are summarized below.

The 178.3 miles of pipeline ROW that possess a low thaw susceptibility potential were screened from further wetlands analysis (Table 1). The 287.7 miles that were categorized as having high or moderate thaw susceptibility potential (Table 1) were carried forward for analysis of potential indirect impacts to wetlands using further GIS queries and site-specific determinations, as reported in Chapter 5 and Attachment 2.

Table 1. Mileage of Thaw Susceptible and Non-Susceptible Land Traversed by the ASAP Mainline

CATEGORY	MILEAGE
Total Mainline Route Length	733
Excluded North of MP 168 (Continuous Permafrost)	-168
Excluded South of MP 634 (South of Discontinuous Demarcation)	-129
Excluded Low Thaw Susceptibility Terrain Units	-178.3
Remaining Potential Thaw Susceptibility	287.7

5. WETLANDS INDIRECT IMPACT EVALUATION

Surface water provides an important positive feedback that enhances permafrost degradation when water is impounded in subsiding depressions. In addition, groundwater in the active layer or within permafrost delivers heat and is often surrounded by thawed zones (Jorgenson, et. al, 2010). AGDC tasked its wetlands subject matter experts with evaluating which wetlands types would be generally associated with already thawed permafrost and to use this to screen areas that would be indirectly impacted by potential permafrost thaw, potential subsidence, and potential drainage.

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Based on prior geothermal modeling (AGDC 2016c), there is a potential for indirect lateral permafrost thaw within a conservative 35ft TAZ on either side of the ROW due to vegetation removal within the ROW. This thaw has been modeled to extend down to a maximum 1 meter (3.3ft) bgs, however this thaw depth will be extremely variable. Therefore, it is assumed for the purposes of this study that an approximately 8 inches (or 20% of maximum) subsidence of underlying soils is possible across the entire 35ft buffer. Based on this assumption, the area within the TAZ was reviewed for potential impacts to wetlands experiencing an 8in subsidence within the TAZ.

5.1 WETLANDS APPROACH

AGDC provided its wetlands subject matter experts with a geodatabase describing terrain units with moderate or high potential for discontinuous permafrost thaw within the indirect TAZ. Qualifying areas were then evaluated for wetlands, screening out types that are generally associated with thawed permafrost. Wetlands that generally would maintain a deeper active zone or thaw bulb, under existing conditions were expected to have a low probability of experiencing an effect from subsidence because the affected areas under them would already be thawed within the interval of analysis. Wetlands types that were screened through this analysis included lakes, ponds, riverine wetlands, and wetlands with a Cowardin class that had a hydrologic modifier, indicating a permanently, semi-permanently, or seasonally flooded water regime. AGDC's wetlands subject matter experts then removed any remaining wetlands with a depressional hydrogeomorphic (HGM) class, as these also generally indicate existing thaw. Finally, uplands were screened from further analysis with the exception of those having a localized potential for impact to abutting and qualifying wetlands. Flat and slope wetlands having a saturated hydrologic modifier comprised the majority of wetland types within the indirect TAZ and were carried forward in the analysis.

The TAZ was subdivided among similar ecological units in order to evaluate wetlands within the same regional conditions. From north to south these regions included: Brooks Range (MP 168 to MP 250), Yukon (MP 250 to MP 356), Fairbanks area (MP 357 to MP 454), Broad Pass (MP 454 MP 608); and South Central (MP 608 to MP 634).

Permafrost thickness was taken into account in potential impact scenarios with respect to the potential to dewater wetlands. Thicker permafrost is generally expected toward the northern sections of the discontinuous permafrost study area (MP 168 to MP 454), and thinner permafrost is generally expected in more southerly areas from MP 454 to MP 634. The presence of standing water and shallow groundwater was also considered due to the potential of these sources to exacerbate permafrost thaw through a more efficient heat transfer process (Jorgenson et al. 2010). AGDC's wetlands scientists similarly considered the potential ponded water effect that may result in the subsidence depression.

AGDC's wetlands subject matter experts have considerable field experience in the ASAP pipeline corridor, documenting that many parts of the study area are overlain by histic epipedons, which are fairly thick saturated organics over low chroma mineral soils. These soils occur primarily in scrub

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shrub and forested areas but also encroach in to mixed shrub and emergent wetlands. Emergent wetlands in the corridor tend to be underlain by histosols, which are thick saturated organics (fibric/histic/hemic). Emergent wetlands tend to hold more water than shrub and forested wetlands. The consultants further used vegetation signatures and Cowardin wetlands mapping to assist in determining the expected soil profile within the TAZ in order to better estimate the potential for ponding impacts and their extent. LiDAR data was also evaluated in potentially impacted areas to assist in determining the potential for surface water and the direction of shallow subsurface water flow.

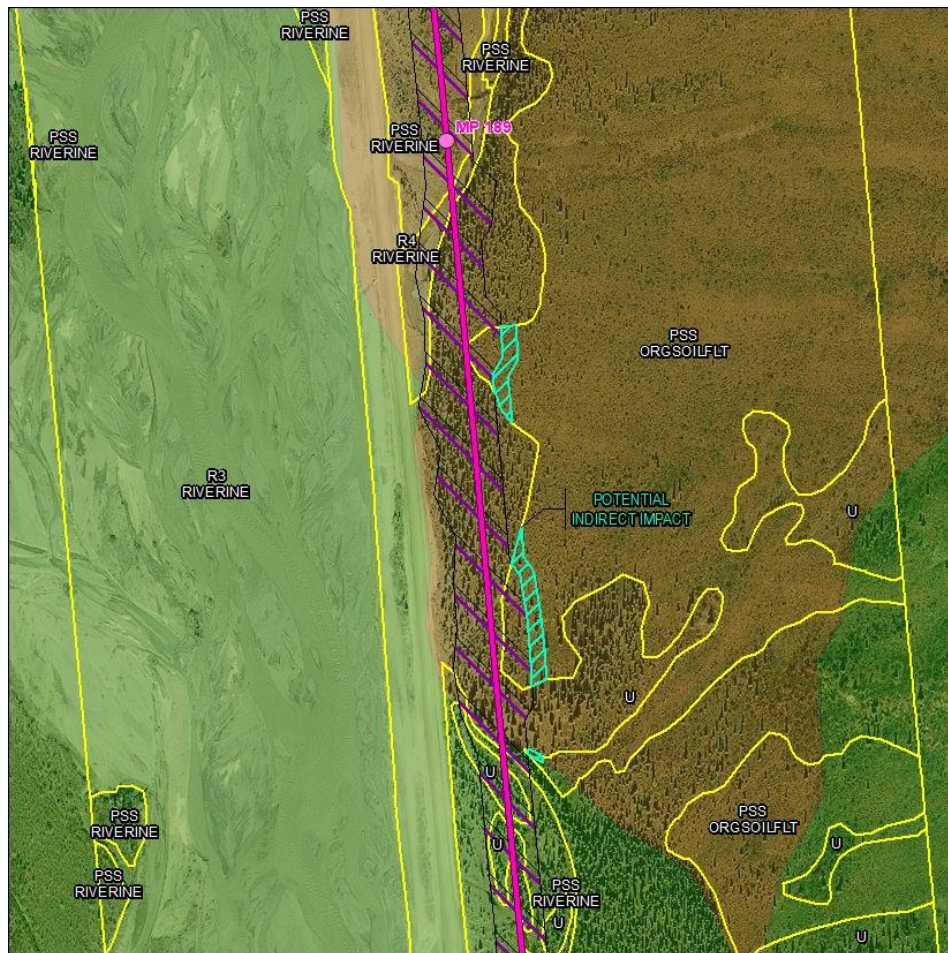
The study was designed as a high-level analysis for the purposes of evaluating impacts to wetlands on a large scale, so there is a potential for some localized effects outside this level of analysis. Descriptions and visual examples are provided, below, to provide representations of these potential impacts and areas of anticipated thawing within the indirect TAZ.

5.2 BROOKS RANGE (MP 168 TO MP 250)

This area, shown in Figure 8, is not expected to result in indirect impacts to wetlands in the TAZ. This area has moderate potential for permafrost thaw and encroaches slightly into the abutting area of low potential were wetlands exist (note that some slight mapping irregularities exist between the wetlands scientists and the terrain unit modelers).

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Figure 8. Moderate Potential for Permafrost Thaw in Wetlands of the Brooks Range Area (MP 168 – 250)



5.2.1 Brooks MP 173

This area represents mixed Scrub Shrub/ Emergent wetlands slope wetlands along the Brooks Range, and adjacent to the upstream side of the Dalton Highway (Figure 9). The wetlands within the TAZ are newly forming wetlands with fairly well-drained gravelly soils. The hydric soil indicator used is problematic soils with low carbon content described in the 2007 Supplement (Page 88, USACE 2007). The profile generally consists of 4 to 5 inches of organics underlain by coarse gravels that are a result of old alluvial fans at the toe of slopes.

Over time, wetlands have begun to form in these areas due to large hydrologic input and soil development that affords prevalence of hydrophytic vegetation. Field evidence showed shallow ponding and flowing water exists immediately below the organic surface; the slope toward the road allows the water to run downward to the road ditch where it is captured and directed along the road

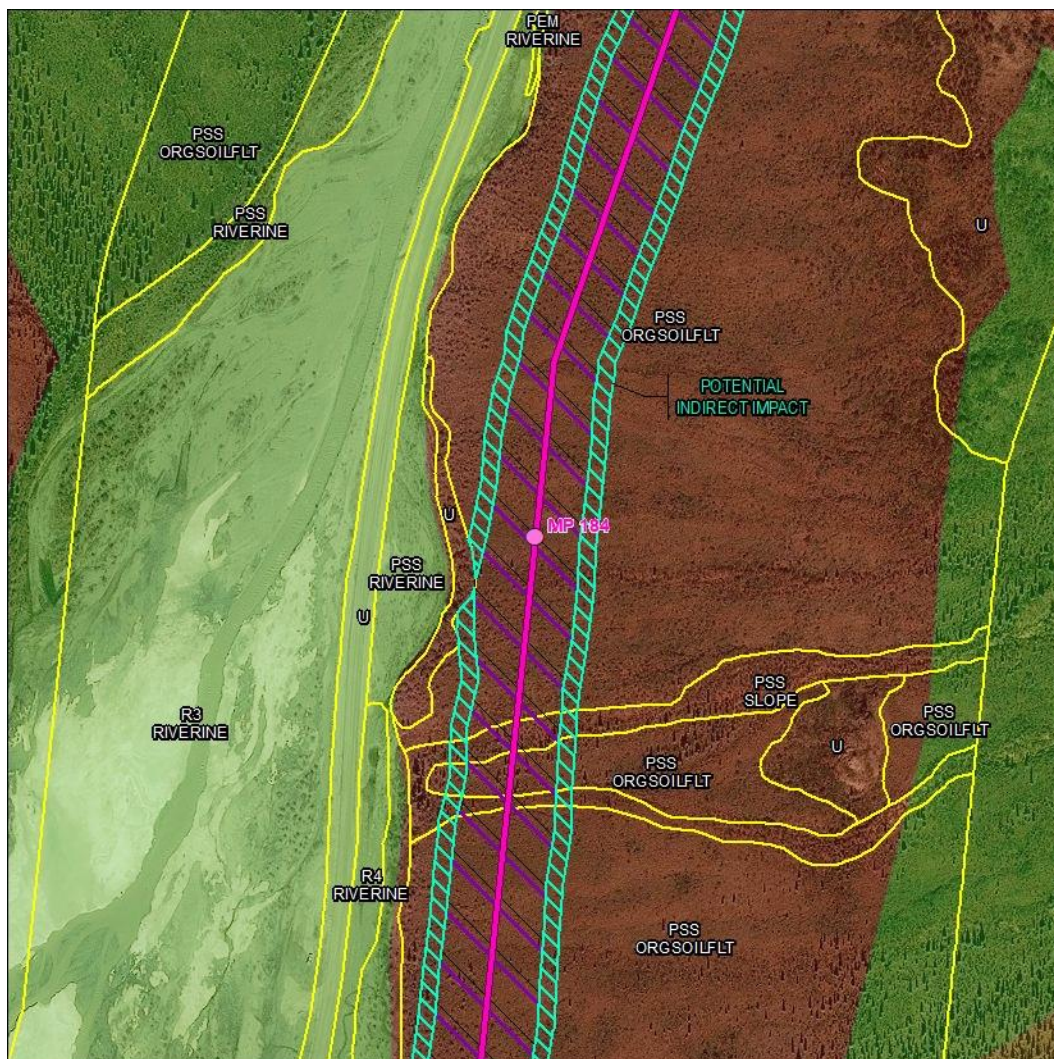
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of emergent grasses and sedges and is typically a little drier in the subsurface because it does not receive as much water as areas that are associated with alluvial fans. These areas appear to be much older, and the hydric soils have been given time to fully develop. The difference in these areas is that the upslope side settlement could result in ponding over time due to the poor drainage of the soils. The downstream side could experience the same effect. Linear drainage down the ROW could be mitigated through ditch plugs or some other mechanism found to be appropriate and practicable for the design.

Figure 10. Brooks MP 184 Area



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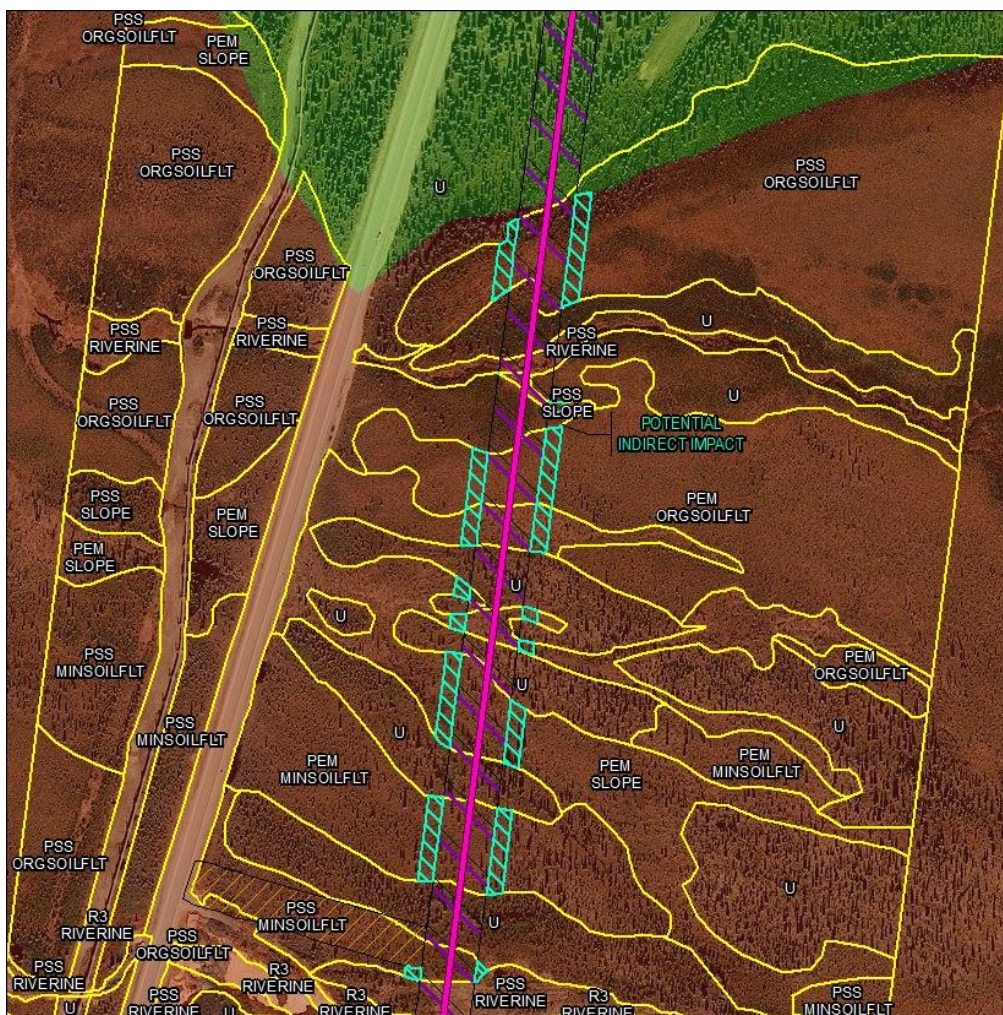
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5.2.3 Brooks MP 219

Figure 11 is an example of a flat wetlands with a mixed vegetative makeup. While subsidence here is expected, long term results are not be expected to alter the overall makeup of the wetland. The adjacent TAPS provides a good analogy to what a similar ROW clearing would have on the nearby uncleared area. There does not appear to be a significant change to the surrounding area around TAPS over the nearly 50 years it has been operating. There could be a slight effect at the edge of the ROW, as appears to be visualized along TAPS, but the overall habitat has not changed. Should current climate trends, coupled with ROW clearing, result in impacts suggested by Smith and Riseborough (2010) (which are not observed in TAPS), then potentially mirroring what TAPS has done may be beneficial in mitigating potential impacts.

Figure 11. Flat Wetlands with Mixed Vegetative Makeup at Brooks MP 219 Area



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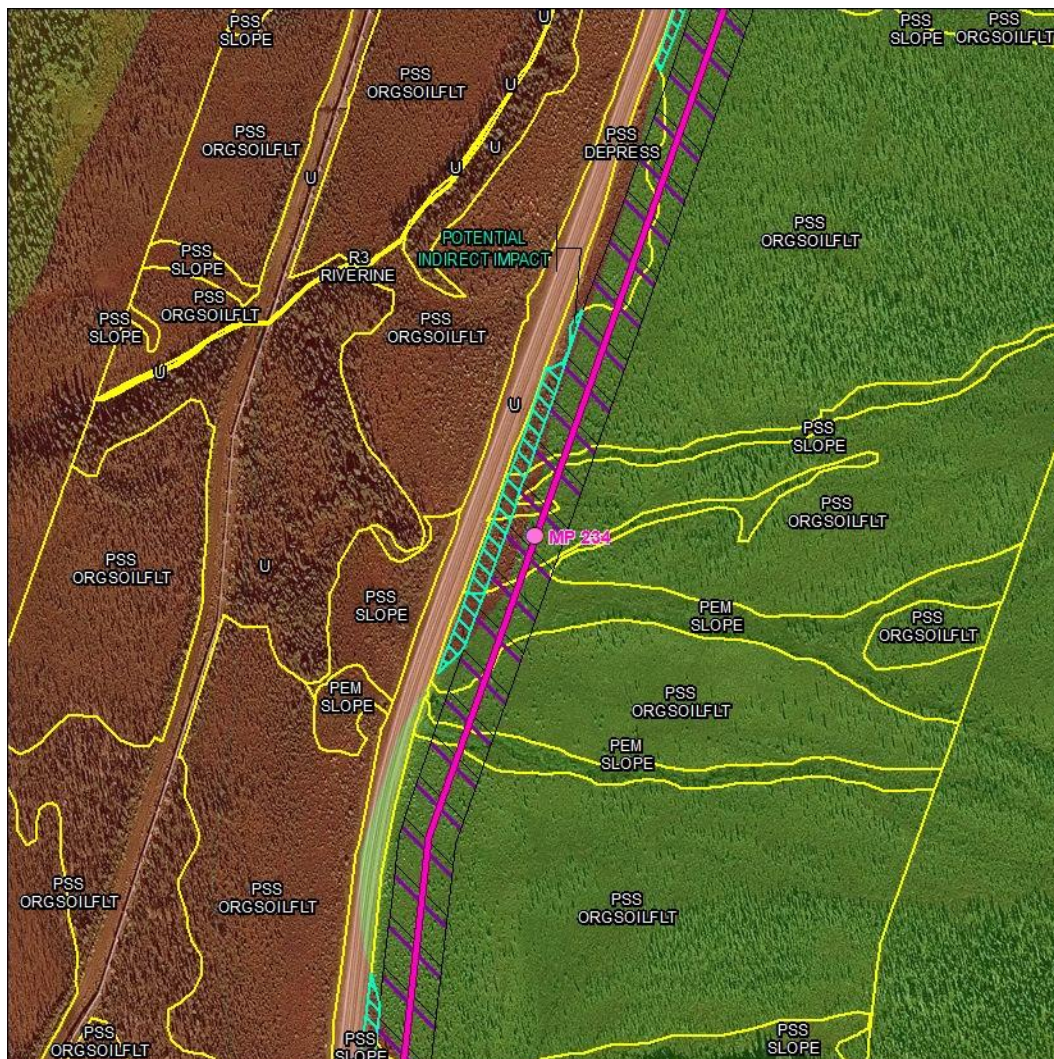
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5.2.4 Brooks MP 234

This area, shown in Figure 12, is similar to the area presented at MP 173, with increasing the hydrology around the Dalton Highway ditch; however, the ponding could last longer and result in additional permafrost thaw over time because flat wetlands with poorly drained soils would be expected to hold water longer. Emergent wetlands could form along this area due a change in the hydrology. It is possible that effect of the dust shadow from the Highway could offset increased hydrologic impacts.

Figure 12. Brooks MP 234 Area



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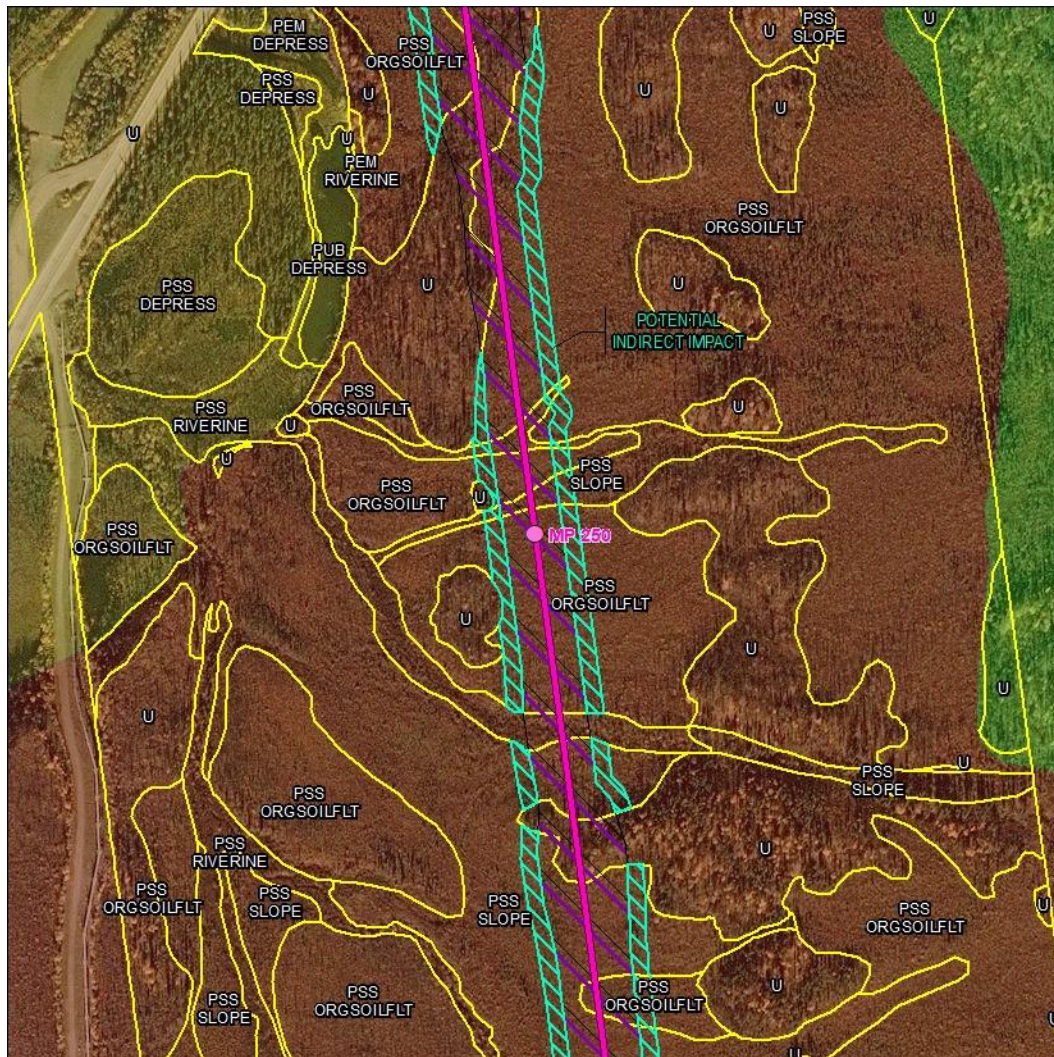
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5.3 YUKON MP 250 TO MP356

5.3.1 Yukon MP 250

This area, shown in Figure 13, may experience significant drying along the edge of the ROW due to dryer soil conditions being better drained than the area at Brooks MP 219. The predominant deciduous scrub/shrub wetlands indicate the presence of a dryer soil profile. As evidenced along TAPS there appears to be a clear indication of taller shrubs and trees potentially developing over time at this location. The dryer soils and re-establishment of vegetation could, over time, afford a re-establishment of permafrost here. This may have been what limited the habitat change evidenced around TAPS.

Figure 13. Yukon MP 250-356



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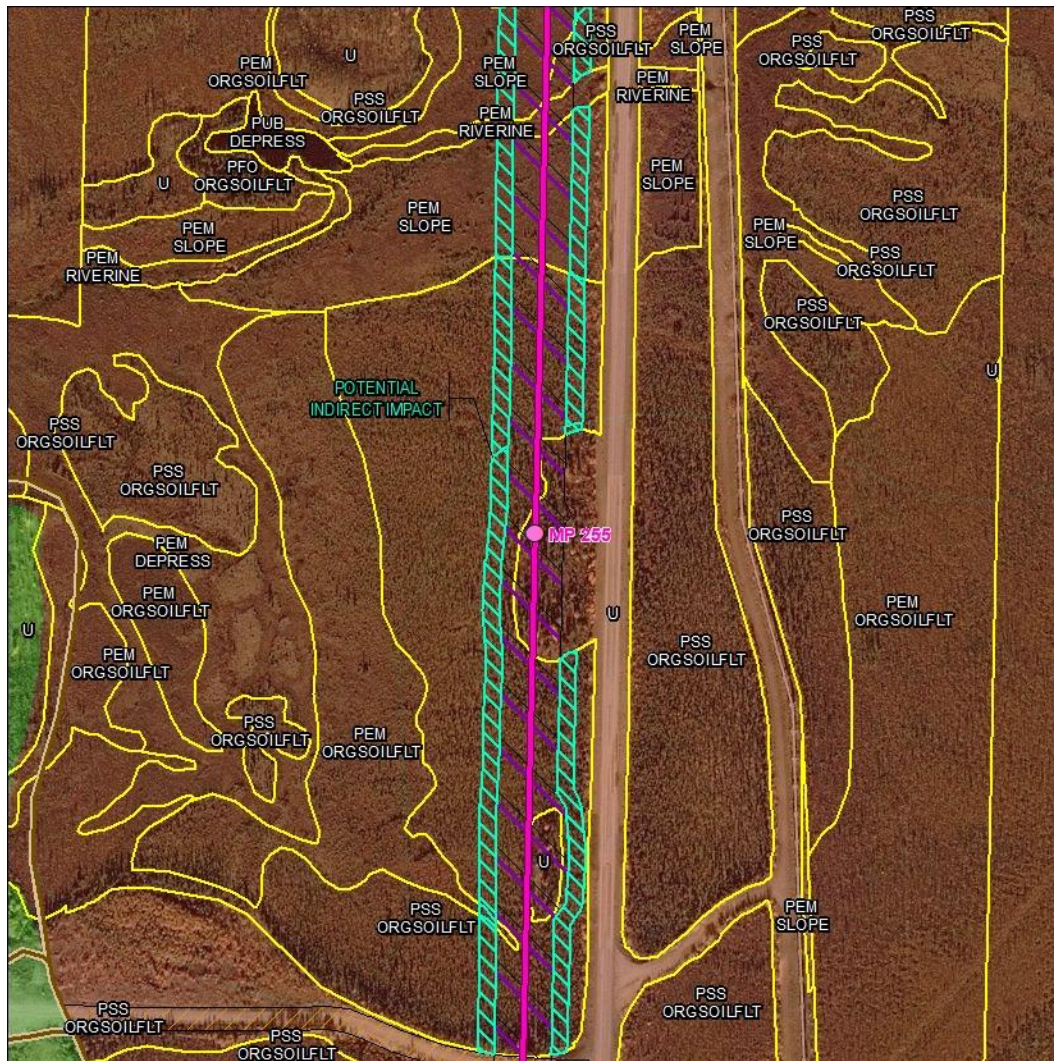
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5.3.2 Yukon MP 255

This area, shown in Figure 14, is dominated by taller evergreen shrubs (PSS4B). Although the area is very similar to that at MP 250, TAPS does not show the effect of potential habitat change immediately adjacent to the ROW. The taller evergreen shrubs in the area may encroach slightly into the mixed wetlands abutting the PSS4B, but overall, no significant habitat change is anticipated.

Figure 14. Taller Evergreen Shrubs Near Yukon MP 255 Area



5.3.3 Yukon MP 272

This area, shown in Figure 15, is very similar to MP 255. However, as seen along the increased cleared area near TAPS facilities, there appears to be no change in habitat adjacent to the ROW.

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This evidence strengthens the likelihood that ASAP ROW clearing would not result in significant impacts to the adjacent indirect TAZ.

Figure 15. Yukon MP 272



5.3.4 Yukon MP 355

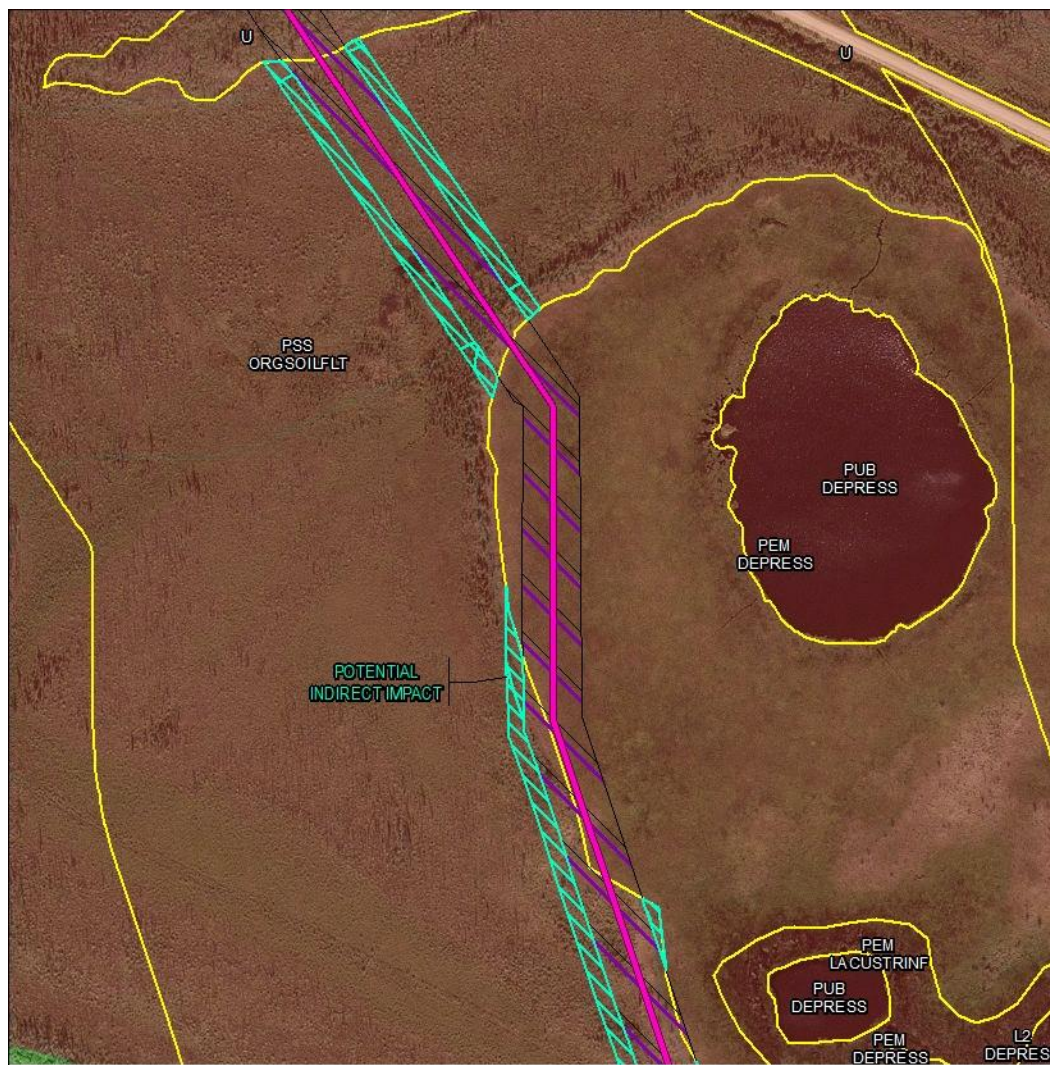
For areas in which the indirect TAZ is abutting a depressional wetland with increased hydrology (Figure 16), there is the potential for expanding the depressional wetland within the TAZ. This would appear to ultimately enlarge these habitats and increase the overall function and services provided by the current dryer shrub wetlands. The effect would be very limited and likely only occur at the edge of the two habitats.

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Figure 16. Yukon MP 355



5.4 BROADER FAIRBANKS REGION (MP 357 TO 454)

5.4.1 Broader Fairbanks Region MP 361

This area, shown in Figure 17, is very similar to Yukon MP 255 except that the vegetation is composed of a forested wetland dominated by black spruce. Similar effects are anticipated in that the dryer subsurface that affords taller vegetation, and this area should not experience significant indirect impacts. The TAPS ROW in the frame seems to strengthen this prediction in that the forested side of TAPS does not exhibit a vegetative change. The shorter shrub side of TAPS does appear to

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exhibit a small local change in vegetation, so a similar result could occur for ASAP. No wetland conversion is anticipated.

Figure 17. Broader Fairbanks Region MP 361



5.4.2 Broader Fairbanks Region MP 370

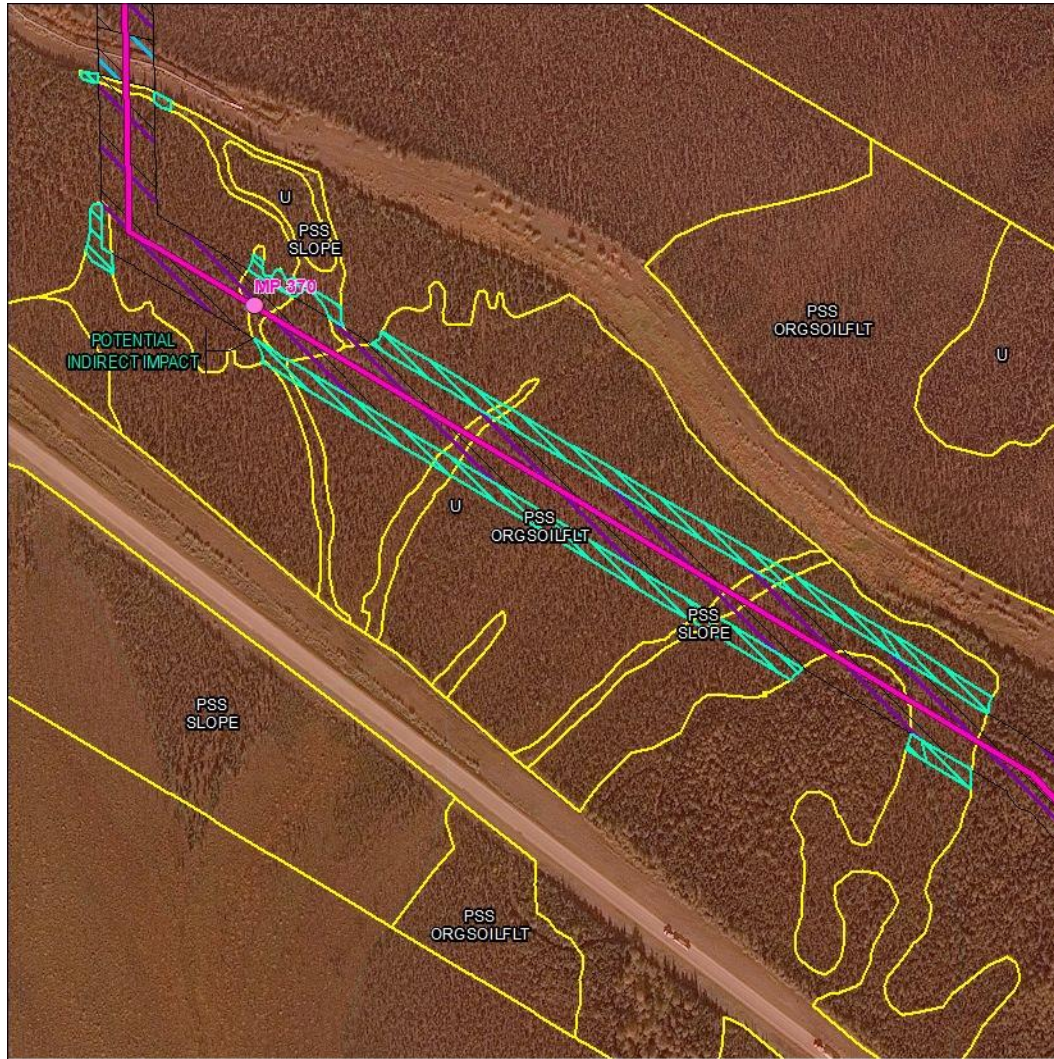
This area, depicted in Figure 18, shows a transition zone along TAPS where the pipeline goes underground. Note that the heated TAPS line does not appear to present a lateral effect on the surrounding taller flat shrub and forested wetlands. Therefore, the ASAP ROW clearing and cold gas pipeline should similarly not result in significant effects to wetlands. Also note the thin cleared ROW currently present along the TAZ; this area shows no significant impact to adjacent wetlands.

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Figure 18. Broader Fairbanks Region MP 370



5.4.3 Broader Fairbanks Region MP 441

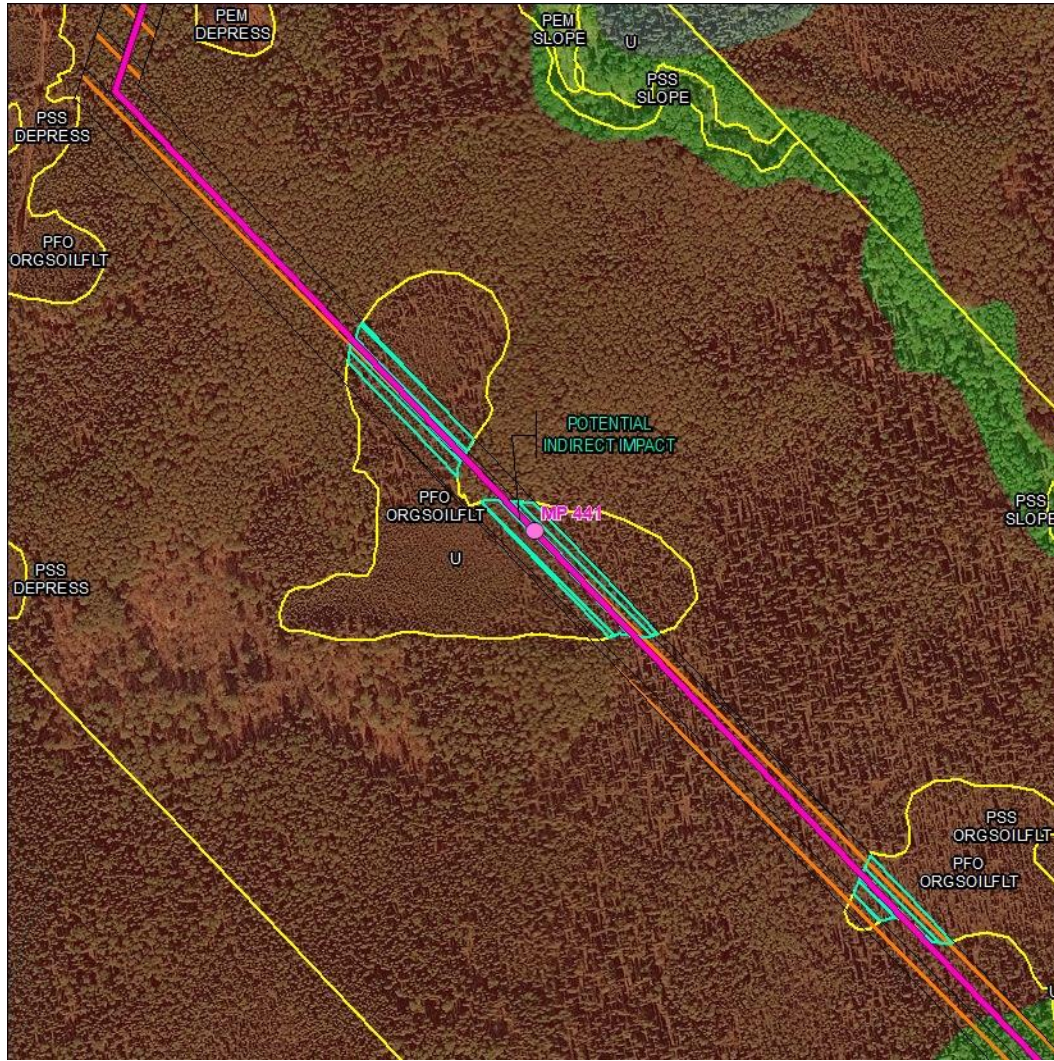
This ASAP pipeline transects taller shrub habitat in this area, and no substantial impacts to adjacent vegetation are expected in the indirect TAZ (Figure 19). As evidenced by the adjacent cut ROW in Figure 19, the impacts would be localized within the actual ROW.

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Figure 19. Broader Fairbanks Region MP 441



5.4.4 Broader Fairbanks Region MP 454

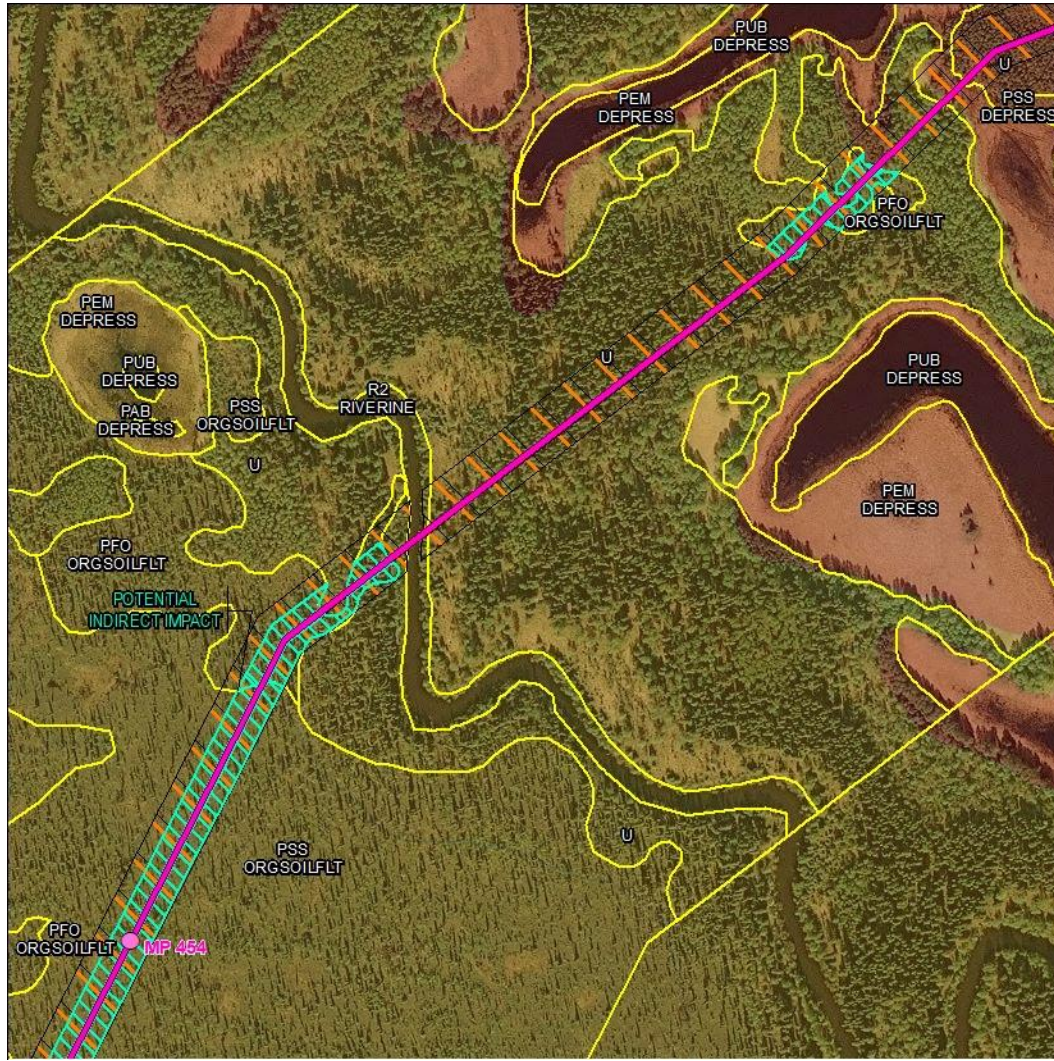
In areas, such as near MP 454 (Figure 20), where the TAZ encounters larger rivers and streams, there exists a potential for localized bank sloughing due to thaw depression. This could occur only on banks that are not depressed wetlands, or wetlands with a very wet hydrologic regime. As the extent of the thaw bulb around the hydrologic feature is unknown, the analysis remains conservative, analyzing the TAZ up to the edge of the mapped feature, when in fact the presence of the thaw bulb could result in the removal of the TAZ.

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Figure 20. Broader Fairbanks Region MP 454



5.5 BROAD PASS (MP 454 TO 608)

5.5.1 Broad Pass MP 455

This area is dominated by forested wetlands composed of black spruce; however, they have small inclusions of shrubs and emergent vegetation (Figure 21). As shown in previous examples, areas composed of taller shrubs and forest are not likely to experience any significant impacts due to a thaw depression forming. However, there could be localized impacts in the emergent and shrub layers. These intermixed layers could indicate that soil conditions have wetter inclusions; if that is true, then ponding could occur and result in additional thaw. However, if soils are fairly well

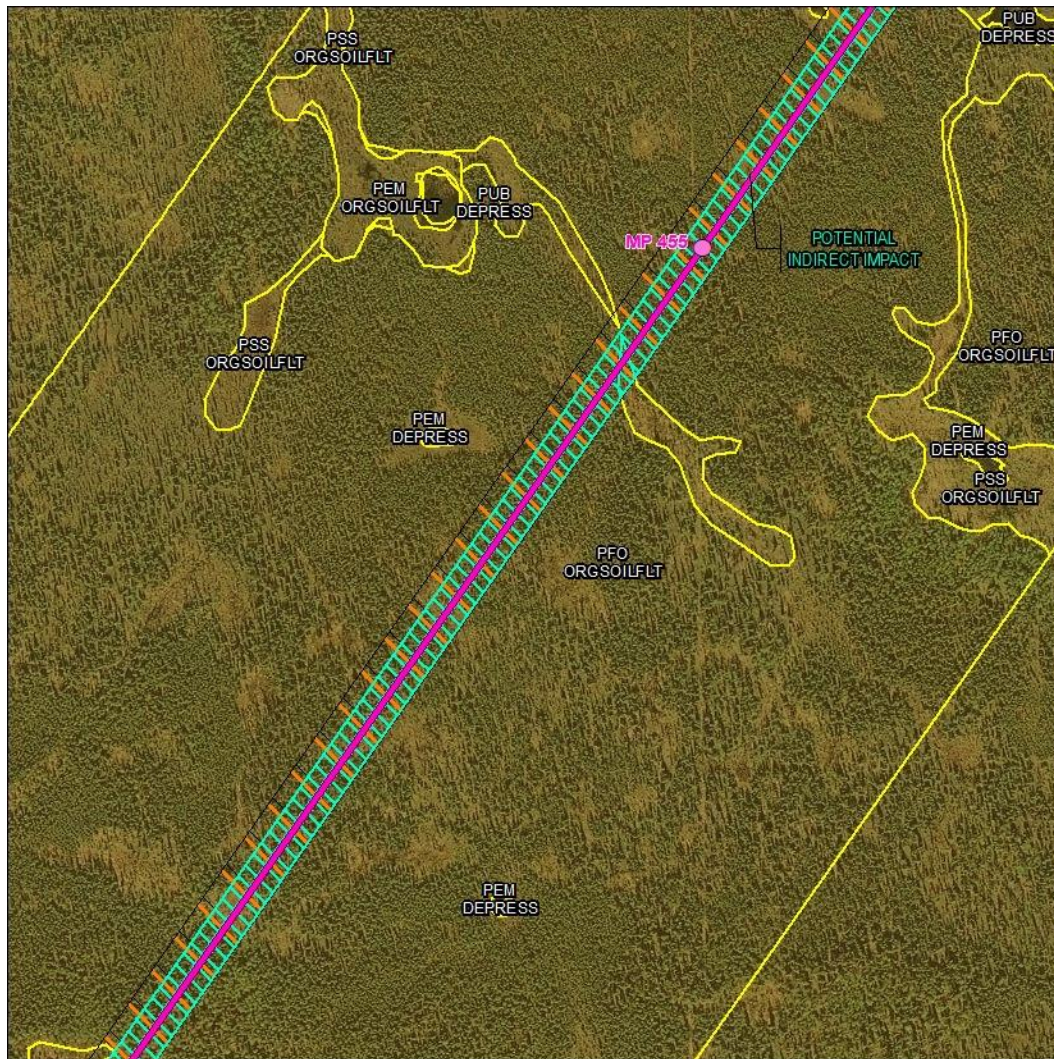
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drained, then these inclusions may be altered to have taller shrubs, as seen along TAPS. The relict survey line ROW clearing appears to indicate the latter is true and that the area would not experience significant vegetative or hydrologic alteration adjacent to the ROW.

Figure 21. MP 455



5.5.2 Broad Pass MP 475

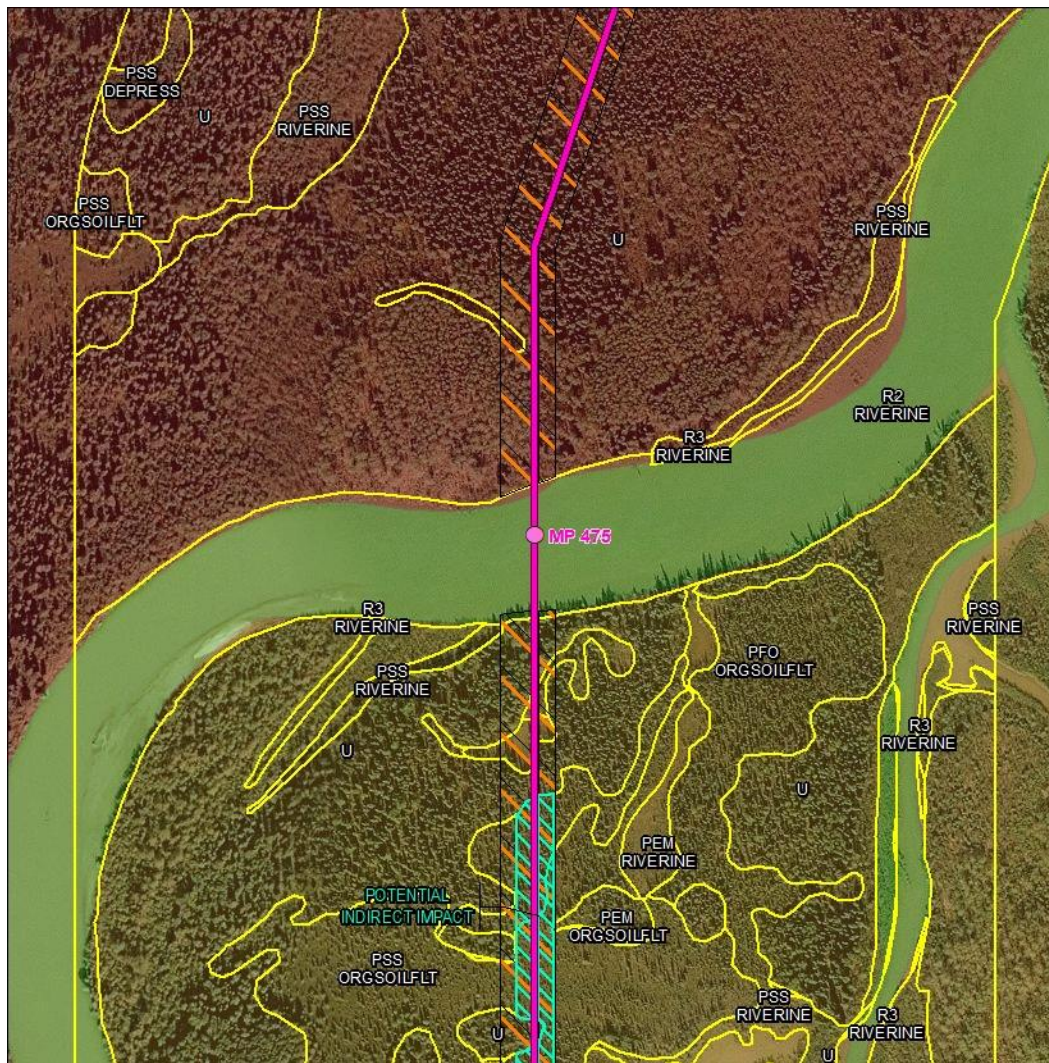
As shown along MP 454, this area may experience bank sloughing form a depression forming in the flat wetlands adjacent to the river (Figure 22). It is unlikely that significant indirect impacts would be observed if the river thaw bulb extends into the TAZ.

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Figure 22. Broad Pass MP 475 Area



5.5.3 Broad Pass MP 501

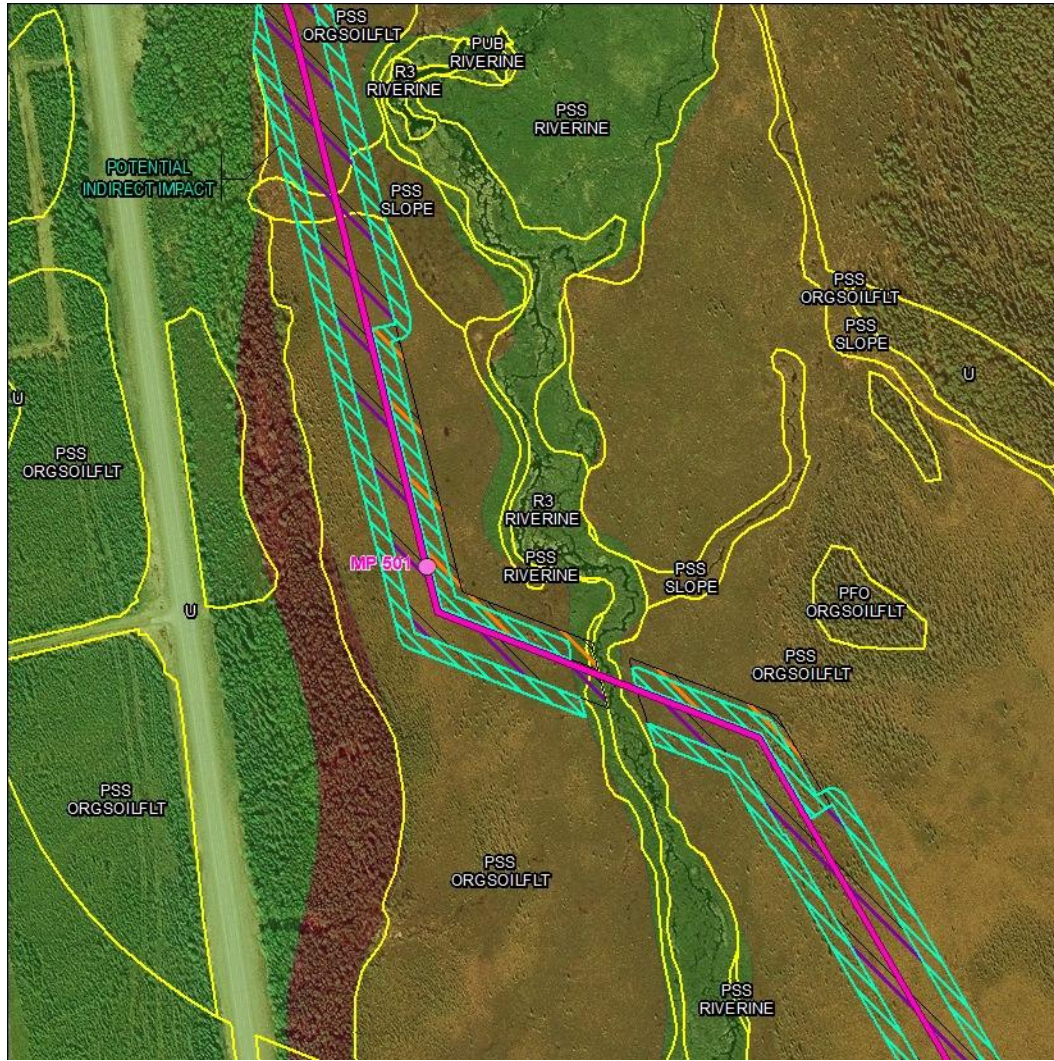
It is possible that some minor upland conversion could be experienced in the TAZ in this area. Dominant saturated wetlands and a more persistent saturation to the surface are seen in the adjacent PSS4B wetlands (in the bottom left) associated with the clearing (Figure 23). It appears that, in the presence of significant surface impact, the water conditions could spread toward the upland edge and saturate the area to the point that wetlands may begin to form. While the localized change may be significant, the effect on the overall area would appear to be negligible. Additionally, some minor sloughing could occur where the TAZ crosses small water conveyances in wet depressions.

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Figure 23. Broad Pass MP 501 Area



5.5.4 Broad Pass MP 548

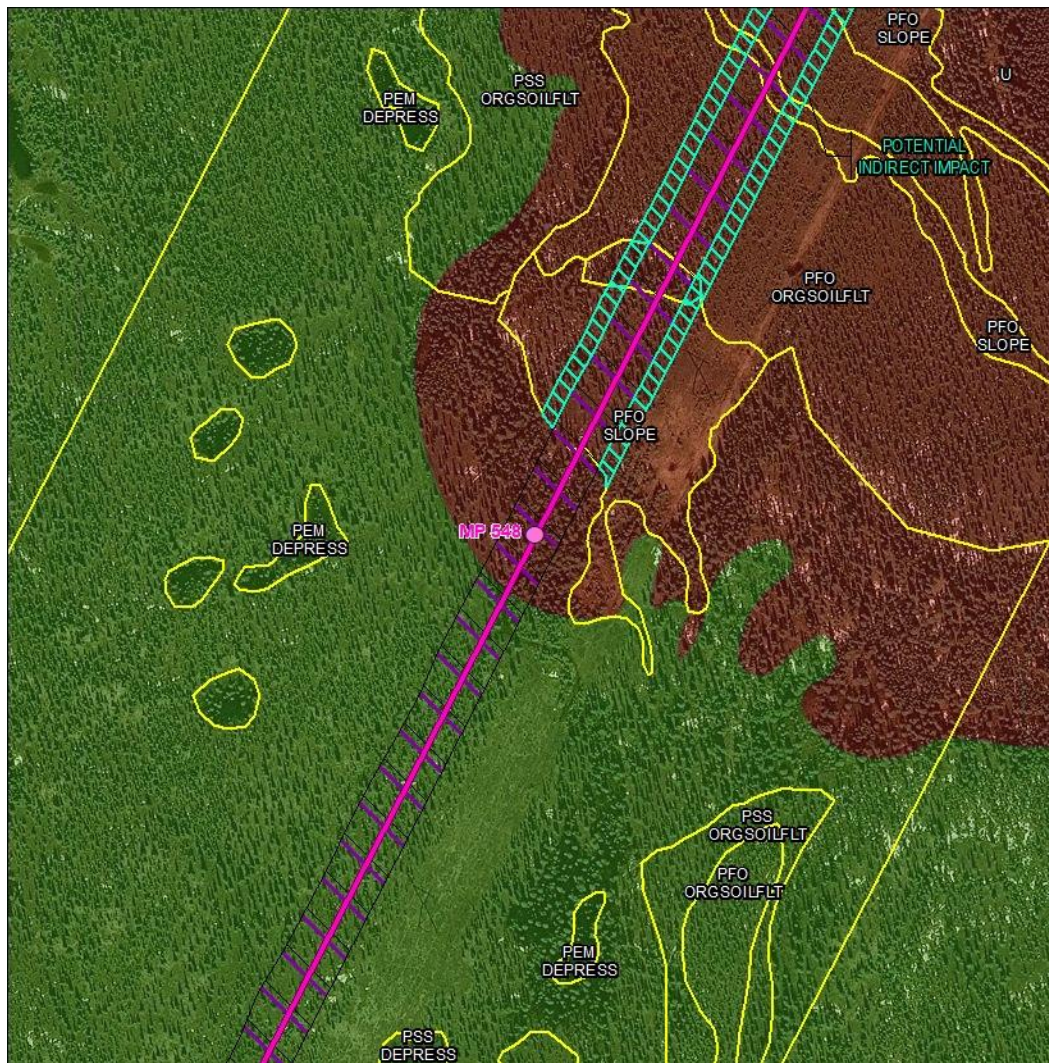
As the TAZ moves south, there appears to be larger areas where thaw depressions are less likely. Figure 24 depicts an area very similar to other areas where the presence of adjacent ROW clearing appears to substantiate the expectation that no significant impacts would occur in areas with taller vegetation. However, near inclusions with near surface persistent saturation, additional thaw could be experienced. This would result in ponded inclusions and the establishment of emergent vegetation. Based on Figure 24, such instances do not appear to be wide-spread and are likely to be more the result of clearing associated with significant ground disturbance.

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Figure 24. Broad Pass MP 548 Area



5.6 SOUTHCENTRAL MP 608 TO 634

5.6.1 Southcentral MP 613

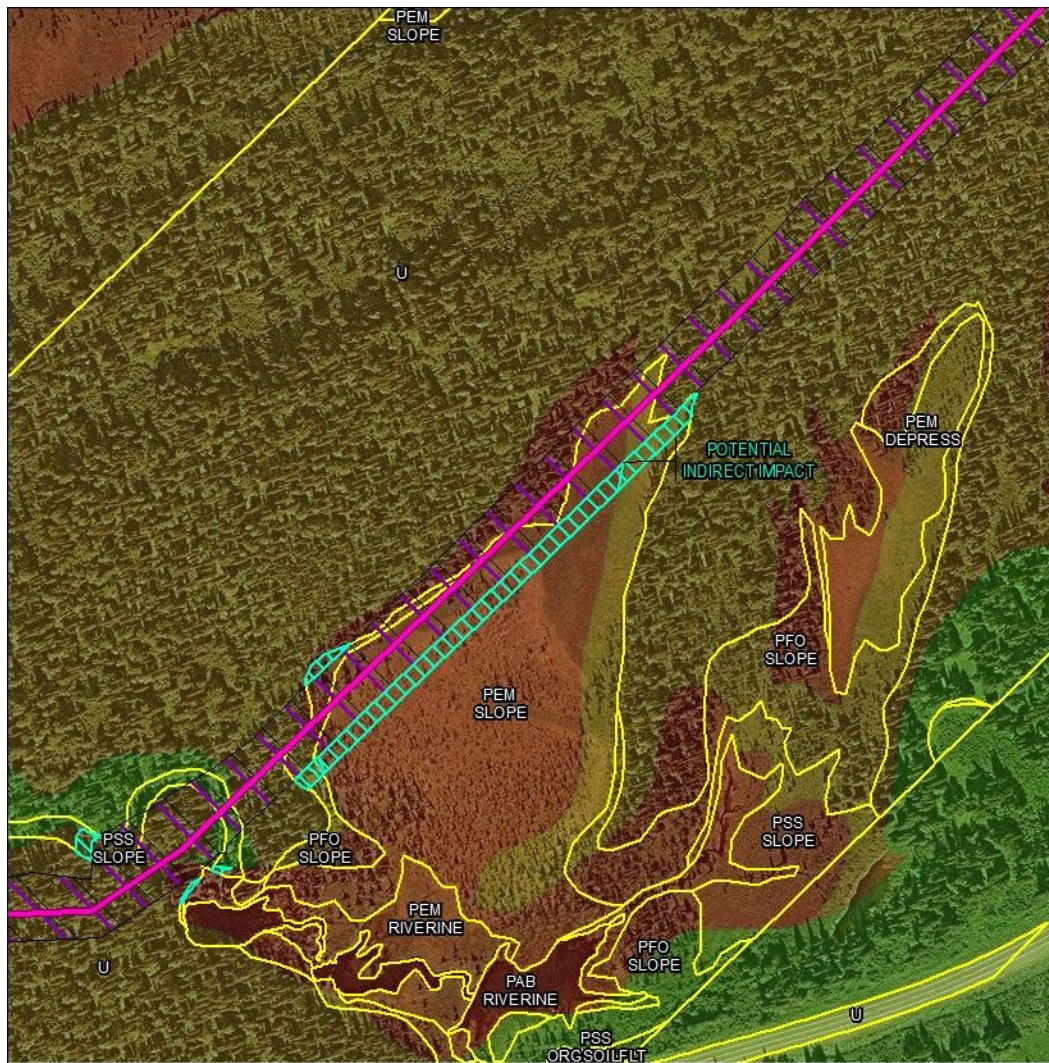
Habitats crossed by the TAZ in the Southcentral region are very sporadic and are composed of larger scrub shrub and emergent inclusion within large upland complexes or near areas where a low probability of permafrost thaw is expected (Figure 25). Impacts in these areas most likely include ponding and sloughing of upland soils, which would expand the wetland inclusion slightly. Some persistent thawing due to water collecting in ponded areas may occur.

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Figure 25. Southcentral MP 613



6. RESULTS AND FINAL ROUTE SUMMARY

AGDC directed its geothermal and wetlands subject matter experts to evaluate the potential for impacts to an indirect TAZ over a 30-year life of project. The analysis, described in detail above and in Attachments 1 and 2, resulted in the tabulation of a maximum 1,170.18 acres of wetlands that have the potential to be indirectly impacted by thawing permafrost, assuming subsidence and drainage of wetlands for all areas (Table 2). Case studies for other projects, such as TAPS, give

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reason to believe that actual indirect impacts to wetlands in the TAZ will be much lower than the maximum possible extent reported here.

This evaluation does not take into account continual monitoring efforts (AGDC 2016b), field investigations and activities, and mitigative options (see Section 7) that will occur during the Operations and Maintenance phase of the Project. These activities would further avoid and minimize potential indirect thaw to permafrost under wetlands. Additional impacts to permafrost that are projected as the result of climate change are also not included in these results; however, these are discussed in a separate report, entitled, ‘Effect of Climate Warming on Expected Long-Term Thaw Depths on the ASAP Right-of-Way, Alaska Stand-Alone Pipeline Project’ (Matrix Solutions 2017).

Table 2 provides a breakdown of potential indirect impacts within the TAZ by Cowardin classification code, terrain unit type and thaw settlement potential. The table was derived using the most recent ASAP project footprint and the 2018 USACE-approved PJD wetlands data.

Table 2. Potential Indirect Impacts within the TAZ by Cowardin Code, Terrain Unit, and Thaw Settlement Potential

Cowardin Code	Primary Terrain Unit	Thaw Settlement Potential	Acres
PEM	C	High	1.52
PEM	Cg	High	0.30
PEM	Cm	Moderate	0.02
PEM	Cs	High	1.20
PEM	Ell	High	0.01
PEM	Elx	High	2.01
PEM	Fp	Moderate	0.10
PEM	Fpa	High	5.76
PEM	Fpa	Moderate	0.20
PEM	Fpab	Moderate	0.33
PEM	Fpab-Ca	Moderate	0.99
PEM	Fpab-Rc	Moderate	0.88
PEM	Fpb	Moderate	0.94
PEM	Fpm	Moderate	0.52
PEM	Fpt	Moderate	0.25
PEM	Fpt-Rc	Moderate	0.09
PEM	Fpt(ft)	Moderate	4.11
PEM	Fpw	High	0.06
PEM	Fs	High	45.41
PEM	Fss	High	2.20
PEM	Fssa	High	0.30
PEM	O	High	6.09
PEM	Unavailable	No Terrain Unit Data	0.22
PFO	C	High	2.07
PFO	Cg	High	0.24

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Cowardin Code	Primary Terrain Unit	Thaw Settlement Potential	Acres
PFO	Cm	Moderate	0.05
PFO	Cmx	High	0.24
PFO	Cs	High	0.39
PFO	EII	High	22.44
PFO	Elx	High	7.39
PFO	Ffs	High	4.38
PFO	Fpa	High	0.72
PFO	Fpa	Moderate	0.39
PFO	Fpab	Moderate	0.35
PFO	Fpab-Ca	Moderate	0.26
PFO	Fpab-Rc	Moderate	0.16
PFO	Fpb	Moderate	3.35
PFO	Fpm	Moderate	1.66
PFO	Fps	Moderate	15.06
PFO	Fpt-Ca	Moderate	2.82
PFO	Fpt-Ho	Moderate	0.93
PFO	Fpt-Rc	Moderate	5.21
PFO	Fpt(ft)	Moderate	13.81
PFO	Fs	High	22.85
PFO	Fsf	High	6.26
PFO	Fsf(ft)	High	2.39
PFO	Fss	High	35.05
PFO	Fssa	High	26.09
PFO	GU	High	0.33
PFO	Lt	High	0.02
PFO	O	High	0.88
PFO	Unavailable	No Terrain Unit Data	4.21
PSS	C	High	47.44
PSS	Ca	High	0.64
PSS	Cg	High	7.23
PSS	Cl	Moderate	1.00
PSS	Cm	Moderate	11.75
PSS	Cs	High	27.66
PSS	EII	High	10.20
PSS	Elx	High	65.24
PSS	F(fa)	High	0.13
PSS	Ffs	High	0.69
PSS	Fp	Moderate	9.87
PSS	Fp(ft)	Moderate	1.46
PSS	Fpa	High	13.43
PSS	Fpa	Moderate	11.85
PSS	Fpab	Moderate	3.94
PSS	Fpab-Ca	Moderate	11.74

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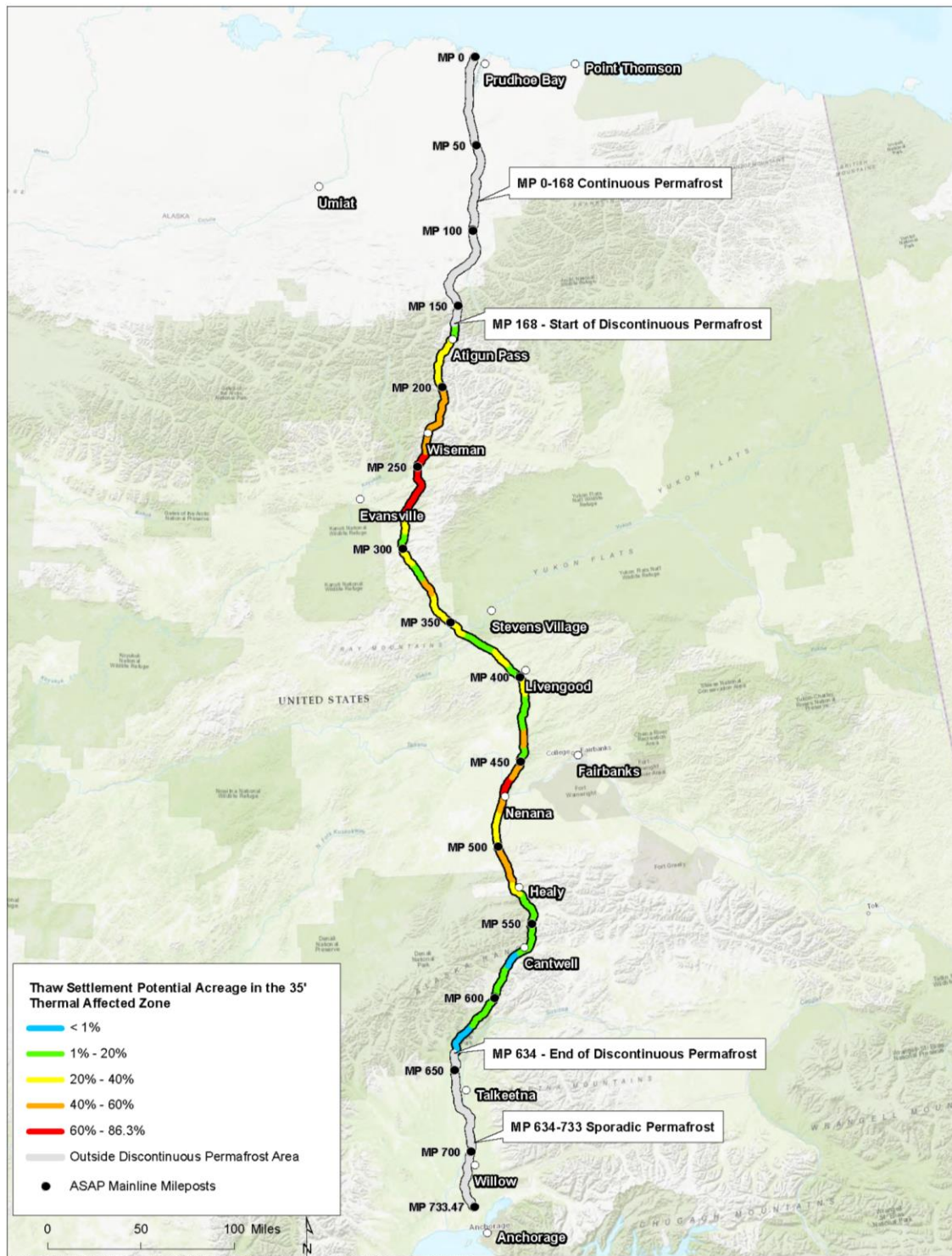
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Cowardin Code	Primary Terrain Unit	Thaw Settlement Potential	Acres
PSS	Fpab-Rc	Moderate	4.53
PSS	Fpb	Moderate	22.23
PSS	Fpm	Moderate	7.19
PSS	Fps	Moderate	6.39
PSS	Fpt	Moderate	1.74
PSS	Fpt-Ca	Moderate	28.90
PSS	Fpt-Ho	Moderate	14.38
PSS	Fpt-Rc	Moderate	10.53
PSS	Fpt(ft)	Moderate	8.05
PSS	Fpw	High	1.51
PSS	Fs	High	434.91
PSS	Fs(fa)	High	0.45
PSS	Fs(ft)	High	3.13
PSS	Fsf	High	4.49
PSS	Fsf(ft)	High	0.85
PSS	Fss	High	62.88
PSS	Fssa	High	20.17
PSS	GU	High	7.43
PSS	Hs	High	0.00
PSS	Lt	High	0.29
PSS	O	High	26.12
PSS	Unavailable	No Terrain Unit Data	26.21
		TOTAL	1,170.18

The areas of land having thaw settlement potential, equating to a total of 1,170.18 acres within the TAZ, were found to be concentrated more heavily in some portions of the route than in others in the discontinuous permafrost region. To display this graphically, the area of land having thaw settlement potential inside the TAZ was divided by the total area of the TAZ in 10-mile increments between MP 160 and MP 640; the resulting percentages of thaw settlement potential in the discontinuous permafrost region were then mapped in 10-mile segments (Figure 26). The area with the highest percentage of thaw settlement potential (60 - 80%) existed between MP 250 – 280. Areas with moderately high percentage of thaw settlement potential (40 – 60%) existed between the ranges of MP 200 – 220, MP 240 – 250, MP 320 – 340, MP 450 – 470, and MP 500 – 510.

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Figure 26. Relative Indirect Thaw Settlement Potential for Discontinuous Permafrost



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7. MITIGATIVE OPTIONS

The following procedures may be employed to ensure that ROW integrity is maintained through all phases of the pipeline – Design, Construction and Operations. The following sections describe how each phase is deployed to undertake this mission so as to ensure integrity for the life of the project, employing, as required, mitigative measures for potential thermal impacts outside the ROW.

7.1 DESIGN

At this earliest phase of the project, the procedures for alignment selection are the most important to ensure minimal impact to the environment. Two guiding principles of special interest in the routing guidelines include the requirements to minimize routing through streambeds and wetlands. A large number of the latest rerouted segments in the current alignment are directly attributable to review of route wetlands and moves to adjacent segments that have no, or lessened, wetlands impact.

Another routing guideline of importance in this discussion is choice of routing segments that avoid, or minimize the impact of, potential geohazards; that is, hazards presented to the pipe and/or ROW by naturally occurring route features or those that may be altered by the project. Some of these geohazards are evident from surface traits such as earthquake fault traces and potential slope stability areas. Others, however, and as discussed in this report, as well as AGDC 2016c, are based on subsurface traits and are only discovered after detailed route evaluation and Terrain Unit identification. In many areas, the presence of subsurface frozen soils can be discerned based on the type of vegetative cover and this is a key element of project alignment studies. However, to quantify the magnitude of the hazard, subsurface investigations are conducted to find the frozen extent and the index properties of the soil regime to evaluate the impact.

These route investigations are ongoing throughout design and even into construction as will be seen in the succeeding section. As these investigations continue, potential impact areas are further evaluated and estimates refined to be more site specific. In the meantime, the project makes conservative bounding assumptions. In other words, the route evaluation based on conservative evaluations is further refined as design progresses.

Nevertheless, it is impractical, if not impossible, to avoid every route segment that may be susceptible to greater impacts from project activities and that may further impact wetlands outside the limits of the ROW. In this event, it is important to recognize the potential impact and guard against it using active design measures. The two most important design mitigative measures in this regard are revegetation and adequate surface water control.

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7.1.1 Revegetation

Revegetation is the primary method for stabilization of frozen subsurface soils. The design of an active revegetation plan to restore the ground surface characteristics to the in situ condition, or an analogous condition would impede subsurface thaw. In this regard, a *Revegetation Plan* (AGDC 2016e) has been developed for the Project through efforts of the State of Alaska's Plant Material Center. The plan describes appropriate seed mixes and best practices for revegetation and soil stabilization based on the climate zones of the project.

7.1.2 Best Practice for Surface Water Control

The other design item to mitigate thaw depth progression and settlement is to employ active measures to intercept surface water flow and prevent sheetflow across and down the ROW. Surface water can be a serious erosional measure that can accelerate ROW settlement and impede other mitigative measures. The measures to control sheetflow at this time are identified, although their specific placement and sizing along the ROW requires site-specific definition during final design and even into the later project phases of Construction and Operations as discussed in succeeding sections. It is evident from experience and review of trial trenching programs that inattention to this design aspect can lead to serious erosional problems that become increasingly difficult to rectify. This topic is described in greater detail in AGDC 2016b.

7.1.3 Temperature Control

Another potential design that might be considered in some specific areas is temperature control. The most common method of temperature control along the ROW limits would be the use of thermosyphons (a.k.a. heat pipes) if the local climate is conducive to their use as described in AGDC 2016b,c. thermosyphons can mitigate thawing and stabilize thaw settlement by freezing the recently thawed ground. For the most part, however, this option is more effectively employed during Operations where site-specific monitoring can designate according site-specific requirements.

7.2 CONSTRUCTION

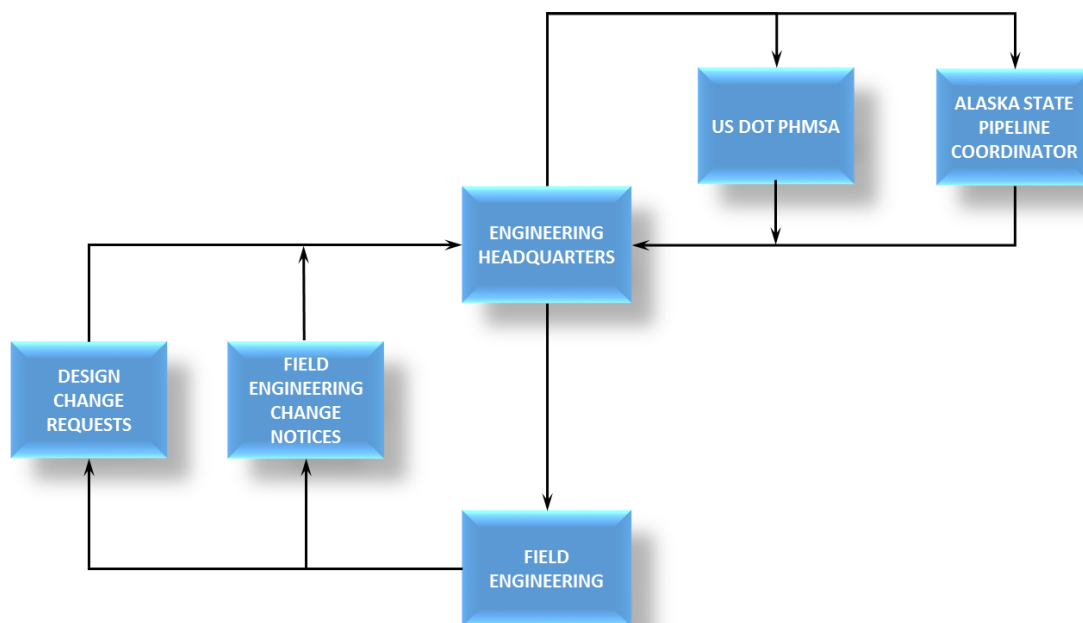
While the goal of the design process is to identify as accurately as possible areas where thaw settlement may be an issue, it is acknowledged there could be instances where installation conditions differ from those anticipated by design, thus requiring site-specific considerations. To address this potential scenario, the use of a field design change procedure to evaluate such areas in a timely fashion is employed. This follows the experience of TAPS Construction, as well as current North Slope Construction practices.

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7.2.1 Field Design Change Procedure

A schematic of the design change control system is presented in Figure 27. This system is established to specify lines of communication, including communication with government review agencies where needed and as noted in the Figure. Depending on the circumstances of the route condition uncovered, the actionable review agency and the appropriate response procedures would differ. For issues related to pipe integrity, the USDOT PHMSA would be considered a key agency and, accordingly, issues such as a localized karst condition under the pipe centerline would require coordination with PHMSA and perhaps active coordination with the SPCO. For issues related to water crossings or ROW conditions involving wetlands, several agencies would need to be consulted.

Figure 27. Design Change Control System



7.2.2 Potential Mitigative Options during Construction

For Construction, the alignment is already well established, so rerouting outside of the detailed final alignment is not a viable option. The mitigative options are then limited to those physical measures which could be adopted during the Construction phase including:

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- Micro Reroute – in some cases, the field conditions encountered might be very site specific and limited. In this case, potential reroute of the ROW pad within the lateral limits of the construction ROW, could limit expected disturbance.
- Overexcavate and replace thaw unstable material – this technique may be a viable method in some locations; the material would be excavated and removed, and foreign material imported, requiring the mining and importation of additional select fill material to backfill the removed material. This technique could be employed in areas where very high displacement strains in near surface soils are evident, such as massive ice in a near surface strata but below the active layer.

The following options would be considered in extraordinary and specific conditions since they would certainly require new materials, increased field scrutiny, and additional construction delay. Nevertheless, they are included here for completeness:

- Install localized thermosyphons, which are passive heat pipes designed for installation in select locations along the edge of the ROW to provide a thermal curtain and limit impact. Their use is discussed and depicted in AGDC 2016b,c.
- Install localized active refrigeration, such as a mechanically driven equipment that would refrigerate sections of the ground around permanent facilities where a power supply is available (e.g., use of a design similar to TAPS Pump 1 brine system)
- Workpad insulation.

7.3 OPERATIONS

The active evaluation of potential hazards to the ROW and potentially beyond the ROW, do not end with Construction. Active monitoring will be required throughout the design life, with a special focus on the early years of Operations for ROW thermal impacts since, as seen in Chapter 2. The thermal impact of the more egregious segments requiring focus should be readily evident during the early years after Construction, while the impact should level off after continued Operations.

7.3.1 Right-of-Way Monitoring Program

For operations, the evaluation of the current state of the ROW surface using monitoring information largely supplants the predictive methodologies used during the design process, and the direct evaluation of the ROW during Construction as it is being altered.

Monitoring and intervention during operations are needed to ensure ROW integrity. Even for a well-executed design based on good design tools and good input data, the overall probability of criteria exceedance for the entire pipeline ROW over the design life is non-negligible and requires continued scrutiny. Monitoring is for all hazards and not just for settlement. Unusual conditions can occur along the alignment that are more severe than selected for design, such as unexpected

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high water conditions or adjacent landowner activity. A project must be prepared for all eventualities during operation.

Operating experience for TAPS has clearly shown the need for such monitoring and intervention. Linewalks are an integral, and required, part of any pipeline operational plan. In the arctic especially, personnel are instructed to be aware of such surface features that may portend surface movement or other threats to integrity such as evidence of change in surface water drainage patterns, sloughing or mounding of soil, or open lateral cracking in the soil. All areas which have been mitigated during Operations will continue to be monitored for any additional issues.

7.3.2 Potential Mitigative Options during Construction

Many of the options available during Construction are also available during Operations. There is a distinct advantage in employing such options during Operations in that site-specific direct evidence is available to guide the type and extent of the options.

Surface-leveling is one possible form of intervention/mitigation that can be employed should the ROW need to be elevated from a settlement condition. New backfill material is placed in the area to be re-leveled. Care must be employed, however, to ensure that the surface characteristics are not adversely affected to further advance thaw progression.

7.4 SUMMARY

The mitigation measures employed during operations of the pipeline to mitigate thaw settlement are believed to either reduce or eliminate the impacts to wetlands in the thaw-affected zones on the outside edge of the pipeline right of way. Further, direct monitoring and mitigative options, outlined in this section, can further reduce wetlands impacts.

8. CONCLUSIONS

Ground surface disturbances during construction can cause changes in heat energy balance that could impact wetlands indirectly, outside of the project ROW. At the request of the USACE, AGDC directed its subject matter experts to carry out additional geothermal and thaw depth modeling, as well as additional wetlands analysis, to determine where changes to surface heat energy balance could occur and where wetlands could potentially be impacted within an indirect TAZ.

In continuous permafrost terrain at MP 0 the gas treatment plant will deliver gas with a year-round constant gas temperature of 30°F, which is slightly warmer than the local mean annual ground temperature of about 21°F. This will warm the permafrost around the pipe at MP 0 and will cause the active layer depth to increase in the vicinity of the pipe in this area. Ground surface disturbance

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at the trench on the North Slope will also contribute to slightly warmer permafrost temperatures in the vicinity of the trench. Geothermal modelling showed that the maximum annual thaw depth (active layer depth) above the pipe and at the edge of the trench (2.5ft from pipe centerline) is expected to be about 3.1ft. For comparison, the model-computed active layer depth in undisturbed terrain was 1.6ft. At MP 0 the maximum active layer depth at distances from the centerline of 5ft, 10ft and 20ft are 2.3ft, 1.9ft, and 1.7ft, respectively. The model showed that beyond 20ft from the pipe centerline, the pipe and trench have practically no influence on the active layer depth.

In discontinuous permafrost terrain, the thermal influence of the gravel pad extends beyond the edge of gravel pad by about 26ft and 33ft in the cases with and without an organic layer below the gravel pad, respectively. For assessment of indirect impacts to wetlands, a conservative distance of 35ft adjacent to the ROW was used to define an indirect TAZ. Minimal or negligible indirect impacts were expected in the more southerly sporadic permafrost area.

Existing terrain unit classifications and their thaw settlement susceptibilities, along with other geophysical data, were used as part of the methodology for determining potential wetland impacts in discontinuous permafrost. AGDC's geothermal subject matter experts assigned conservative set of criteria to terrain unit classifications with respect to thaw susceptibility to focus subsequent wetlands analyses on where thaw susceptible soils would potentially occur in the indirect TAZ. AGDC documented where a high or moderate thaw settlement potential exists under wetlands. Within the indirect TAZ, AGDC's wetlands subject matter experts applied a conservative set of criteria to further delineate which wetlands were susceptible to be impacted through subsidence or drainage as a result of indirect permafrost thaw.

Based on this comprehensive analytical screening process, AGDC's geothermal and wetlands subject matter experts determined that, without monitoring or mitigation, a maximum of 1,170.18 acres of wetlands could potentially be indirectly impacted over a 30-year period by thawed permafrost resulting from ground disturbance during construction of ASAP. However, an extensive monitoring program and mitigative options are planned to ensure that, like other belowground pipelines, any indirect impacts to permafrost and wetlands are minimized and avoided to the extent practicable.

Additional impacts to permafrost that are projected as the result of climate change are discussed in a separate report, entitled, 'Effect of Climate Warming on Expected Long-Term Thaw Depths on the ASAP Right-of-Way, Alaska Stand-Alone Pipeline Project' (Matrix Solutions 2017).

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ATTACHMENT 1 - EXPECTED LONG-TERM THAW DEPTHS IN COLD PERMAFROST ON THE ASAP RIGHT-OF-WAY, ALASKA STAND ALONE PIPELINE

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TECHNICAL MEMORANDUM

TO: Keith Meyer, Pipeline Engineering Manager, Alaska Gas Development Corp.
Scott Lust, Pipeline Engineer, Alaska Gas Development Corp.

FROM: Ron Coutts, Senior Geological Engineer, Matrix Solutions Inc.

RE: Expected Long-Term Thaw Depths in Warm Permafrost on the ASAP Right-of-Way, Alaska Stand-Alone Pipeline Project

DATE: July 12, 2016

1. INTRODUCTION

Thermal modeling was undertaken to determine the expected 30-year thaw depths across the ASAP pipeline right-of-way (ROW). In addition it was also necessary to assess thaw beyond the edge of the ROW in adjacent undisturbed terrain.

It is understood that information presented in this report will be passed along for review by the U.S. Army Corps of Engineers.

2. TECHNICAL OVERVIEW

Long-term ground temperatures, as characterized by mean annual ground temperature (MAGT), are a result of heat energy exchange between the ground and the above ground environment at the ground surface. The significant energy exchange components at the ground surface are solar radiation, longwave radiation emitted from the ground and snow surface, convective heat transfer with atmospheric air, and evapotranspiration from surface water evaporation and plant transpiration.

Ground surface properties such as summer and winter albedo (surface reflectivity) and evapotranspiration factor affect the net energy flux at the ground surface. For example, summer and winter albedo values, which each range from 0 to 1, affect the amount of solar radiation that is absorbed at the ground and snow surfaces respectively. An albedo value of 0.85 for snow represents 85% reflectance of solar radiation, and correspondingly, 15% absorption of solar radiation at the snow surface. Evapotranspiration factor, which also ranges from 0 to 1, quantifies the degree to which

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latent heat energy at the ground surface is intercepted to vaporize water by evaporation or by plant transpiration.

A surface energy balance (SEB) model for heat energy exchange at the ground surface developed by Hwang, 1976, was used to determine the net heat energy flux at ground surface nodes in a geothermal modeling finite element analysis (FEA) of heat transfer in the soil. The FEA tool used was TEMP/W (Geo-Slope 2016).

Ground surface properties of summer albedo and evapotranspiration factor were varied in the SEB model to simulate ground surface disturbances such as tree clearing, the gravel pad surface on the pipeline right- of-way (ROW), and revegetation of ground surfaces disturbed during construction and which are beyond the permanent ROW width.

This technical memo summarizes the geothermal model setup and long-term (30-year) thaw depth results calculated from geothermal modeling. The model conditions are representative of a warm permafrost area near Fairbanks with a mean annual ground temperature of 31.1°F and with ground surface disturbances on the ROW from tree clearing and gravel pad placement.

3. GEOTHERMAL MODEL SETUP

3.1 Domain Geometry

As shown in Figure 1, the typical pipeline ROW configuration in discontinuous permafrost is planned to be 120ft wide. This includes an 18in thick, 70ft wide gravel pad on one side of the pipe centerline, and a 30ft wide cleared area for trench spoil, each setback 10ft from the pipe centerline. After one construction season, the permanent ROW is planned to be 53ft wide and centered over the pipe. With time, grasses and shrubs and eventually trees (in originally treed areas along the route) will revegetate the ROW. Young trees growing on the permanent 53ft ROW will be cleared while those beyond the 53ft ROW to the edge of the 120ft temporary construction ROW will grow unhindered.

Figure 2 shows the entire geothermal modeling domain representing the typical ROW cross-section described above. Figure 3 shows a closer view of the soil types and boundary conditions over the 120ft wide construction ROW. Note that the length units in these figures are in meters, not feet, as it was necessary to perform the modeling in metric units due to current limitations in the TEMP/W add-in module that computes the surface energy balance flux boundary conditions at the ground surface.

Undisturbed terrain was modeled using an 8in thick organic peat layer overlaying a fine-grained and ice- rich mineral soil. Cleared terrain occurs on the ROW where trees were cleared and the organics layer is preserved. Equipment operating on the spoil side of the ROW during construction will compress the organic layer somewhat. To simulate this disturbance, the organic soil properties were modified to represent compressed organic peat. The 18in thick gravel pad was modeled as either being placed directly on top of the organic layer (having ‘buried’ organic soil properties), or, as a bounding case, with no organic layer below the gravel pad. The 36in pipe was buried with 3 feet of cover depth above the pipe.

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The finite element mesh over the entire domain geometry is shown in Figure 4 and included 4721 nodes and 4621 elements. The highest temperature gradients within the modeling domain are near the pipe and downward from the ground surface. In these areas a higher node/element mesh density was used as shown in Figure 5.

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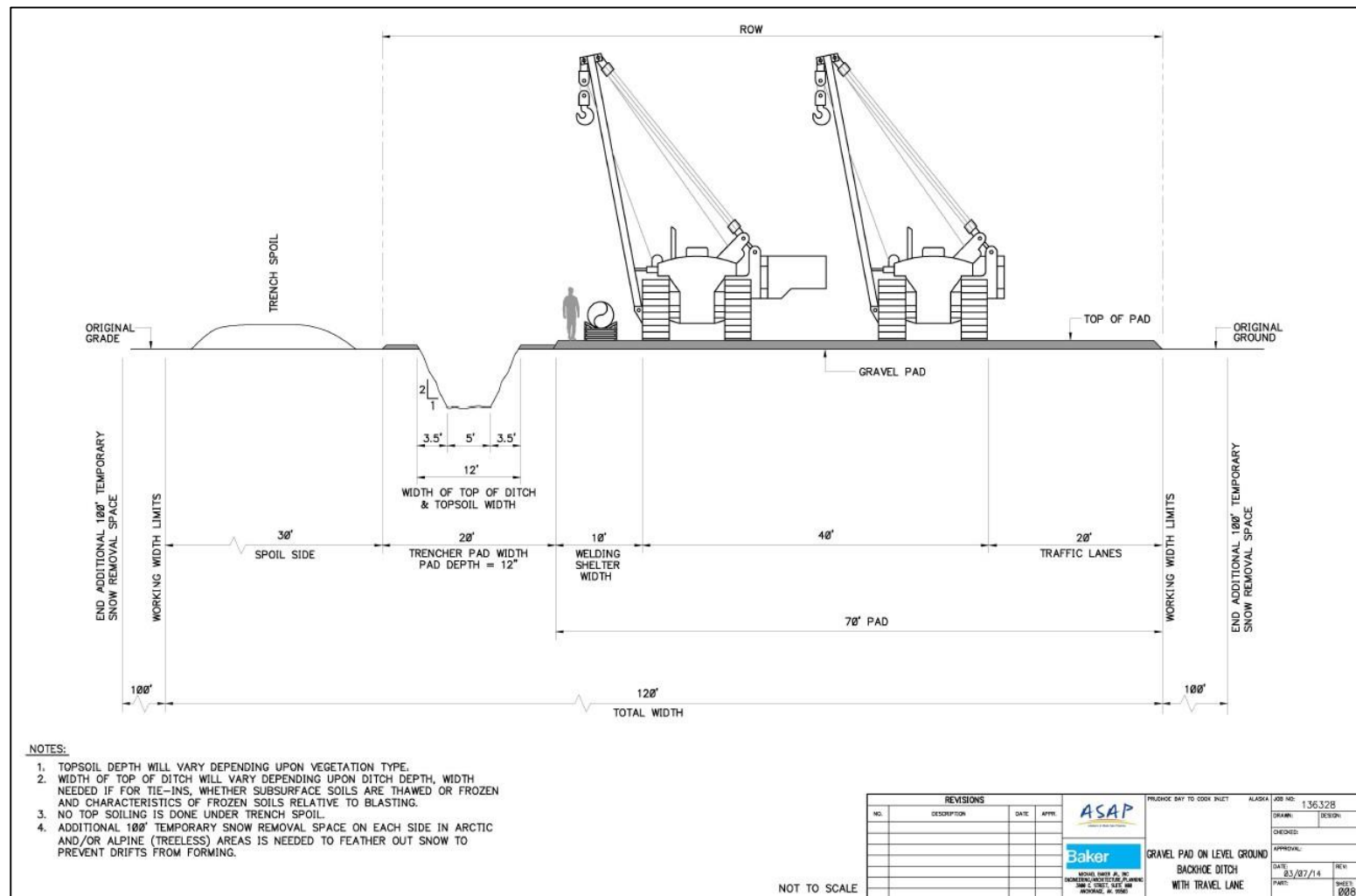


Figure 1 Typical ROW in Discontinuous Permafrost

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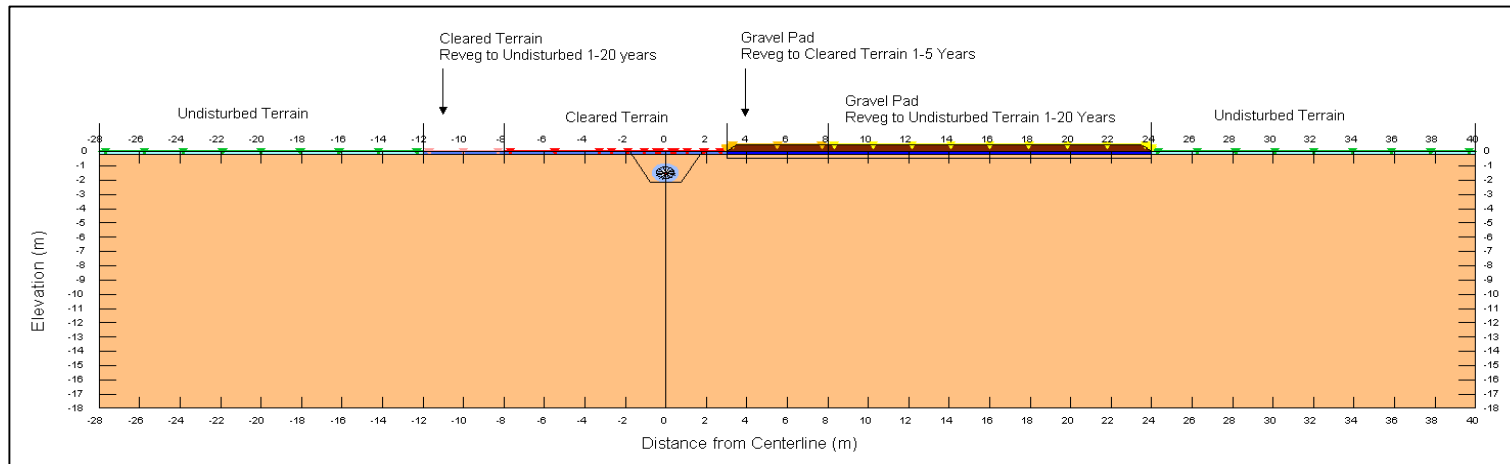


Figure 2 Geothermal Modeling Domain

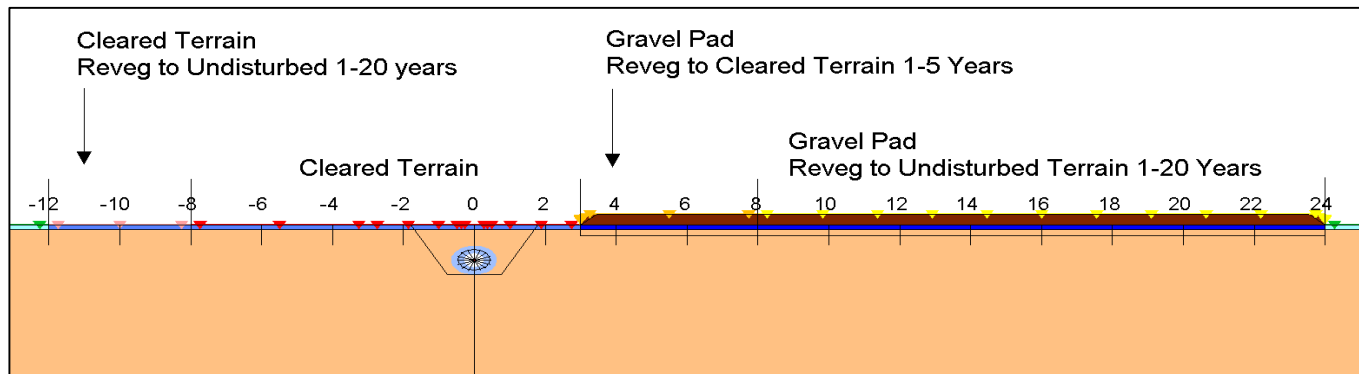


Figure 3 Soil Types and Boundary Conditions

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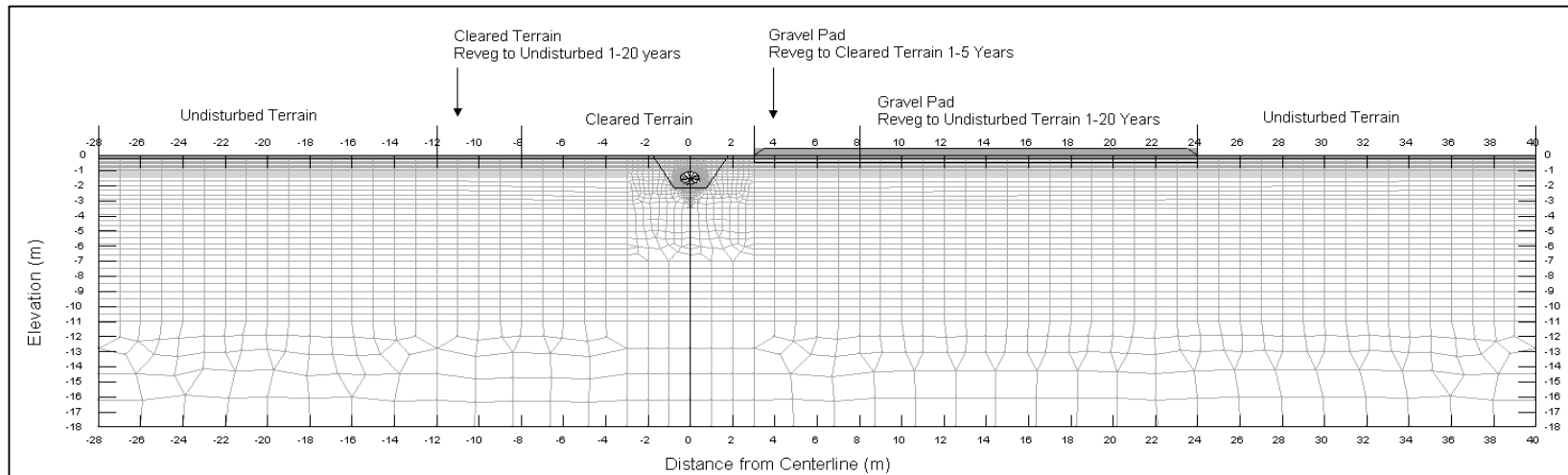


Figure 4 Finite Element Mesh

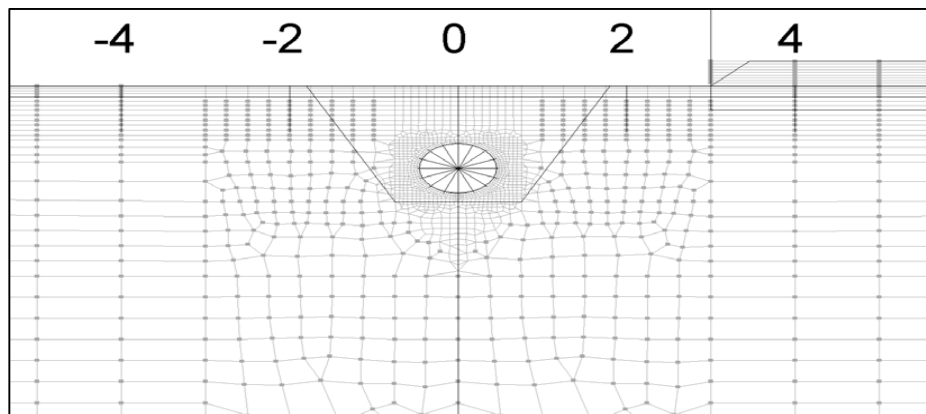


Figure 5 Finite Element Mesh near Pipe

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3.2 Material Properties

Table 1 shows soil property parameters for water saturated fine-grained mineral soil at two moisture contents, for organic soils which are undisturbed, compressed and buried, and for the gravel pad material. For the modeling reported herein, 35% moisture content was used for the fine-grained mineral soil which is representative of ice-rich permafrost.

A constant snow thermal conductivity of 0.29 W/m-°C was used for all analyses and was determined by model calibration as discussed later.

Table 1 Soil Properties

Parameter	Sat. Silt & Clay Soil w=35%	Sat. Silt & Clay Soil w=25%	Organic Soil w=200%	Compressed Organic Soil w=150%	Gravel Pad w=10%	Buried Organic Soil w=140%	Unit	Description
Gs	2.67	2.67	1.4	1.4	2.67	1.4	--	specific gravity of solids
n	0.48	0.40	0.76	0.70	0.25	0.66	m ³ /m ³	porosity
S	1.00	1.00	0.90	0.90	0.80	1.00	m ³ /m ³	saturation
w	0.35	0.25	2.04	1.50	0.10	1.40	g/g	gravimetric water content
A	0.100	0.100	0.050	0.050	0.030	0.050	--	unfrozen water content at -1 C
B	-0.300	-0.300	-0.700	-0.700	-0.700	-0.700	--	unfrozen water content function exponent
Ku	1.20	1.40	0.40	0.43	2.70	0.60	J/(s*m°C)	unfrozen thermal conductivity of soil
Kf	2.00	2.00	0.90	0.87	3.20	2.90	J/(s*m°C)	frozen thermal conductivity of soil
L	3.34E+08	3.34E+08	3.34E+08	3.34E+08	3.34E+08	3.34E+08	J/m ³	latent heat of water
Cw	4.187E+06	4.187E+06	4.19E+06	4.187E+06	4.187E+06	4.187E+06	J/(m ³ *C)	heat capacity of water
Ss	0.17	0.17	0.4	0.4	0.17	0.4	--	specific heat capacity of solids
Cu/Cw	0.696	0.651	0.828	0.741	0.540	0.810	--	unfrozen heat capacity of soil relative to water
Cf/Cw	0.463	0.457	0.482	0.449	0.440	0.495	--	frozen heat capacity of soil relative to water
pdry	1350	1550	340	390	2000	450	kg/m ³	dry density of soil
pwat	1000	1000	1000	1000	1000	1000	kg/m ³	density of water
theta	0.48	0.40	0.68	0.63	0.20	0.66	--	volumetric water content of soil
Ku	103.7	121.0	34.6	37.2	233.3	51.8	kJ/(d*m°C)	unfrozen thermal conductivity
Kf	172.8	172.8	77.8	75.2	276.5	250.6	kJ/(d*m°C)	frozen thermal conductivity
Cu	2915	2724	3467	3103	2260	3390	kJ/(m ³ *C)	unfrozen heat capacity
Cf	1938	1913	2018	1878	1842	2072	kJ/(m ³ *C)	frozen heat capacity
L	3.34E+05	3.34E+05	3.34E+05	3.34E+05	3.34E+05	3.34E+05	kJ/m ³	latent heat of water

3.3 Climate Data

Table 2 provides mean monthly climate normals for Fairbanks. These data were used in the surface energy balance model to determine the net heat energy flux into or out of the ground surface at each node in the thermal model at each time step.

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Table 2 Fairbanks Climate Data

Month	Air Temp (°C)	Air Temp (°F)	Wind Speed (km/h)	Wind Speed (mph)	Solar Radiation (W/m ²)	Solar Radiation (BTU/hr/ft ²)	Snow Depth (cm)	Snow Depth (ft)
January	-23.9	-11.0	4.7	2.9	7.7	2.4	46.2	1.52
February	-19.4	-2.9	6.1	3.8	34.4	10.9	58.0	1.90
March	-12.8	9.0	7.9	4.9	103.6	32.8	50.8	1.67
April	-1.4	29.5	10.4	6.5	182.6	57.9	25.7	0.84
May	8.4	47.1	12.2	7.6	227.6	72.1	0.0	0.00
June	14.7	58.5	11.2	7.0	248.9	78.9	0.0	0.00
July	15.4	59.7	10.4	6.5	216.0	68.5	0.0	0.00
August	12.4	54.3	9.7	6.0	156.4	49.6	0.0	0.00
September	6.4	43.5	9.7	6.0	92.0	29.2	0.0	0.00
October	-3.2	26.2	8.6	5.3	39.7	12.6	4.0	0.13
November	-15.6	3.9	6.1	3.8	13.6	4.3	18.1	0.59
December	-22.1	-7.8	5.0	3.1	2.9	0.9	32.3	1.06

3.4 Boundary Conditions

At the ground surface, the net heat energy flux into or out of the ground was calculated at each ground surface node of the finite element model at each time step using a surface energy balance model based on Hwang, 1976.

Ground surface properties for undisturbed terrain, the cleared ROW terrain, and the gravel pad surface are shown in Table 3. Ground surface disturbance for the cleared terrain was simulated by varying the summer albedo and evapotranspiration factors. These values have been shown to reproduce the long-term thaw depths observed at the Fairbanks Surface Disturbance Test site (Linell 1973 and Douglas et. al. 2008), however those results are beyond the scope of this document.

The side boundaries and bottom boundaries were zero-flux boundaries. As such, the geothermal model calculated the temperatures at these boundaries. The side boundaries are far enough away from the thermal disturbance of the ROW that there is no horizontal heat transfer at the sides of the modeling domain. A small non-zero geothermal heat flux could have been included at the bottom boundary, however it was not because it does not significantly affect the calculated temperatures at the relatively small scale depths here, which are on the order of tens of feet. In addition, the geothermal heat flux is very small relative to the net heat flux from energy exchange at the ground surface. Including the geothermal flux would therefore add unnecessary complexity to the model.

To simulate revegetation on the ROW, ground surface properties of summer albedo and evapotranspiration factor were linearly varied over a specified time period from their values during construction to their long-term values. For example, the cleared terrain on the spoil side of the ROW outside of the 53ft permanent ROW was simulated to revegetate from cleared terrain (during construction) to undisturbed terrain over an elapsed time period from 1 to 20 years. Similarly, the gravel pad outside of the 53ft permanent ROW was simulated to revegetate to undisturbed terrain over the same time period, 1 to 20 years. The gravel pad within the permanent 53ft ROW was simulated to revegetate to cleared terrain over a time period from 1 to 5 years. The cleared terrain on the spoil side of the ROW and above the pipe trench was simulated to remain unchanged as cleared terrain throughout the entire simulation period of 30 years.

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Table 3 Ground Surface Properties

Terrain	Summer Albedo	Winter Albedo	Evapotransp Factor
Undisturbed (trees)	0.65	0.85	0.65
Cleared	0.08	0.85	0.30
Gravel Pad	0.07	0.85	0.20

Pipe temperature boundary conditions were obtained from hydraulics modeling (Baker, 2015) from ASAP pipeline milepost 440 near Fairbanks. The maximum, minimum and average pipe temperatures at MP440, used in the modeling reported herein, were 22.7°F, 42.4 °F and 32.4°F, respectively. From previous thaw depth analyses for pipe integrity, it was observed that the pipe temperatures from this set of hydraulics runs may be warm by 2°F to 3°F, which may have been the result of some conservatism in the hydraulics analysis regarding maximum gas throughput. In any event, the pipe temperatures may be slightly conservative for the thaw depth analysis presented herein but are inconsequential to maximum thaw depths on the ROW which are too far from the pipe to be influenced by it.

3.5 Model Calibration

The geothermal model was calibrated such that it would reproduce a MAGT of 31.1°F (-0.5°C) in undisturbed terrain. This is representative of warm permafrost in the Fairbanks area.

A series of one-dimensional (1D) model runs using an undisturbed soil profile was performed. For each run, a constant (time-invariant) snow thermal conductivity was used and the model was run to periodic steady-state (approximately 10 years). This technique was used to find the snow thermal conductivity value such that the model would produce the target MAGT, in this case 31.1°F for Fairbanks.

4. ROW THAW DEPTH RESULTS

If present, the top layer of organic peat soils provides an insulative layer in permafrost environments. To assess the insulative effect of preserving the organic soil layer beneath the gravel pad, a pair of two-dimensional (2D) geothermal modeling runs were performed with and without a buried organic layer below the gravel pad.

Figure 6 shows the 30-year thaw depth profile across the ROW for the case with a buried organic layer beneath the gravel pad. The edge of the gravel pad is located 24m (80ft) from the pipe center-line. As shown in the figure, the 30-year thaw depth rises towards the edge of the gravel pad and tapers to the active layer depth of the undisturbed terrain at about 32m (105ft) from the pipe center-line, or about 8m (26ft) from the edge of the gravel pad.

Figure 7 shows the 30-year thaw depth profile across the ROW for the case where the organic layer is not present beneath the gravel pad. In this case the 30-year thaw depth beneath the gravel pad is somewhat deeper, and the influence of the gravel pad thaw extents to about 34m (112ft) from the

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pipe centerline, or about 10m (33ft) beyond the edge of the gravel pad, which is about 2m (7ft) farther than in the case where the organic layer below the gravel pad was present.

Comparison of Figure 6 and Figure 7 shows that the 30-year thaw depths on the spoil side of the ROW are the same in both cases and as one might expect, the presence of the organic layer below the gravel pad does not affect thaw depth on the spoil side of the ROW.

Figure 8 shows the variation with time of the deepest thaw depth on each side of the ROW. As stated earlier, the cleared terrain on the spoil side of the ROW outside of the permanent 53ft cleared ROW was simulated to revegetate to undisturbed terrain over years 1 to 20. The gravel pad within the 53ft cleared ROW on the gravel pad side of the ROW was simulated to revegetate to a cleared terrain state over years 1 to 5. Outside the 53ft cleared ROW, the gravel pad was simulated to revegetate to undisturbed terrain (treed) over years 1 to 20. As shown in Figure 8 the maximum 30-year thaw depths on the spoil and gravel pad side of the ROW were calculated to be nominally 18ft and 22ft, respectively.

Figure 9 shows the same thaw depth information as Figure 8 for the case where no organic layer was present beneath the gravel pad. In this case, the 30-year thaw depth is unchanged at 18ft as mentioned earlier. Beneath the gravel pad, the 30-year maximum thaw depth increased to nominally 25ft, an increase of about 3ft from the case where an organic layer was present beneath the gravel pad.

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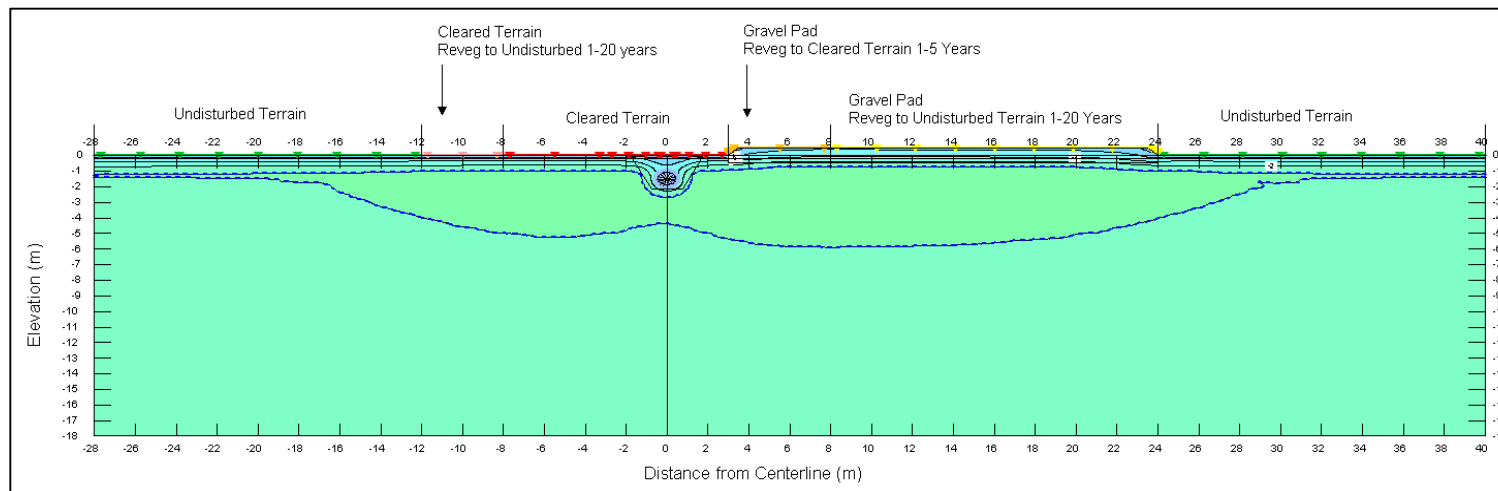


Figure 6 ROW 30-Year Thaw Depth Profile for Case with Buried Organic Layer below Gravel Pad

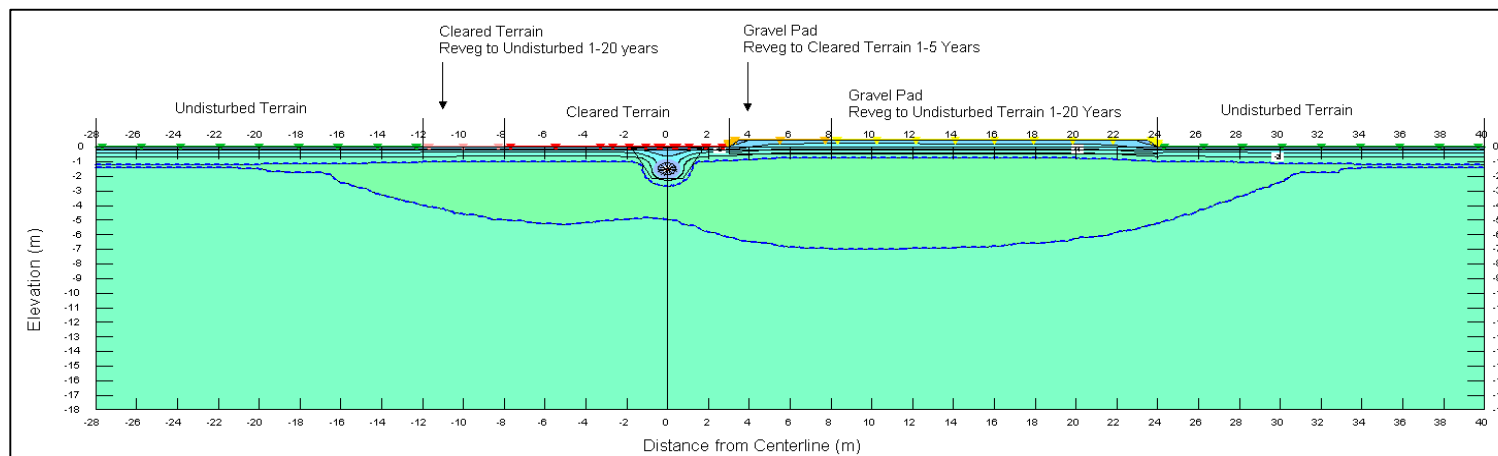


Figure 7 ROW 30-Year Thaw Depth Profile for Case without Buried Organic Layer below Gravel Pad

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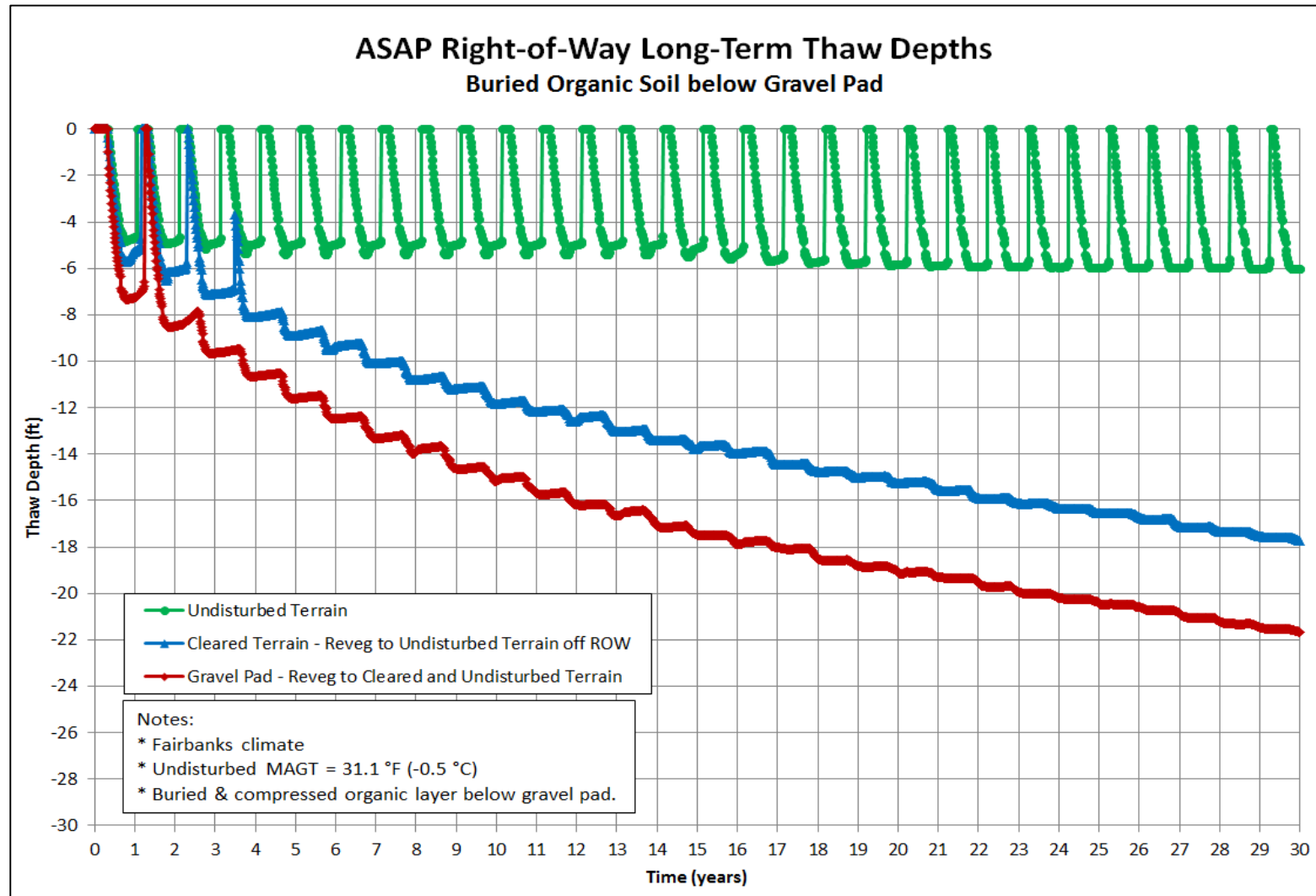


Figure 8 ROW Thaw Depths for Case with Buried Organic Layer below Gravel Pad

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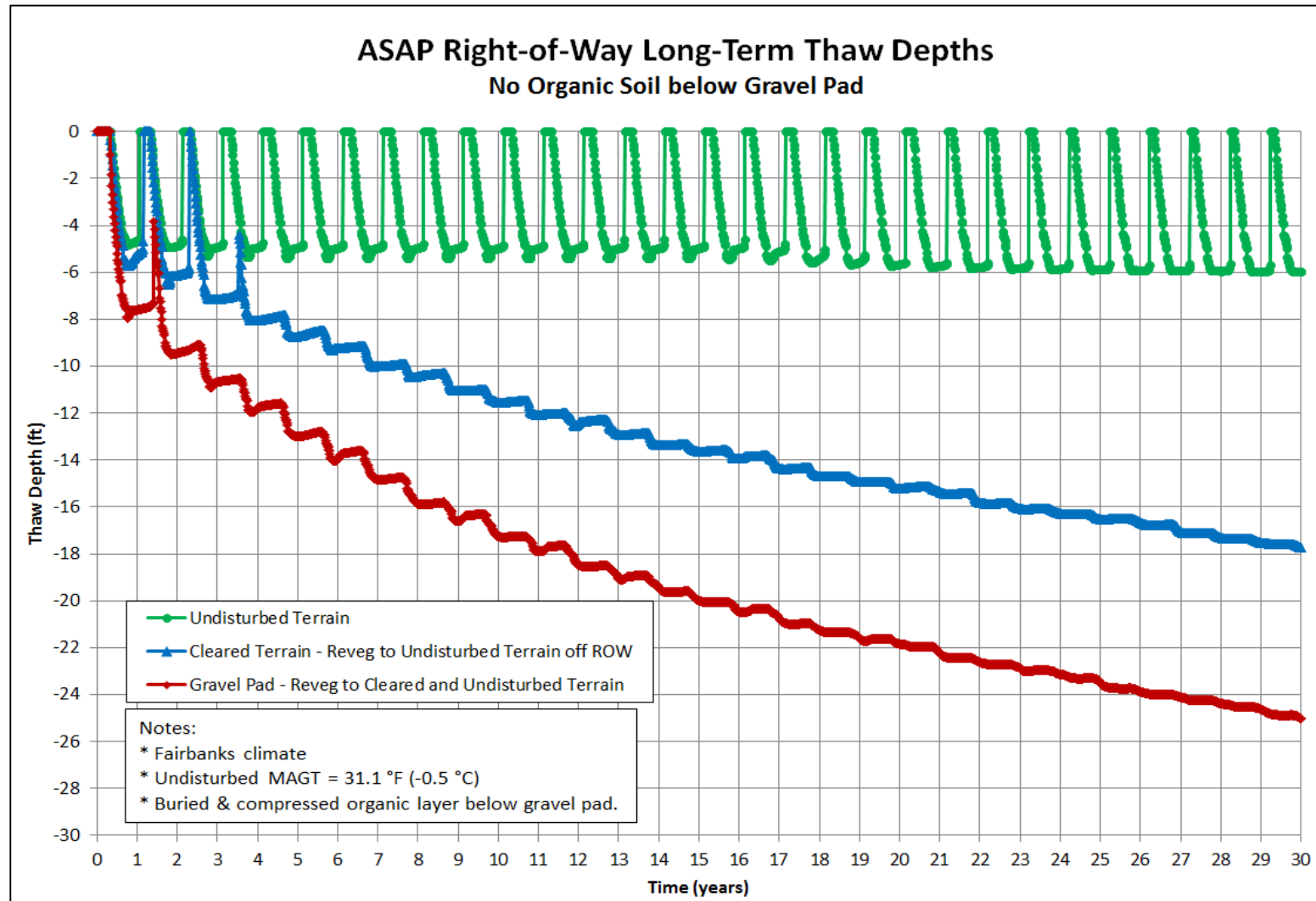


Figure 9 ROW Thaw Depths for Case without Organic Layer below Gravel Pad

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5. CONCLUSIONS

The following conclusions were drawn from the thaw depth modeling results presented herein:

- Disturbances to the ground surface during construction and subsequent pipeline operations cause changes to the surface heat energy balance and a corresponding increase to net heat energy flux into the ground at the ground surface. The increase in net energy flux into the ground causes long-term progressive thaw depth deepening that does not freeze back over the winter seasons.
- It is reasonable to expect deeper thaw depth beneath the 18in thick gravel pad compared to the thaw depth beneath cleared terrain. This is a result of higher net energy influx from the gravel pad caused by higher solar radiation absorption and less evapotranspiration of the gravel pad surface compared to the vegetated surface of cleared terrain. For cleared terrain, the 30-year thaw depth was calculated to be 18ft whereas beneath the gravel pad the 30-year thaw depth was calculated to be 22ft to 25ft with and without an organic layer below the gravel pad, respectively.
- The thermal influence of the gravel pad extends beyond the edge of gravel pad by about 26ft and 33ft in the cases with and without an organic layer below the gravel pad, respectively.

6. CLOSURE

We trust that this technical memo suits your present requirements. If you have any questions or comments, please call the undersigned at 403-727-0260.

Yours truly,

MATRIX SOLUTIONS INC.

Ron Coutts, M.Sc., P.Eng. (AB) Senior Geological Engineer

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DISCLAIMER

We certify that this letter report is accurate and complete and accords with the information available at the time the work was undertaken. Information provided by third parties is believed to be accurate but is not guaranteed. We have exercised reasonable skill, care and diligence in assessing the information obtained during the preparation of this letter report.

This letter report was prepared for Michael Baker Jr. Inc. and the Alaska Gas Development Corp. The letter report may not be relied upon by any other person or entity without our written consent and that of Michael Baker Jr. Inc. and Alaska Gas Development Corp. Any uses of this letter report by a third party, or any reliance on decisions made based on it, are the responsibility of that party. We are not responsible for damages or injuries incurred by any third party, as a result of decisions made or actions taken based on this letter report.

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ATTACHMENT 2 – THAW AFFECTED ZONE GIS METHODOLOGY OVERVIEW (10-MARCH-2017)

Thaw Affected Zone (TAZ) GIS Methodology Overview (10-March-2017)

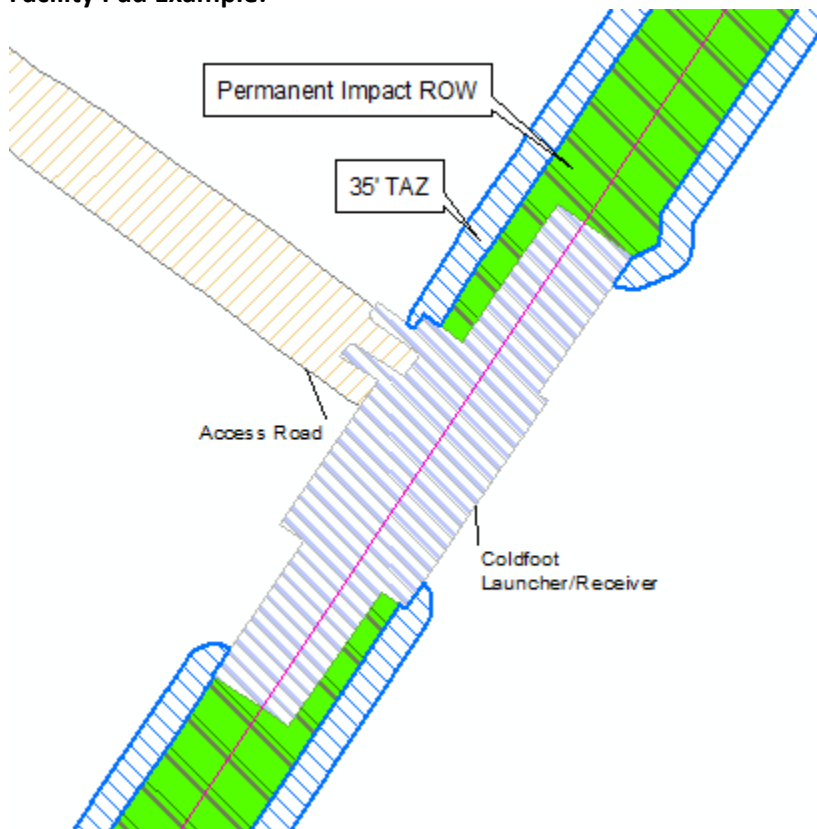
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The area of interest is the ASAP Mainline from MP 168-634 and excludes the Fairbanks Lateral. The 35ft indirect Thaw Affected Zone (TAZ) was generated on the outer edge of direct Permanent impact areas within the project ROW. These impact areas included Permanent Construction Impact and HDD Entry/Exit Pad categories. Facility Pads in the ROW (Coldfoot Launcher/Receiver, Fairbanks Lateral Tie-In) did not require generation of a TAZ due to adequate pad thickness, so any TAZ adjacent to facility pads outside the ROW was removed. As the acreage of the facility pads and the Permanent Impact ROW have already been accounted for in the direct wetlands impact footprint, the indirect TAZ never overlaps these areas.

Facility Pad Example:



There is no TAZ applied to stream crossing features, which exist as 5' trenches (open cut or isolated open cut), bridges, and horizontal directionally drilled (HDD) crossings. These areas were

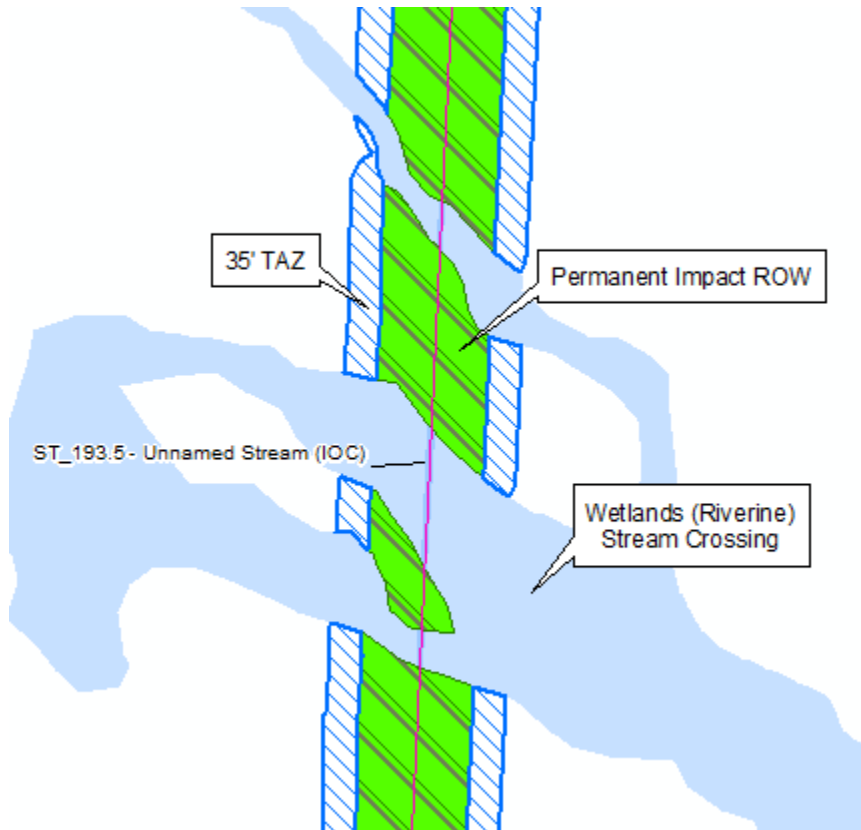
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excluded by trimming in GIS using the wetlands delineation definition for stream crossings. This is the same technique that was used to develop stream crossing features for the project footprint. Any wetlands layer 'ATTRIBUTE' that started with 'R' represented a stream crossing. These included HGM CLASS 'Riverine' and Cowardin codes 'Intermittent', 'Lower Perennial', 'Upper Perennial', or 'Unknown Perennial'.

Stream Crossing Example:



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Temporary Impact features in the project footprint ROW do not generate a TAZ. These include temporary workspaces, temporary construction impacts (e.g., matting) and HDD false ROW features. Any temporary direct impact to wetlands was previously calculated for these features. However, any adjacent TAZ from a permanent impact was allowed to overlap these features; this is due to ongoing thermal impacts after the area has been temporarily impacted.

Temporary Workspace Example:



Existing road crossings (e.g., Dalton Highway, Parks Highways) and existing Access Roads have been removed from the TAZ.

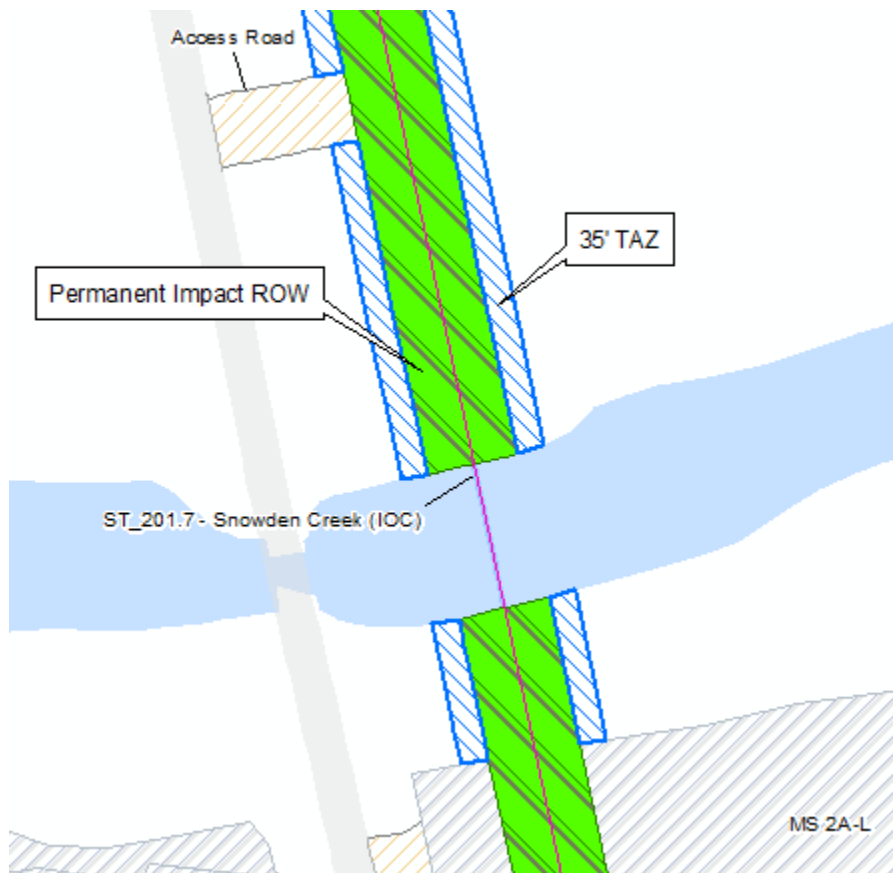
Other permanent impact features include new access roads, camps, pipe storage yards (PSYs), material sources and railroad sidings. These do not require an indirect TAZ per the rationale described in the main body of the report. In locations where these features overlap the ROW TAZ, the TAZ area has been removed. The direct impact for these overlapping areas has already been accounted for in previous calculations.

Access Road and Material Source Example:

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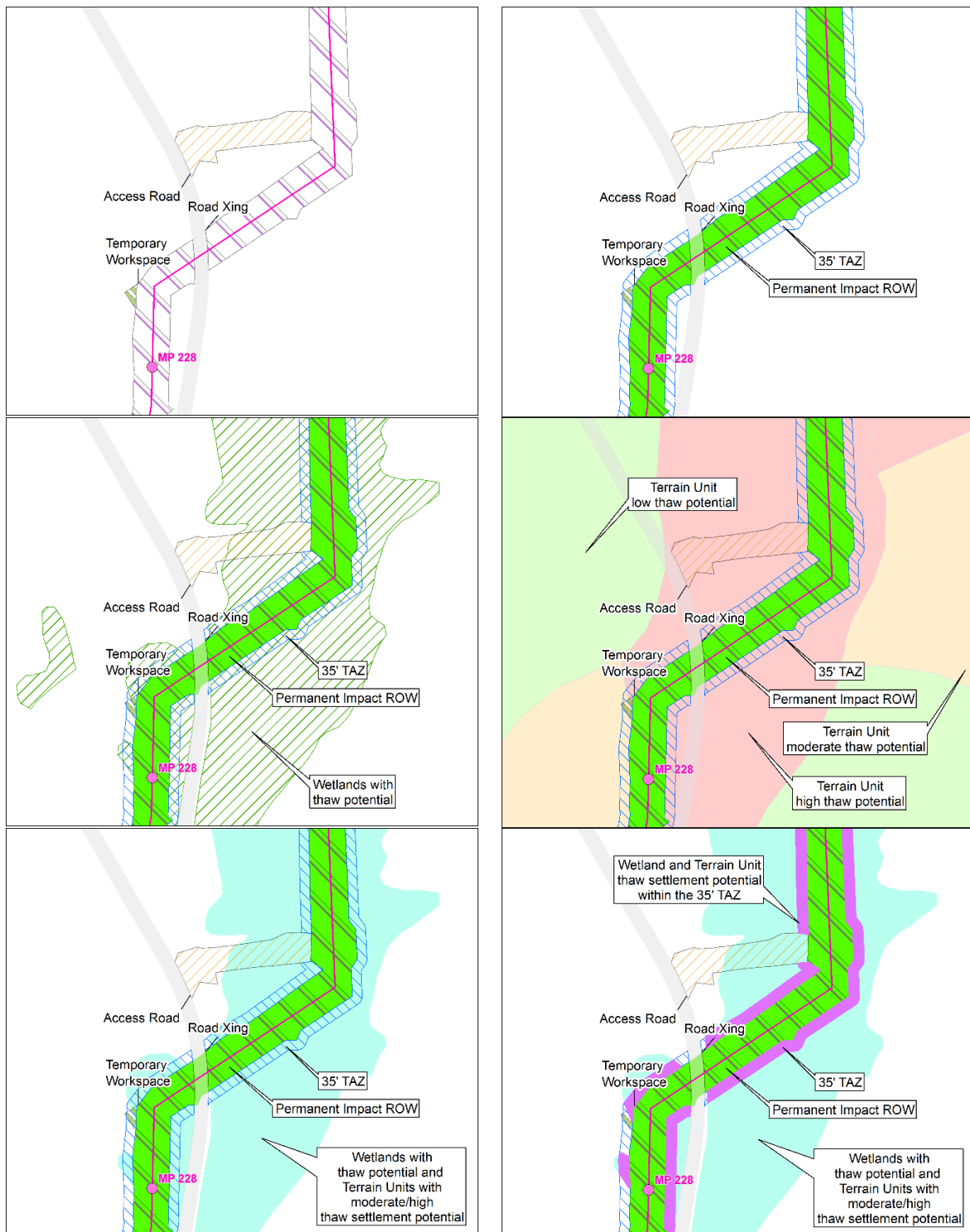


Thaw Affected Zone GIS Analysis Steps:

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Segregation of the Surface Layer

Request for Information

Federal agencies have asked the Alaska Gasline Development Corporation (AGDC) to provide a rationale for why specific design or mitigation measures for “topsoil” segregation have not been proposed for the entirety of the natural gas pipeline. AGDC has been asked to define under what conditions would such mitigation measures be ineffective and why.

Executive Summary

AGDC’s goal has been to stabilize the pipeline right-of-way (ROW) through the re-establishment of vegetation so that lands can effectively be used to operate the pipeline for 30 years. AGDC has worked with the Alaska Department of Natural Resources (ADNR) Plant Material Center (PMC), Alaska’s experts in erosion control, in developing a Revegetation Plan (AGDC 2017) based on proven methodologies that will achieve the goal of the project. While certain agency-proposed methods of “harvesting tundra sod blocks” or “removing and replacing topsoil throughout the entire ROW” are not practicable for this project, there are select areas along the ROW where the surface layer is intended to be salvaged prior to ground disturbance as a mitigation measure to aide in enhancing future stabilization efforts.

Salvaging the surface layer is intended to occur in permafrost areas where underlying soils are thaw-stable, pipeline construction is planned for summer, ROW preparation mode is grading (e.g. cut/fill), and cross slope and/or the longitudinal slope is less than or equal to 2%; where slopes range from 2 to 20%, the cut area only will be salvaged. Where underlying permafrost soils are thaw-sensitive, pipeline construction is planned for summer, and cross slope and/or longitudinal slope is greater than 10%, the surface layer will be segregated from the area to be excavated only. This will result in salvaging the surface layer over approximately 186 miles of the ROW in continuous and discontinuous permafrost areas. In non-permafrost areas, salvaging the surface layer will occur where pipeline construction is planned for summer, ROW preparation mode is grading or cut/fill, and cross slope and/or longitudinal slope is less than or equal to 2%; where slopes range from 2 to 20%, the cut area only will be salvaged. This will result in additional mileage where the surface layer will be salvaged for future use in ROW stabilization.

Surface layer segregation and replacement is not practicable for the entire ROW due to limitations of cost, logistics, and available technology. However, even if it was practicable for the entire route, the majority of this very thin surface layer is defined by physical and chemical characteristics that could be naturally limiting or unstable if moved and replaced. AGDC also investigated whether an experimental method of harvesting sod tundra blocks could be used as a mitigation measure. The method was determined to be impracticable for ROW stabilization because: tundra blocks can only be segregated intact when the active layer is thawed; access with heavy equipment is required while ground is thawed; harvested tundra blocks must be stored until after pipeline construction; and winter placement of tundra blocks would result in complications that would not achieve the desired result. Therefore, AGDC dismissed this suggested mitigation, selecting instead to rely upon the measures proposed in its Revegetation Plan (AGDC 2017) that use proven stabilization methods developed and practiced by an experienced state agency.

Detailed Response

Alaska has very little “topsoil” as defined by typical Lower 48 standards, so in essence this term is a misnomer. Instead, Alaska’s lands have a thin surface layer that typically consists of a combination of loose surficial herbaceous material consisting of small shrubs, vegetation, and woody debris, overlaying a thin layer of organics and weak, compressible mineral soils. The majority of the pipeline ROW traverses areas underlain by either continuous or discontinuous permafrost, reaching from MP 0 at Prudhoe Bay to the Hurricane area (approximately MP 607) (USACE 2017; Jorgenson et al., 2015). In permafrost terrain, the ground surface may be tundra (mostly north of the Brooks Range) or stunted boreal forests (mostly south of the Brooks Range). For either vegetation type, beneath the organic surface mat is normally intermingled an ice-rich silty layer known as the ‘active layer’ because it thaws in the summer months and freezes solid in the winter months. When the active layer thaws, the ground surface becomes soft due to the saturated silty soils in the active layer beneath the vegetation.

AGDC will address the questions raised by the agencies by providing the following information:

1. **What specific design or mitigation measures with regard to segregation of the organic surface layer (“topsoil”) are proposed;**
2. **Why segregation of the surface layer is not proposed project-wide; and**
3. **Under what conditions will surface layer segregation be ineffective as a mitigation measure and why.**

1. What specific design or mitigation measures with regard to segregation of the organic surface layer (“topsoil”) are proposed.

As stated above, the ADNRC PMC have a proven record of revegetation control erosion and rehabilitation of sites in the state, including areas north of the Brooks Range (e.g., Project Chariot) (ADNRC PMC 1995) and areas south of the Brooks Range (e.g., Kanuti Pit, monitored over 5 years from 2003 - 2008) (ADNRC PMC 2008). ADNRC PMC staff have been involved in detailed discussions with AGDC regarding revegetation along the pipeline ROW since 2016. The ADNRC PMC have also communicated that surface layer segregation has been attempted in Alaska with mixed results. In some cases, removal and replacement of the surface layer has failed to produce desired results, and supplemental fertilization and re-seeding have been required to meet cover standards. The plan proposed by the ADNRC PMC will be both practicable and effective for re-establishing vegetation along the pipeline ROW.

That said, AGDC does intend to segregate the surface layer to the extent practicable in some locations based on the prevailing local site and climatic conditions, as such methods are recommended by AGDC engineers in certain instances. These surface organics may be useful for enhancing revegetation in areas where it is thought that stabilization of lands might be benefited or enhanced by applying the stockpiled material; however, surface organics may not always be replaced in the exact location or condition from where they came, as this is not the goal of stabilization of the ROW.

The criteria for determining whether the surface layer will be segregated is as follows:

Permafrost Areas

- Where the underlying soils are thaw-stable, the pipeline construction is planned for summer, the ROW preparation mode is grading (e.g. cut/fill), and;
 - The cross slope and/or the longitudinal slope is less than or equal to 2%; the surface layer will be segregated from the Construction ROW and stockpiled near the edge of the ROW for use in future stabilization efforts.
 - Or, the cross slope and/or the longitudinal slope is greater than 2% but less than or equal to 20%; the surface layer will be segregated from the cut area of the Construction ROW and stockpiled near the edge of the ROW for use in future stabilization efforts. However, the fill area will not have the surface layer segregated.
 - When the cross slope or longitudinal slope is greater than 20%; the surface layer will not be segregated. These locations will typically have a work pad that is constructed with granular fill.
- Where the underlying soils are thaw-sensitive, the pipeline construction is planned for summer, and the cross slope and/or the longitudinal slope is greater than 10%;
 - The ROW preparation mode will be grading on the uphill side; however, the excavated material will not be suitable for use as a work pad construction material. As these locations will typically have a work pad that is constructed with granular fill, the surface layer will be segregated from the area to be excavated only.
- Segments that require winter construction will not employ topsoil segregation, as effective segregation of frozen material is impracticable (see a further explanation below). For areas along the alignment that employ measures to minimize surface disturbance (e.g. icepads), topsoil segregation is not proposed.

Non-Permafrost Areas

- Where pipeline construction is planned for summer, the ROW preparation mode is grading or cut/fill, and;
 - The cross slope and/or the longitudinal slope is less than or equal to 2%; the surface layer will be segregated from the Construction ROW and stockpiled near the edge of the ROW for use in future stabilization efforts .
 - The cross slope and/or the longitudinal slope is greater than 2% but less than or equal to 20%; the surface layer will be segregated from the cut area of the Construction ROW and stockpiled near the edge of the ROW for use in future stabilization efforts. The fill area will not have the surface layer segregated.
 - However, when the cross slope and/or the longitudinal slope is greater than 20%; the surface layer will not be segregated. These locations will typically have a work pad that is constructed with granular fill.

- Segments that require winter construction will not employ topsoil segregation, as effective segregation of frozen material is impracticable (see a further explanation below). For areas along the alignment that employ measures to minimize surface disturbance, topsoil segregation is not proposed.

The application of the above criteria will generally yield the results in Table 1.

Table 1. Potential Locations of Surface Layer Segregation in Continuous and Discontinuous Permafrost

From	To	Distance (Miles)	Potential Amount of Surface Layer Segregation (Miles)
Prudhoe Bay (MP 0)	Atigun (MP 168)	168	0
Atigun (MP 168)	South Fork Koyukuk River (MP 261)	93	18
South Fork Koyukuk River (MP 261)	Yukon River (MP 356)	95	30
Yukon River (MP 356)	Tanana River (MP 473)	117	36
Tanana River (MP 473)	Summit Lake (MP578)	105	74
Summit Lake (MP578)	**Hurricane (MP 607)	29	28
	Totals	607	186

Note: AGDC will also segregate the surface layer on agricultural lands, which are not denoted in this table

* Includes both planned summer and winter construction areas.

**The 126 miles between Hurricane (MP 607) and the Terminus (MP 733) is considered to be outside of the continuous or discontinuous permafrost area, and grading will be the preferred construction ROW preparation mode in uplands. Therefore, there will be additional mileage (yet to be determined) where the surface layer will be salvaged in non-permafrost areas for future use in stabilization efforts.

2. Why segregation of the surface layer is not proposed project-wide.

As stated above, AGDC's goal is to stabilize the pipeline right-of-way (ROW) through the re-establishment of vegetation in the project area so that lands can effectively be used to operate the pipeline for 30 years. AGDC's proposed revegetation efforts (AGDC 2017) were designed by the ADNRC PMC, the State of Alaska's experts in the re-establishment of vegetative cover with a proven record of erosion control through site revegetation around the state. Surface layer salvaging and replacement is not proposed project-wide because doing so is impracticable in terms of cost, logistics and available technology. However, even if the methodology was practicable, the vast majority of the extremely thin surface layer along the pipeline ROW is defined by physical and chemical characteristics that may be naturally limiting, per USDA NRCS STATSGO2 data (USDA NRCS, 2017) (see below) or that may become unstable if transported (i.e., removed and replaced).

Soil Type Classification – characterizes the type of soil with respect to genesis and development. The highest categories of soil classification taxonomy are distinguished by the presence or absence or a variety of combinations of diagnostic horizons and characteristics. Soil horizons are the result of the dominance of one or more sets of processes over other processes through time. Young soils are weakly developed and have indistinct soil horizons while older (mature) soils are strongly developed and have well defined soil horizons. The majority of the soil orders crossed by the proposed project have limited or shallow horizon development and consist of significant organic matter. Unlike soils in

hot climates, where horizons form fairly quickly, soils in cold climates decompose and integrate organic material into the soil surface more slowly. This lack of development often results in topsoil layers that are either thin and poor in quality or non-existent. As shown in Figure 1, below, the “topsoil” thickness (USDA NRCS data) varies along the ROW for the Alaska Stand Alone Pipeline (ASAP) project, with an average of less than 3 inches for the majority of the route in continuous permafrost areas and less than 4 inches in discontinuous permafrost areas. Descriptions of the parameters described by the dataset are as follows.

Soil Texture – describes soil composition in terms of percent of sand, silt, and clay. Evaluation of soil texture can allow for differentiation of viable soils for re-vegetation purposes. USDA NRCS rates soils as either “good,” “fair,” or “poor” as potential sources of topsoil. The ratings are based on the soil properties that affect plant growth; the ease of excavating, loading, and spreading the material; and reclamation of the borrow area. Properties that are inferred from soil texture, such as available water capacity and fertility, affect plant growth. Suitable soils are typically a blend of various sized particles that include sand, silt, and clay, known as loams. Soils are unacceptable if they are dominated by one particle size. Highly organic soils lacking an aggregate structure (e.g., peat or muck) can become unstable if transported. The removal and storage of these soils often result in impacts to structural integrity, which may reduce the function of these soils. The NRCS STASGO2 data classifies a significant amount of the soils crossed by the proposed project as peat, mucky peat, decomposed plant material, or unweathered bedrock (USDA NRCS, 2017). These classifications indicate the soil material remains largely unweathered and undeveloped. Common features in these soils include excessive wetness (peat soils), high organic matter content (partially decomposed plant material) or rock fragments (unweathered bedrock); Alaska soils are typically rated as “poor” regarding topsoil suitability.

Rock Fragment Content – The presence of rock fragments can reduce the amount of water and nutrients a soil can hold. At high volumes in the soil, rock fragments limit the biomass and vegetative cover a site can support. As shown in Figure 2, the majority of the soils along the ROW have a percent of stony / rocky soil greater than 50%.

Soil pH - is a measure of the acidity or basicity of a soil. Acid soils have a pH below 7 and alkaline soils have a pH above 7. Ultra-acidic soils (pH<3.5) and very strongly alkaline soils (pH>9) are the extremes of the spectrum. Soil acidity determines the solubility of soil minerals, which affects many microbial processes such as organic matter decomposition and nitrogen fixation. The availability of most nutrients is maximized in the pH range of 5.5 to 6.5. Some soil minerals contain nutrients, and these nutrients may become available for plant growth only when the soil pH is in a favorable range. As shown in Figure 3, the soil pH for the majority of the soils crossed by the proposed pipeline is below 5.0, indicating the soils range from strongly acidic to ultra acidic. Acidic soils are limited in fertility and are generally unsuitable for “topsoil” salvage.

Figure 1. STATSGO2 Topsoil Thickness

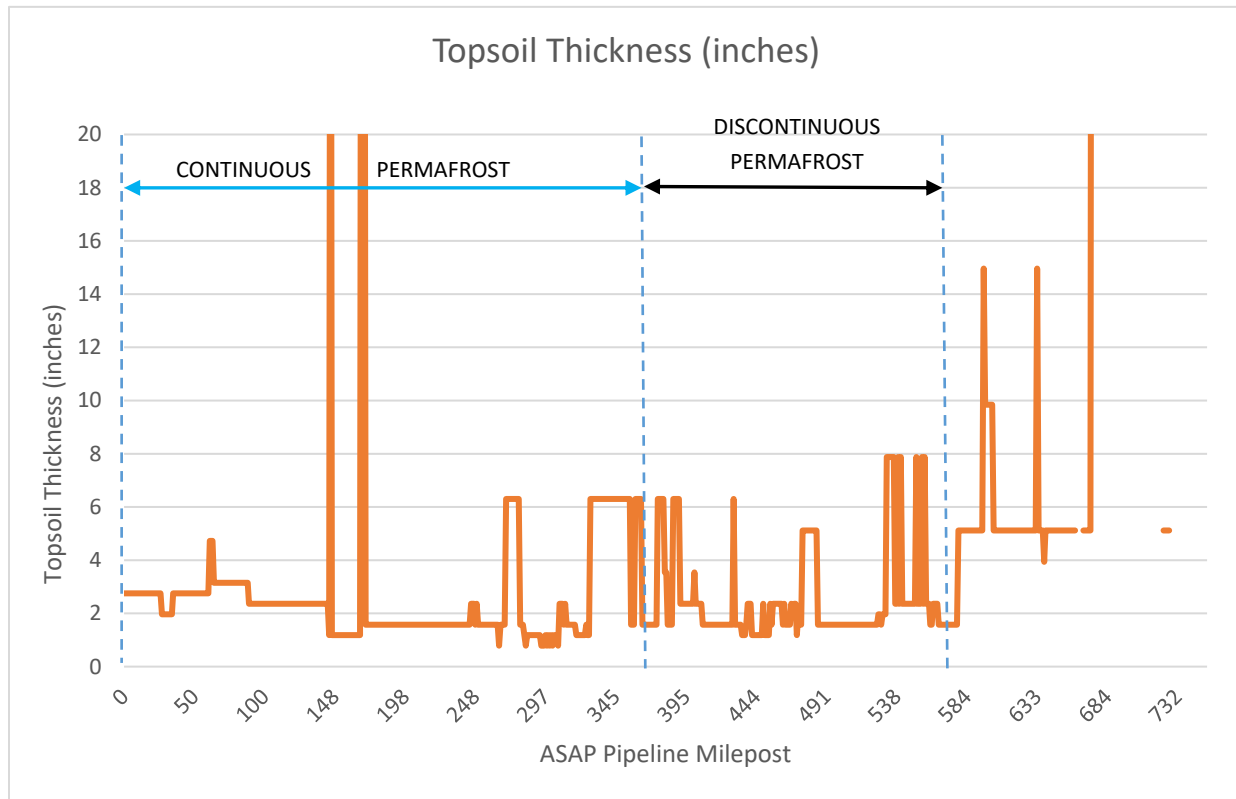


Figure 2. STATSGO2 Percent of Stony/Rocky Soils

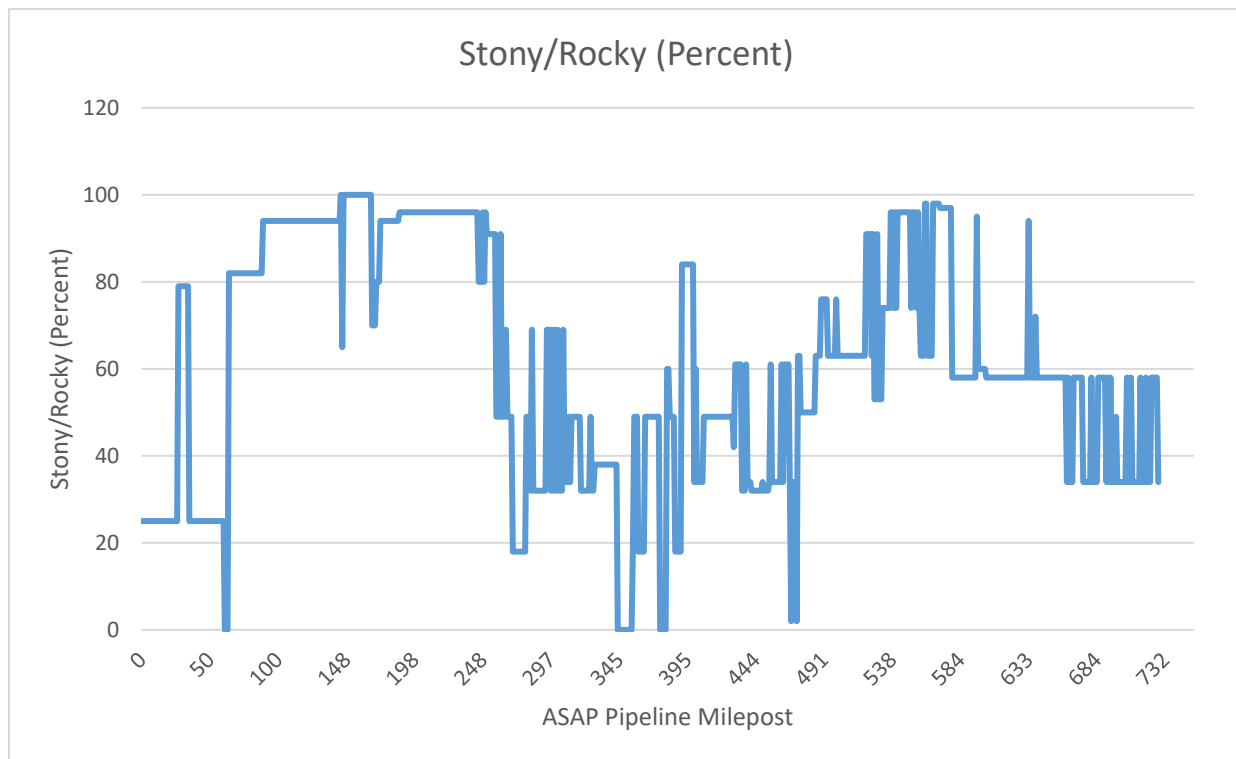
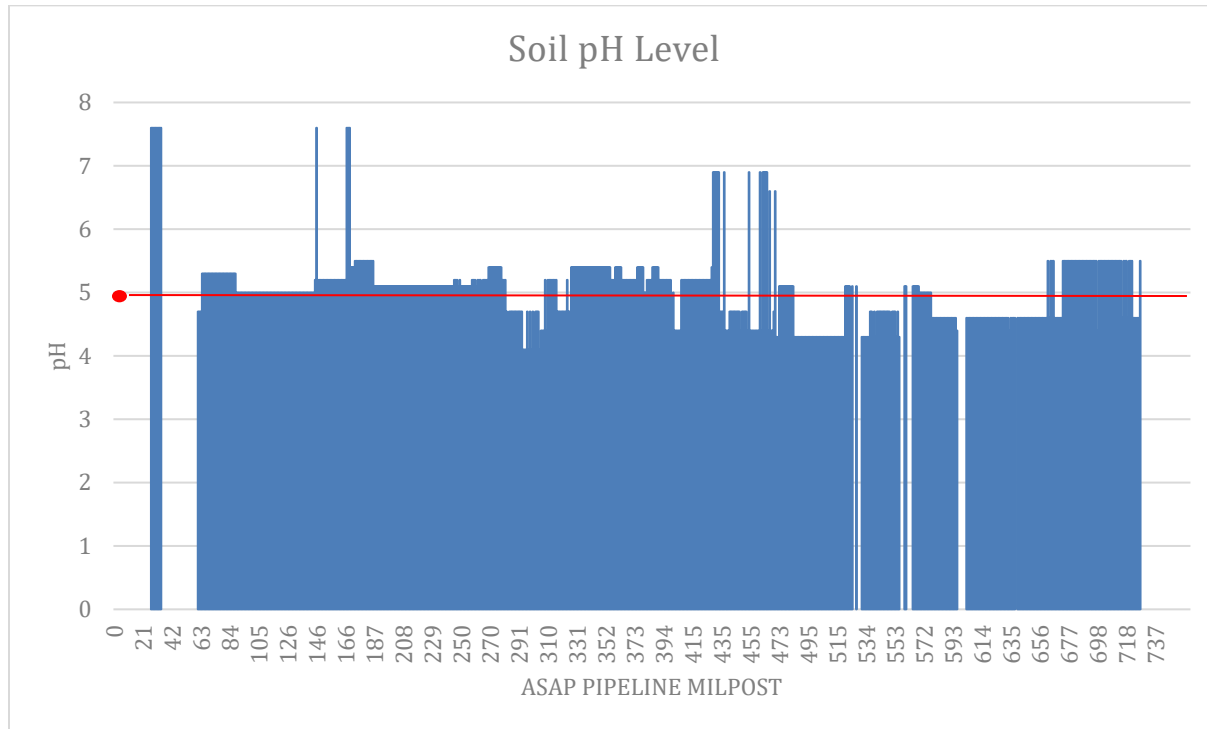


Figure 3. Topsoil pH Level



3. Under what conditions would surface layer segregation be ineffective as mitigation measure and why.

This broader question can be addressed by answering several more targeted questions:

Why is the Surface Layer Segregated in Select Areas and Not Others?

If the surface layer is mixed into the soil matrix used to construct thin work pad embankments, the result could be a work pad with poor trafficability, resulting in safety hazards and impediments to sound constructability. Because of this, AGDC intends to segregate the surface layer from the underlying mineral soils in areas of uplands that are planned for summer grading / excavation (where terrain and existing conditions permit). In areas of winter grading, the surface layer will be frozen and will provide suitable trafficability. As a result, the surface layer will not be segregated prior to grading activities in winter.

Why is the Surface Layer not Segregated in Permafrost Underlain by Thaw-Sensitive Soils?

Removing the surface layer creates long-term issues in permafrost where thaw-sensitive soils exist. If overlying vegetation is removed or disturbed, its insulating qualities are lost or diminished; therefore the permafrost may begin to degrade or melt. Waterlogged ground becomes soft and collapses and does not possess the structural strength to support heavy construction equipment or to allow for rubber-tired transport of pipe and materials. These conditions are effectively unworkable for any type of heavy construction.

During the construction of the Haul Road to the North Slope (Dalton Highway) in 1974, the crews quickly learned that disturbing the surface layer caused rapid and uncontrolled melting of the underlying permafrost, and the practice was halted immediately. The construction method was switched to overlay of more stable surface material such as gravel without disturbing the surface layer, and the road was successfully completed.

Why is Segregating the Surface Layer Not Practicable in Winter?

Segregating the surface layer within the ROW and trench line is impracticable in winter because the surface layer profile will be frozen and bonded to the underlying mineral soil. Conventional excavation equipment (backhoes, trenchers, and excavators) would not be able to properly separate frozen organics from the mineral soil underneath. Such a mixture would provide no benefit to revegetation efforts because trenching, ripping, or blasting would grind up the roots and rhizomes of arctic tundra plants making it difficult for them to re-establish on the trench backfill. Instead, the material graded from the ROW or excavated from the trench will be spread or backfilled following pipeline installation to facilitate restoration.

- ***Information from Non-permafrost Locations Can be Misinterpreted***

Complicating the issue for regulators and the public is that concepts and pictures, such as those shown in Figure 4, have been presented in other venues to give examples of how winter salvaging of soil can theoretically be accomplished. However, these photos are typical for areas of the Lower 48, but NOT for Alaska.

Figure 4. Winter Salvaging of Soil in Lower 48 (Not Alaska)



In Alaska, the surface layer freezes to extreme depths and forms a large monolithic block with the underlying mineral soils. Depths of freeze range from 6 feet in non-permafrost areas to several hundred feet in permafrost areas. In these areas it is impracticable to segregate the surface layer from the underlying mineral soils in winter. Additionally, in areas of winter grading, the surface layer will be frozen and will provide suitable trafficability and support of the construction equipment. As a result, the surface layer will not be removed prior to grading activities.

Why is Segregating the Tundra in Sod Blocks not Practical?

Segregating the tundra in sod blocks is not practicable for AGDC's proposed project the following reasons:

- ***The tundra blocks can only be segregated intact when the active layer is thawed.***

Exxon segregated the tundra blocks during the summer of 2013 from around the perimeter of a developed gravel pit, within a future development area. As discussed previously, separating the tundra layer, especially in coherent blocks, from the underlying mineral soils is virtually impossible unless the active layer is thawed.

- ***Access, with heavy equipment, is required while the ground is thawed.***

ExxonMobil used an existing gravel pit and gravel pads to access, harvest, transport, and place the tundra blocks in summer conditions. Access to the pipeline ROW with heavy equipment during summer conditions is not possible in areas of tundra without the construction of an all-weather access road. The use of mats to access the pipeline ROW during summer is generally not feasible due to the micro terrain within the tundra areas. In addition, as mentioned above, removing the insulating layer during summer conditions causes rapid melting of the underlying permafrost.

- ***The harvested tundra blocks must be stored until after pipeline construction.***

ExxonMobil was able to haul and directly place some of the harvested blocks, but others were required to be stored separately on pallets, overwintered, and placed the following summer. These activities all require summer access, which is infeasible, as discussed above.

- ***Placement of the tundra blocks is not feasible in winter conditions.***

Placement during the winter of pipeline construction would not be possible due to the "crown" or mounded up material that is placed over the trench. This mounded up material is required to account for the thawing and settlement of the backfill material that will occur in spring. If the tundra blocks were placed on the mound, it would be almost impossible to predict what position they would ultimately end up in after the next summer's thawing and settlement. The result would be very irregular, with incomplete coverage, and could possibly disrupt the ultimate surface drainage profile. Remediation would be extremely difficult since, by the time access could be gained the following winter, the blocks would be frozen into place.

Therefore, the relative success, or lack of success, of this experimental program is not germane to AGDC's proposed natural gas pipeline project. AGDC dismissed this suggested mitigation, deferring instead to its Revegetation Plan (AGDC 2017) to arrive at a proven methodology for ROW stabilization that was developed by an experienced state agency.

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ADNR PMC. 1995. Project Chariot Site Revegetation Program 1993 – 1995. S. Wright, Ed. Prepared for U.S. Fish and Wildlife Service. December.

ADNR PMC. 2008. Rehabilitation of the Kanuti Pit Materials Site 65-9-031-2 Located at Milepost 105 of the Dalton Highway. A. Nolen, Ed. Prepared for State of Alaska Department of Transportation and Public Facilities. March 6.

AGDC. 2017. Revegetation Plan - Alaska Stand Alone Pipeline (ASAP) Project. Prepared for AGDC by the Alaska Department of Natural Resources Plant Materials Center. ASAP-22-PLN-LND-DOC-00001. October 31, 2017.

ExxonMobil. 2013. Plan to Use of Tundra Sod for Rehabilitation Purposes. Including Revegetation at Alaska State C-1 Pad for Stream 24A Buffer and Experimental Reuse at the Point Thomson Project. Proposed Plan to ADNR Division of Mining, Land, and Water. March.

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Comparative Belowground Designs and Return of Wetlands

AGDC was asked to address 9 requests for information (RFIs) following an October 6, 2017 Cooperating Agency Meeting. To date, seven of these responses have been addressed. The two remaining requests were related to a discussion on the return of wetland vegetation and function to the right-of-way (ROW) over time and a comparison of design features between ASAP and other projects in which ground-disturbed areas were impacted and revegetated. The specific RFIs are as follows:

- *AGDC to provide documentation / evidence of return of wetland function within years and complete recovery of wetland function within 30 years for pipelines with similar design features and mitigation measures*
- *AGDC to prepare comparison of ASAP proposed design features / mitigations that are different than what was done for Prudhoe Bay trench test plots as well as TAPS buried portions*

Since the meeting, AGDC clarified that it would return wetlands vegetation, and likely wetland function to the ROW shortly after installing the pipeline, but that it would not be restoring the wetlands to preconstruction condition. AGDC and USACE agreed that the permanent impact to wetlands would be a total of 9ft wide (5ft trench plus two feet either side of the trench to account for mounding) for 62 miles, equating to approximately 67 acres of impact. AGDC provided information showing that the entirety of this 67 acres of impact would quickly revegetate and would likely return to having a wetland function following fertilization and aerial seeding of mostly wetland / facultative wetland species and implementation of an intensive monitoring and maintenance program. AGDC also noted that the wetland function of the revegetated ROW would change over time given that progressive ecological succession of natural species into the ROW would occur, as has been shown on other projects (discussed in detail, below). In contrast to the altered wetland function associated with the belowground design, the use of VSMs would equate to approximately 2-5 acres of permanent impact to wetlands that would not recover any function. This estimated impact of up to 5 acres would be permanent loss of wetland and would retain no wetland function (total loss).

Factors for Consideration in the LEDPA Decision

AGDC assumes that its responses to the above RFIs, along with prior responses, will factor into the forthcoming LEDPA decision by the USACE regarding the pipeline mode for the first 62 miles on the Arctic Coastal Plain. As a precursor to providing responses to the above RFIs, AGDC is providing a summary of factors that support its design, which AGDC hopes will be useful to USACE in providing context during its review of the RFI responses and ultimately in its LEDPA decision.

Engineering Practicability – Advantage: Belowground

- There are engineering concerns over the potential for liquid dropout associated with an aboveground pipeline on the North Slope (AGDC 2016a)¹. The Project is not designed to cope with liquids in the line, and this could lead to prolonged shut down to deal with these issues, should they arise (see ‘Pipeline Safety & Reliability’, below for impacts of a prolonged shutdown to customers).
- The engineering design and constructability of the belowground pipe has been proven to be sound. The belowground North Slope design is built upon 40 years of design work, including three finalized NEPA documents prepared and public-noticed by three different federal agencies: ANGST EIS (Department of Interior, 1976)², TAGS EIS (BLM and USACE, 1988)³, ASAP EIS (USACE, 2012)⁴.

Pipeline Safety & Reliability – Advantage: Belowground

- The belowground pipeline will be safer during operation, as it will rest hidden and protected below at least 30 inches of cover. Aboveground pipelines in Alaska have notoriously been damaged, both through natural causes (NSB 2014)⁵ and as the result of vandalism or terrorism (CBS 2001⁶, ADN 2014⁷). There are also significant safety and logistical challenges associated with fixing a pipeline 7-10 feet in the air.
- Users of gas in Fairbanks, southcentral Alaska, and other Alaska communities would rely on gas from the pipeline to heat their homes and business. The impact of an interruption of service due to damage to an aboveground pipeline resulting from vandalism, terrorism or liquid dropout would be catastrophic, especially since Alaska’s cold winters make a reliable heat source a requirement to generate warmth for health and well-being and to maintain the integrity of building infrastructure (e.g., water pipes). The belowground design sufficiently mitigates this potential high-risk scenario.

Cost as a Prohibitive Factor – Advantage: Belowground

- The costs associated with constructing an aboveground pipeline on the Arctic Coastal Plain could price the streamlined ASAP Project out of an acceptable range. The belowground design is cost effective and will allow the project to provide gas at a reasonable price to consumers.
- AGDC must comply with Alaska Statute 31.25.005, under which AGDC is required to develop the project that makes natural gas available to Alaskan communities “at the lowest rates possible”

¹ AGDC. 2016a. The ASAP Belowground Pipeline Mode: Selection, Construction, Operation, and Maintenance on Alaska’s North Slope. ASAP-22-RTA-DDD-DOC-00066. July 12.

² USDO. 1976. Alaska Natural Gas Transportation System. Final EIS. March (ARLIS online).

³ BLM and USACE. 1988. Trans-Alaska Gas System. Final EIS. June. BLM-AK-PT-88-003-1792-910 (ARLIS online).

⁴ USACE. 2012. Alaska Stand Alone Gas Pipeline. Final EIS. October.

⁵ North Slope Borough (NSB). 2014. Annual Comprehensive Report (ACR) for the Nuiqsut Natural Gas Pipeline Project (NNGP).

⁶ CBS News. 2001. Alaska Oil Pipeline Pierced by Bullet. October 5, 2001.
<https://www.cbsnews.com/news/alaska-oil-pipeline-pierced-by-bullet/>

⁷ ADN. 2014. Feds Charge Fairbanks Man with Lying about 1978 Pipeline Sabotage Bombing.
<https://www.adn.com/alaska-news/article/feds-charge-fairbanks-man-lying-about-1978-pipeline-sabotage-bombing-0/2014/05/24/>

and to customers “at commercially reasonable rates”. The aboveground design would not allow AGDC to comply with this statute when there is a cost-effective and environmentally harmonious belowground design that would lead to lower energy rates that were commercially reasonable.

Taken together, the cumulative risks and challenges associated cost, logistics, and available technology make the aboveground design not practicable for the streamlined ASAP Project.

In addition to the above facts, many important environmental factors must be considered.

Permanent Subsistence Impacts – Advantage: Belowground

- An elevated pipe on VSMs would negatively impact subsistence, in particular caribou. BLM’s 810 subsistence analysis attached to the DSEIS indicated that an aboveground pipeline on the North Slope would present a significant impact to the east-west moving caribou, which are a primary subsistence item for North Slope users that hunt the Arctic Coastal Plain.
- Nuiqsut and Barrow residents have voiced complaints on the record to USACE that an aboveground pipeline would impact caribou movements.
- Residents would not be able to safely discharge firearms when hunting caribou or birds in or around the vicinity of the aboveground pipeline. This would place a limitation on subsistence use in this area.
- Subsistence impacts associated with a belowground pipeline would be localized and temporary.

Permanent Visual Impacts – Advantage: Belowground

- The aboveground design would permanently impact the visual landscape of the tundra, obstructing scenic views.
- The belowground design would have some impact initially, but would recover vegetation quickly and ultimately blend with the natural landscape as natural ecological succession occurs (See references cited in RFI response below demonstrating this for TAPS, Nuiqsut, and Barrow, in particular NSB 2014).
- The route length of the aboveground pipe on the Arctic Coastal Plain would be several miles longer than that of the belowground pipe, as the aboveground design would require additional points of inflection, similar to TAPS. This would create additional visual impact (as well as wildlife and subsistence impact)

Wildlife / ESA Species Habitat, Behavior, and Well-being – Advantage: Belowground

- The aboveground alternative would obstruct and fragment important habitat. It would negatively impact at least 9,820,800 cubic feet of 3-dimensional habitat of three ESA species (spectacled eider, Steller’s eider, polar bear), many other migratory birds, and caribou. This estimate is based on a 62-mile long route, when in actuality an aboveground route would have to be miles longer to accommodate additional points of inflection in an aboveground design.
- The belowground alternative would have only temporary and localized 3-dimensional habitat impacts and no long-term 3-D habitat fragmentation or permanent obstructions. It would have moderate temporary and localized 2-D impacts at the terrain surface, but immediate revegetation and natural ecological succession would ensure some immediate wetland function would be replaced followed by continued later succession species and changing wetland function over time.
- The aboveground design would deter / affect movements of caribou, polar bear, and other animals.

- The aboveground alternative would result in bird strikes, causing injury and death to migratory birds and potentially ESA species.
- The aboveground design would negatively impact small mammals and nesting birds by providing a perch for avian predators.

Permanent Socioeconomic Impacts – Advantage: Belowground

- The aboveground design would have a negative socioeconomic impact, as it would not allow gas to be delivered to rate payers at the lowest possible rates and would impact the project's ability to be commercially competitive.

Impacts to Continuous Permafrost - Tie

- ASAP's belowground design will operate at below-freezing temperatures on the North Slope year-round with temperatures ranging from 8 to 30 degrees F (AGDC 2016a). Geothermal modeling predicts no subsidence on the North Slope and only an incremental increase in the depth of the active layer adjacent to the pipe (AGDC 2017a)⁸.
- Use of VSMs would have a major direct permanent impact to permafrost, but over a smaller total area (2 – 5 acres total). Additional indirect impacts to permafrost will result when ground freezes and thaws (expands and contracts), allowing water to flow down VSMs and thaw additional permafrost over time.

Permanent Impacts to Wetlands and Surface Water – Tie (when avoidance, minimization, and appropriate mitigation are applied)

- The avoidance, minimization and appropriate mitigation measures AGDC has incorporated into its design have eliminated, reduced, and mitigated major impacts to wetlands and surface water.
- Routing targeted uplands and lower-value wetlands, avoiding open water and high value wetlands wherever practicable.
- Design dictates that work will be done off of ice pads, ice roads, and snow pack to restrict impacts to wetlands and surface water to the minimum extent practicable. The only disturbance to the ground will be a 5ft wide trench, with two feet either side of the trench for mounding.
- The belowground Mainline would parallel the general direction of sheet water flow, following the south-to-north gravitational gradient from the foothills to the Beaufort Sea, facilitating easier mitigation. If it were an east-to-west belowground pipeline, impacts would be more challenging to mitigate.
- The Project aims to maintain natural surface water drainage patterns through areas of cross-flow using numerous ditch plugs, aggressive bank revegetation, and other mitigation, as described in AGDC 2016a. Even in a potential aboveground design, the pipeline would still go belowground at stream crossings.
- Both designs require use of the ROW year-round during operations and maintenance, including access by crews with winter vehicles and in summer by helicopter or approved low-pressure tire vehicles.
- Permanent wetlands impacts for a belowground pipeline for the first 62 miles would result in a difference of only about 63 acres, or 0.85% of the Project's overall 7,503 acres of wetlands impacts (maximum 67 acres belowground vs. maximum 5 acres aboveground). However, the entirety of this 67 acres of impacted wetlands will immediately return to a functioning wetland,

⁸ AGDC. 2017a. Analysis of Potential Indirect Impacts to Wetlands Related to Buried Pipeline Construction. ASAP-22-RTA-ENV-DOC-00002. March 10.

albeit a different and changing wetland in terms of its functions over time while the project ROW is in use over 30 years. Wetland vegetation will be brought back quickly and aggressively into the right-of way through implementation of the ASAP Revegetation Plan, developed by the ADNR Plant Materials Center (AGDC 2017b)⁹. This will stabilize the land, eliminating any temporary fragmentation of functioning wetland caused by installation of the pipeline. Early succession species are expected to return to the right-of-way within the first several years. Late ecological succession will follow with more mature species growing in the ROW during operations while the pipeline is in use, ultimately leading to more and more recovery of wetland function over time. AGDC does intend to compensate for impacts to any wetland functions that wouldn't recover right away, in accordance with the USACE's 2008 Mitigation Rule¹⁰ and its Compensatory Mitigation Plan (AGDC 2016b)¹¹.

- In contrast to the belowground design that will return wetland function to all impacted areas, the VSMs associated with an aboveground pipeline would permanently impact (i.e., obliterate) between 2 to 5 acres of wetlands, all wetland function from this acreage would be irreparably lost, with no ecological succession or recovery over time. These VSM impacts would also require compensatory mitigation for permanent loss.
- The aboveground design would have a negative, permanent indirect impact to wetlands, as VSMs and the pipeline would cast shade upon the same wetlands in the same locations each summer, impacting growth and function.

Public Health – Advantage: Belowground

- The belowground pipeline is safer to construct and operate. As stated above, users of gas would rely on it to heat their homes and business, so the impact of an interruption of service due to damage of an aboveground pipeline due to vandalism, terrorism, liquid dropout would be catastrophic, especially during cold winters, when heat is required to generate warmth for health, well-being and maintaining integrity of building infrastructure.

Recreation – Advantage: Belowground

- The belowground pipeline would have fewer long-term impacts on recreational snowmachining and hunting.

Municipal Government Preference – Advantage: Belowground

- The North Slope Borough (NSB) submitted a letter to the USACE strongly supporting the belowground design, largely for reasons related to impacts to caribou.
- The NSB Mayor's Office voiced concerns that caribou were negatively impacted by the aboveground portions of TAPS on the North Slope in 2002 during the TAPS renewal EIS.

⁹ AGDC. 2017b. ASAP Revegetation Plan. Prepared by the Alaska Department of Natural Resources Plant Materials Center. ASAP-22-PLN-LND-DOC-00001. October 31.

¹⁰ 40 C.F.R. § 230.290. Compensatory Mitigation for Losses of Aquatic Resources, Final Rule. 73 Fed. Reg. 19594 (2008).

¹¹ AGDC 2016b. ASAP Draft Wetlands Compensatory Mitigation Plan. ASAP-22-PLN-REG-DOC-00001. October 20.

Land Owner Preference – Advantage: Belowground

- The ADNR Commissioner, representing the land ownership interests underlying the 62 miles of pipeline, strongly supported the belowground design.
- The State of Alaska, through ADNR, holds the state's interest in restoring the land; therefore, they wish to ensure involvement of their Plant Materials Center (PMC) to ensure stabilization and revegetation.

Public Preference – Advantage: Belowground

- The USACE received many more letters from the public supporting the belowground design than the aboveground design.

1.0 Examples of Operating Belowground Pipelines on the North Slope where Vegetation and/or Wetlands have Recovered

1.1 The TransAlaska Pipeline System (TAPS), Buried for 40 Miles on the North Slope and in other Tundra Regions

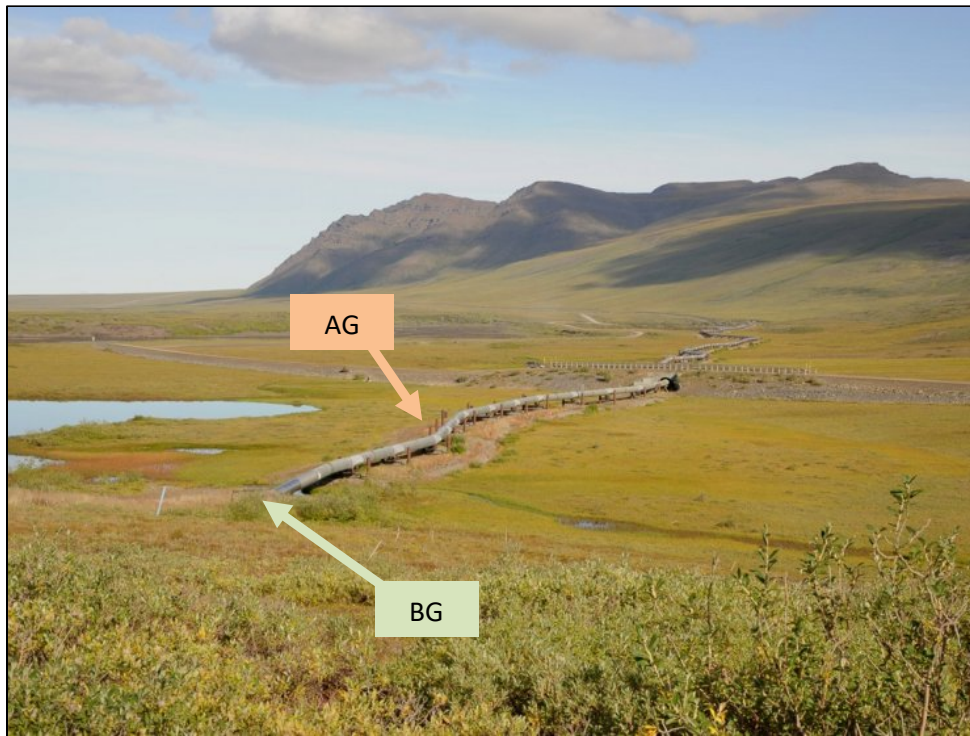
During construction of TAPS in the mid-1970s, the pipeline was buried below the surface on the North Slope from TAPS Milepost 12.6 to Milepost 52, a continuous stretch of approximately 40 miles. There are also other belowground sections of TAPS in tundra regions, including the approach to the Brooks Range. TAPS is a hot oil line that required regular maintenance, monitoring and stabilization efforts for 5 to 8 years post-construction (White, 2013). A similar multi-year monitoring plan is proposed for the ASAP natural gas pipeline, which will operate at below freezing temperatures; therefore, impacts to continuous permafrost are expected to be minimal and erosion and drainage impacts mitigatable (White, 2013).

Aerial View of Belowground Sections of TAPS on Alaska's North Slope



Approximately 40 miles of continuous BG pipe on the North Slope exists for the Trans-Alaska Pipeline System (TAPS). The photo shows an area in which the Trans-Alaska Pipeline System (TAPS) transitions from a long segment of belowground (BG) pipe to a segment of aboveground (AG) pipe on the North Slope. (Image Source: Google Earth) Soils and hydrology were stabilized around TAPS in the years following installation to control water drainage, thaw, and erosion.

Belowground Section of TAPS in Alaska's Tundra Region



The TransAlaska Pipeline transitions from an aboveground (AG) to a belowground (BG) mode in a tundra region of Alaska near riverine (above) and ponded wetlands (below). [Image Source: BLM Alaska / Flickr (above); Center for Land Use and Interpretation (below); <http://clui.org/page/trans-alaska-pipeline-0>]

Belowground Section of TAPS in Alaska's Tundra Region (continued)



Muskox enjoy areas along buried sections of the pipeline (above); Vegetation and wetland functions appear preserved along buried sections of TAPS (below). BG = Belowground (Image source: Center for Land Use and Interpretation; <http://clui.org/page/trans-alaska-pipeline-0>)

Belowground Section of TAPS in Alaska's Tundra Region (continued)



South of Pipeline Milepost 300, but still in tundra, the Dalton Highway curves, and the pipeline runs in a straight line underground (Image source: Center for Land Use and Interpretation; <http://clui.org/page/trans-alaska-pipeline-0>)

1.2 The Nuiqsut Natural Gas Pipeline, Buried for 5.6 Miles on the North Slope

The Nuiqsut Gasline is a 14.4-mile long 3-inch pipeline that transports natural gas from the Alpine Production Facility to the village of Nuiqsut, within the Colville River Delta. The pipeline design is based on a maximum operating pressure of 1440 psig. It is the primary energy source for village residents. The pipeline is aboveground for approximately 8.8 miles as it leaves the Alpine Production Facility, sharing vertical support members with the Alpine Pipelines. The gasline is buried under the Nigliq channel of the Colville River and under arctic tundra in permafrost for 5.6 miles. The buried portion of the Nuiqsut gasline is a coiled line that was installed in 2001 using a chain trencher in winter off of ice pad, almost identical to the proposed ASAP design. Additional grading and revegetation efforts occurred in 2002. Startup and commissioning of the entire system was commenced in July 2008, much longer than the time that ASAP would sit idle without cold gas flowing through. By fall of 2009, service had been extended to all who had requested service, including 122 homes, 30 commercial buildings, and the village power plant.

The North Slope Borough (NSB) is required to submit occasional reports (NSB 2014) for the Nuiqsut Natural Gas Pipeline to the Alaska Department of Natural Resources (ADNR) State Pipeline Coordinator's Section (SPCS), in accordance with the stipulations of the State of Alaska ROW Lease that was granted for the project (ADNR 1999)¹². The 2014 Report to ADNR mentions two key pieces of information that are appropriate to the ASAP design:

¹² Alaska Department of Natural Resources. 1999. Right-of-Way Lease for the Nuiqsut Natural Gas Pipeline. Lease agreement between State of Alaska and North Slope Borough. ADL 416202. Available online at <http://dog.dnr.alaska.gov/Documents/SPCS/Nuiqsut/Related/NuiqsutGasLease-ADL-416202.pdf>

- There was reported damage to pipeline insulation, coated pipeline, and test heads along the aboveground line at various locations (NSB 2014). This was not the first damage noted, as prior damage in a 2012 report is noted.
- There was a request from DNR to add markers along the entire buried section of the pipeline, which indicates that revegetation efforts were so effective in blending with surrounding wetlands and vegetation that its exact location underground is no longer apparent – hence, the need to place line markers in 2014 (NSB 2014).

Winter Chain Trenching for the Nuiqsut Gasline on Alaska's North Slope



A joint venture between CONAM Construction Company and AGLAQ Construction of Point Hope, Alaska completed the work scope consisting of the 5.6 mile buried gas supply pipeline from ConocoPhillips' Alpine Oil Field to the village of Nuiqsut. The pipeline routing was primarily across arctic tundra and the Colville River, thus requiring winter construction from ice roads and ice pads built by the joint venture team. The 6 foot deep trench excavation was performed using trenching equipment, shown here, that would be similar to what would install the ASAP pipeline. (Image Source: CONAM Construction Company website: <http://conamco.com/services/alaska-pipeline-projects/nuiqsut-natural-gas-pipeline-project/>)

Aerial View of Nuiqsut Gasline on Alaska's North Slope



A segment of the belowground (BG) Nuiqsut Gasline as it ties into aboveground (AG) pipelines. Approximately 5.6 miles of the Nuiqsut gasline lies belowground. (Image Source: Google Earth). By 2014, revegetation had blended well enough with surrounding wetlands and vegetation, that DNR required installation of line markers for belowground sections (NSB 2014).

1.3 NARL Gasline in Barrow and Gas Distribution Pipelines in Utqiagvik (Barrow), Nuiqsut

The North Slope villages of Utqiagvik (Barrow) / Browerville and Nuiqsut contain natural gas distribution infrastructure that is widely belowground (e.g., the NARL Gas Pipeline in Barrow), except at bridge crossings and metering stations or valves. The cold gas reduces moisture belowground; however, aboveground pipeline infrastructure introduces corrosion issues and requires insulation that can be damaged (NSB 2014) and must be maintained. These distribution and transmission lines lie belowground to heat and power these villages.

Barrow is served by the buried NARL Gasline and local Distribution Lines



Buried natural gas distribution pipelines run throughout the North Slope village of Utqiagvik (Barrow) / Browerville (above). Barrow's gas utility, where a distribution line transitions from belowground (BG) to aboveground (AG) (below left) to enter a metering station (below right) is depicted. (Image Source: Panoramio (above); AGDC (below left and below right)). Nuiqsut also has distribution belowground infrastructure.

1.4 Additional Belowground Arctic Pipelines in Operation Today

Belowground natural gas pipelines are not a new concept for areas underlain by permafrost. In addition to the Nuiqsut Gas Pipeline, the NARL gasline, and other local distribution infrastructure noted above, there are several buried cold-temperature natural gas pipelines operating in the Arctic today. These include the IKHIL gasline in Inuvik, Canada, and multiple larger diameter natural gas pipelines in Russia. Russia's state owned gas company, Gazprom, recently began operating a second buried 786 mile-long buried gas pipeline, Bovanenkovo-Ukhta-2, that was constructed parallel to the existing gas pipeline (Bennet 2017)¹³. These

¹³ Bennet, M. "Gas begins to flow in Russia's third arctic pipeline". Cryopolitics. February 13, 2017. Accessed online at <https://spe.org/en/print-article/?art=2678>. Accessed on 07-12-2017.

buried pipelines stretch from the frozen Bovanenkovskoye gas field of the Yamal Peninsula in the Russian Arctic the Russian city of Ukhta, with the new pipeline doubling the capacity of gas flowing from Russia to Europe. Two additional newly constructed buried gas pipelines, known as Zapolyarye-Purpe and Kuyumba-Taishet, also began operating in arctic Russia in early 2017 (Bennet 2017).

The ASAP Project, whose Final EIS was completed in 2012, evaluated an almost entirely belowground pipeline on the North Slope without an aboveground design considered. However, the history of proposed gas pipeline projects designed to deliver North Slope natural gas to market goes back to the late 1970s and early 1980s. Two major projects, the Alaska Natural Gas Transportation System (ANGST) and the Trans Alaska Gas System (TAGS) completed the NEPA process, and both were designed as belowground natural gas pipelines. There were additional attempts to commercialize North Slope natural gas that did not undergo full NEPA evaluation, but which were consistent in that they were designed as belowground pipelines. AGDC has provided a design consistent with previously approved designs evaluated under the NEPA process.

In addition to the cold temperature natural gas pipelines in operation, there are also several buried oil pipelines in arctic and subarctic regions that have operated for years at warmer temperatures, with crews working to implement mitigation to impacts and ensuring stability of the ROW. Alaska's example is the belowground segments of TAPS, as described above. TAPS spans from Prudhoe Bay to Prince William Sound, with approximately 40 miles belowground on the North Slope (as noted above). Others developed in Canada include the Enbridge pipeline from Norman Wells, NWT to Zama, AB, the Cameron Hills pipeline from southern NWT to Bistcho, AB, and the Spectra pipeline from Fort Liard, NWT to BC.

Chain Trencher Operating in the Arctic at Prudhoe Bay



(Image Source: Blanchet et al., 2002)¹⁴

¹⁴ Blanchet, D., Lenstra, N., Skalski, J., Zhou, J., Smith, B. 2002. Pipeline Trenching in Permafrost: a Review. Proceedings of International Pipeline Conference. Sept. 29, 2002. Calgary, AB. ASME.

1.5 EVIDENCE OF ADNRC PMC REVEGETATION SUCCESS

AGDC's goal has been to stabilize the pipeline ROW through the re-establishment of vegetation so that lands can effectively be used to operate the pipeline for the 30-year life of the project. AGDC has worked with the Alaska Department of Natural Resources (ADNR) Plant Material Center (PMC), Alaska's experts in erosion control, in developing a Revegetation Plan (AGDC 2017b) based on proven methodologies that will achieve the goals of the project.

The ADNRC PMC have a proven record of revegetation, erosion control, and rehabilitation of sites in the state, including areas north and south of the Brooks Range. ADNRC PMC staff have been involved in detailed discussions with AGDC regarding revegetation along the pipeline ROW since 2016. Examples of ADNRC PMC recovery efforts with methodologies similar to ASAP include:

- North Slope – Project Chariot, Northwest Alaska near Kotzebue (ADNR PMC 1995)¹⁵
- Interior – Kanuti Pit, Interior Alaska near Kanuti River (ADNR PMC 2008)¹⁶

These are described in detail, below, with photographic evidence provided. Wetland function can return to a disturbed area quite rapidly (1-2 summers) when a seed mix containing wetland or facultative wetland species is introduced and promotes immediate stabilization, followed by succession of natural species over the next several years. This has been noted in other studies as well, including the trenching trials of the North Slope and Interior, described in Section 2, below, and in NSB 2014 as evidenced by the need for markers to help identify the location of the belowground sections of the pipeline.

Aerial broadcast of seed and fertilizer onto the settled mound, or crown, over the pipeline in spring will result in faster revegetation that will facilitate stages of ecological succession. Based on results from the trenching trials, succession of wetland species is expected to occur continually and in stages following disturbance between year one and year ten – first with early succession species entering the disturbed area, and then with late succession species replacing some early succession species (see Section 2, below). The Revegetation Plan proposed by the ADNRC PMC will be both practicable and effective for re-establishing vegetation along the pipeline ROW. However, revegetation efforts are generally not without challenges, including managing cross flow drainage, ponding, and thermokarsting; however, these issues can usually be anticipated and effectively mitigated through maintenance standards and a robust monitoring plan, along with other procedures described in this and other ASAP documents.

The following subsections provide photographic evidence of progressive revegetation and ecological succession associated with the ADNRC PMC-led revegetation efforts similar to those proposed for ASAP. Examples of their work using similar methods proposed for ASAP are provided for the North Slope and for Interior Alaska.

¹⁵ ADNRC PMC. 1995. Project Chariot Site Revegetation Program 1993 – 1995. S. Wright, Ed. Prepared for U.S. Fish and Wildlife Service. December.

¹⁶ ADNRC PMC. 2008. Rehabilitation of the Kanuti Pit Materials Site 65-9-031-2 Located at Milepost 105 of the Dalton Highway. A. Nolen, Ed. Prepared for State of Alaska Department of Transportation and Public Facilities. March 6.

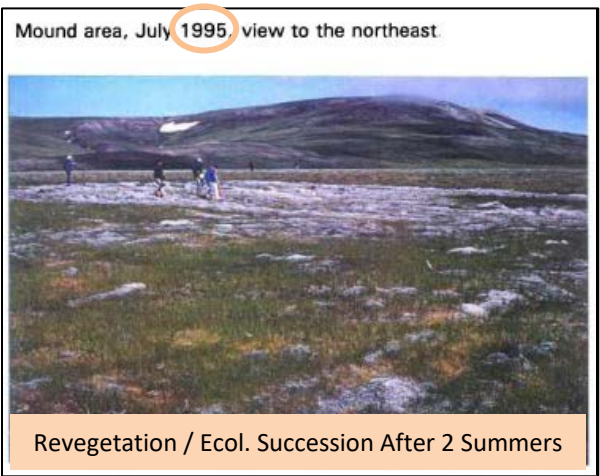
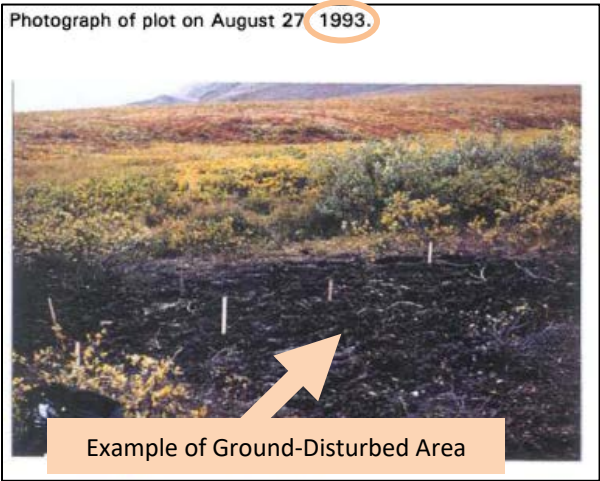
1.5.1 Project Chariot (North Slope)

The Project Chariot site documents initial revegetation on Alaska's North Slope after the first year, and early ecological succession through invasion of natural vegetation into disturbed areas after two summers (ground disturbed in 1993, revegetation documented in 1994, early succession of natural species documented in 1995). Photographic evidence is provided, below.

The ADNRC PMC has proposed similar methods for revegetating the North Slope for the ASAP Project.

For examples of other North Slope revegetation and rehabilitation projects, examples are provided in Section 2.0, below. While the past trenching projects described in that section are not reflective of ASAP's design, and therefore led to issues requiring corrective action – once corrected, the revegetation efforts of these wetland sites demonstrated that adequate vegetative abundance and biodiversity can be achieved over a disturbed area a relatively short period of time, thereby rapidly returning some wetland function to the affected areas.

Annual Progression of Project Chariot Revegetation – ADNR PMC-led Project



(Photo Credits: ADNR PMC 1995)

Re-invasion of Natural Vegetation at Project Chariot – ADNRC PMC-led Project



Natural reinvading on the mound area, July 1995. Note: *Betula* sp., *Carex* sp., *Vaccinium* sp. and *Ledum* sp. (Photo Credit: ADNRC PMC 1995)



Reinvading *Carex* sp., *Betula* sp., *Salix* sp., and moss, 1995 (Photo Credit: ADNRC PMC 1995)



Area of heavy moss growth, July 1995 (Photo Credit: ADNRC PMC 1995)

1.5.2 Kanuti Pit (Interior)

The Interior Kanuti Pit site documented initial revegetation after one year, followed by more lush revegetation and early ecological succession after 2-3 summers (1.5 to 2.5 calendar years). After a total of 5 summers (4.5 calendar years), the area had additional natural species re-invading, showing advanced stages of ecological succession. Photographic evidence is provided, below.

The ADNRC PMC has proposed similar methods for revegetating the Interior for the ASAP Project.

Progression of Kanuti Pit Revegetation – ADNR PMC-led Project (Photo Point 3)

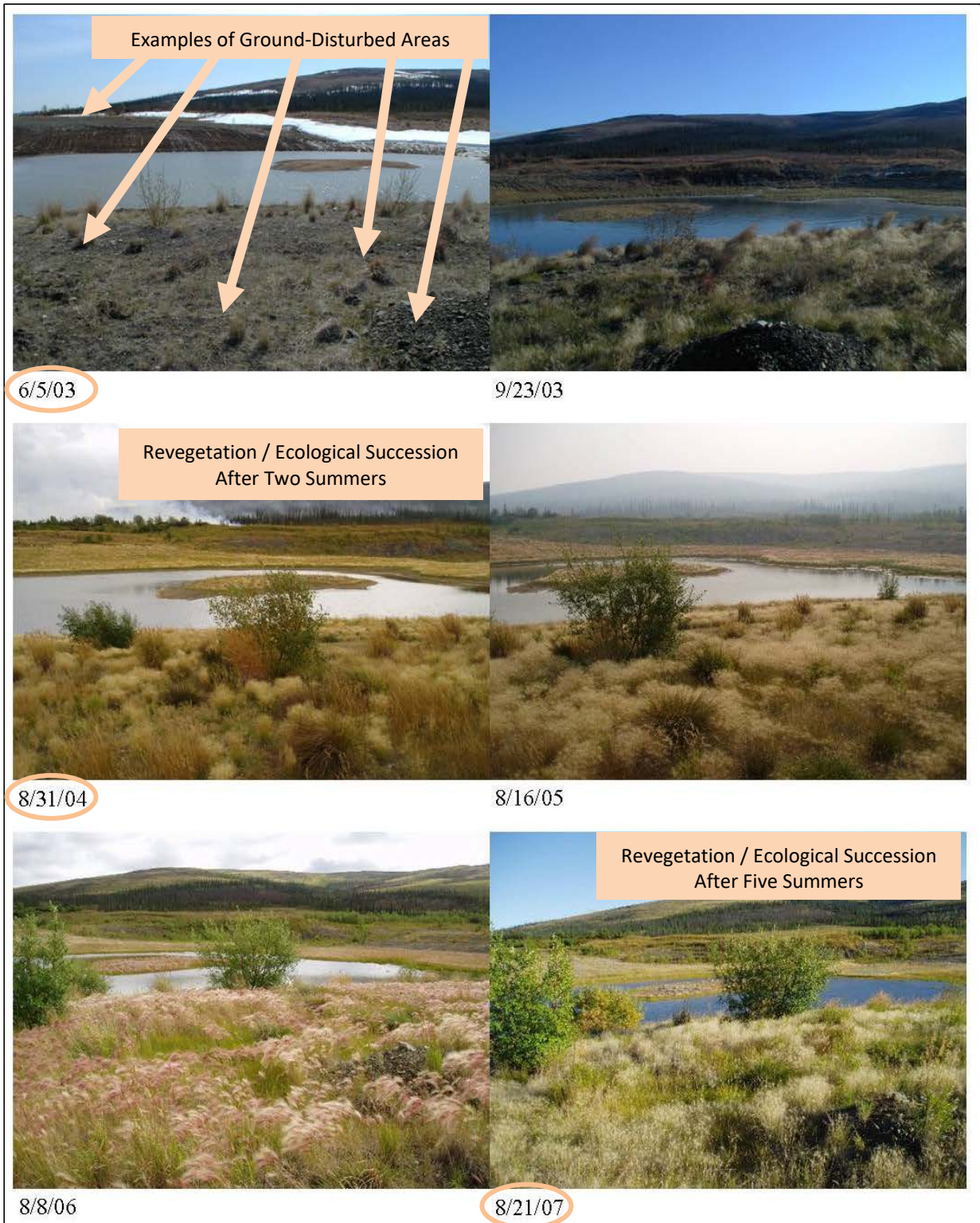


Photo Credit: ADNR PMC 2008

Progression of Kanuti Pit Revegetation – ADNRC PMC-led Project (Photo Point 6)

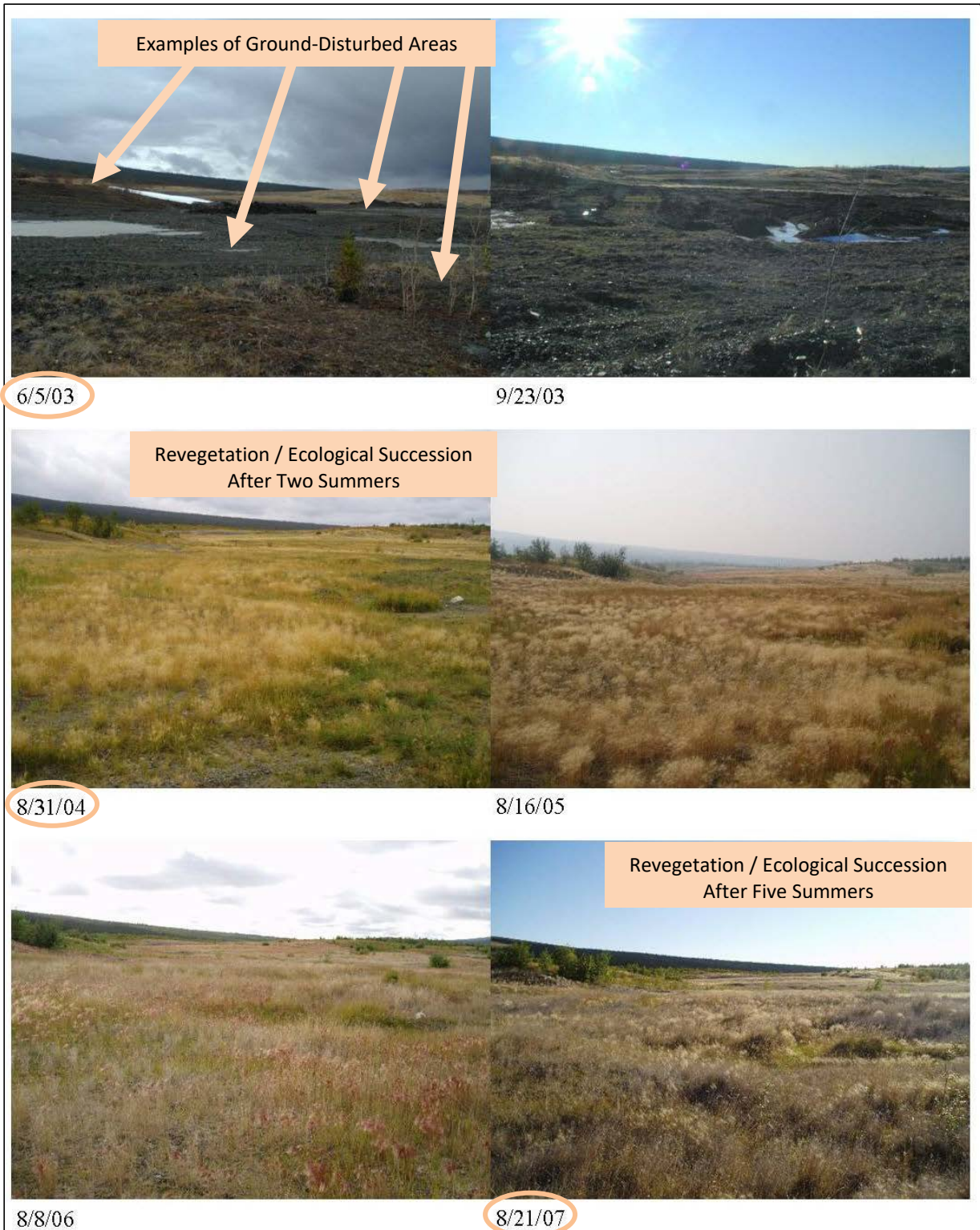


Photo Credit: ADNRC PMC 2008

2.0 Past Trenching Activities Do Not Reflect ASAP's Design

AGDC was provided with examples of trench work and rehabilitation efforts on the North Slope and Interior Alaska that are not representative of its methods or intended revegetation efforts. Specifically, the North Slope trenching trials have been identified, which were carried out in 2002 by the now defunct Alaska Gas Producers Pipeline Team (AGGPT). A set of BP powerline trenches have also been identified; these were permitted in the late 1990s, with installation and rehabilitation efforts occurring in the 2000s. The trench work and associated rehabilitation efforts are described below, along with descriptions of why these projects are vastly different from ASAP. ASAP's methods were designed, in part, by former TAPS Operations and Maintenance Staff and the ADNRC PMC, are expected to be successful, similar to the other successful stabilization and revegetation projects discussed above (TAPS pipeline, Nuiqsut gasline, Barrow / Nuiqsut gas distribution pipelines, Project Chariot, Kanuti Pit, etc).

2.1 AGGPT Trenching Trials

The AGGPT conducted trenching trials in permafrost areas on the North Slope and near Fairbanks. The trials were designed to evaluate the economic and technical feasibility of using trenching equipment in permafrost (i.e., the purpose was to evaluate the effectiveness of trencher operation and efficacy). Trenching was carried out in winter between February 12 and April 5, 2002. (ADNR Land Use Permit LAS 23611; US Army Corps of Engineers Permit 4-2001-1279).

2.1.1 North Slope Sites (MS3)

The North Slope MS3 site was adjacent to an Alaska Department of Transportation and Public Facilities material site approximately 1 mile south of Deadhorse along the Dalton Highway (ABR and BPXA, 2009). The North Slope Put-23 site was an undeveloped cell (Expansion Phase III) at the Put-23 gravel mine near Deadhorse. This discussion will focus on the MS3 site, as it is the one for which AGDC has reporting available¹⁷.

Over the 37 acre site, a total of 4 acres were disturbed by 13 different trenches. Different trenching methods, as well as explosives used to fracture permafrost, were tested at these sites. Only a single trench used a 48-inch culvert to simulate burial of a pipeline. The others were all backfilled without any pipe installed. The trenches were filled with either imported stable material or backfilled native material. Some surface soils from some very small plots were segregated, but not all, and rehabilitation reports indicate that there is no information about which trenches had soils segregated (ABR and BPXA 2009).

2.1.1.1 Ditch Plugs Not Incorporated in Initial Design

The study did not initially incorporate trench breakers or ditch plugs to restrict cross flow of water in areas of trenches where it was needed. This resulted in some trenches holding more water and restricting vegetation growth than others. Several years after initial ground disturbance, ADNRC site inspections led to a requirement for ditch plugs and additional backfill to be installed or added to select trenches to promote greater surface stability. Indications are that this "after-the-fact" mitigation measure was successful in achieving stabilization of the few trenches that were still

¹⁷ ABR and BPXA. 2009. Rehabilitation Site Report 2009: Backfilled areas at MS3 Trenching Test Site, Prudhoe Bay, Alaska. Nov 20.

having issues with subsidence or erosion due to water accumulation in the trench. Once these issues were resolved through mitigation of the added trench breakers, the trenches remained largely above grade and revegetation occurred.

2.1.1.2 Not Enough Cover Material Initially Available

Agency field inspections several years after initial disturbance required that segments of certain trenches in the trials had to be supplemented with additional overburden from a nearby out-of-service airstrip, as not enough cover material was initially placed over the trenches. Supplemental fill was placed in select trenches that had subsided to a depth ranging from 12-18 inches. The goal of using supplemental fill was to bring the subsided areas back to surface elevation of surrounding tundra. A total of 200 cubic yards of fill were added to select segments to correct the fact that not enough cover material was used during the initial trenching. The mounding, or crown, over the ditch is an important consideration and must be determined based on soil ice content.

2.1.1.3 Soil Ice Content Not Measured; Crown Height Uniform

All trenches were backfilled to a uniform height of approximately 3.6 feet (1.1m) above grade; there is no indication that soil ice content was measured beforehand to determine site specific ice content and potential for subsidence. As noted above, this resulted in some trenches subsiding more than others and supplemental fill being brought in to correct this issue years later.

2.1.1.4 No Cold Temperature Pipeline to Limit Additional Thaw

The North Slope trenching studies did not simulate the effect of a cold temperature pipeline in the ground to limit thaw after 1.5 years, the approximate time that a gasline would be operating after installation. While a colder-temperature pipeline would drive freezing temperatures into the ground around it in summer, essentially reversing the flow of heat via conductance between pipe and ground, the trenching trials did not have this element, thereby passively allowing additional vertical and longitudinal thaw.

2.1.1.5 Revegetation Efforts not Diverse or Aggressive

The revegetation program implemented into the North Slope trenching trials was neither robust nor diverse. To encourage natural vegetation at the trenching sites, only a single species of grass was used, along with hand-spread fertilizer the first year. Seed of the native grass cultivar, *Puccinellia borealis* (Arctic alkali grass) was applied. A more aggressive and diverse seeding program would have led to earlier stabilization for trenches that did not subside or hold water.

2.1.1.6 Natural Biodiversity Returned when Trenches Not Subsided / Submerged

One positive aspect of these trenching trials was that for trenches that were above grade and not subsided or covered by water, revegetation occurred and met expectations by providing adequate cover and biodiversity. Many of the areas had recovered natural vegetation and appeared to be recovering wetland function. One to two summers after installation of ditch plugs and other mitigation measures, these areas were covered by:

- The single native grass cultivar that was originally seeded
- 11 species of indigenous graminoids, including abundant *Arctophila fulva*
- 3 species of indigenous forbs

In 2014, the project noted that wetland vegetation continued to establish on the backfilled trenches by natural colonization from the adjacent, undisturbed tundra, and some areas are becoming visually integrated with the tundra community (ABR 2014)¹⁸. Higher, drier areas that historically were mostly barren were starting to be colonized by dwarf willows (e.g., *Salix ovalifolia* [oval-leaf willow and *S. arctica* [arctic willow) and the forb *Saxifraga hirculus* (yellow marsh saxifrage). Wetland sedges such as *Eriophorum angustifolium* (tall cottongrass) and *Carex aquatilis* (water sedge) were establishing in previously barren areas where the trench has subsided to an elevation closer to tundra grade. Vegetation cover was likely to remain limited near the ends of some of the trenches, where deep ponds formed due to subsidence in the first few years after the trenches were backfilled. The project reported that vegetation response on the backfilled trenches at MS3 had been mostly favorable, with areas that were initially open water or dry barrens now colonized with a variety of sedges, grasses, and forbs, depending on soil moisture conditions.

AGDC intends on achieving biodiversity in its project through first re-seeding and then by allowing similar natural ecological succession to occur. The observed ecological succession is representative of the gradual process by which ecosystems change and develop over time following disturbance. Habitats constantly change, as was observed in 2014 at these North Slope sites after the original disturbance in 2003.

Revegetation over North Slope Trenches after Eleven Years



Example of stabilization efforts following trenching trials on the North Slope near Prudhoe Bay with photos taken in 2003 (left) and 2014 (right). When crown height is sufficient and water is kept out of the trench, wetlands vegetation will re-establish. Photo Credit: ABR 2014.

2.1.1.7 Monitoring and Maintenance Program Not Robust

The initial monitoring and maintenance program for the trenching trials was not robust; only a two-year monitoring program and separate four-year monitoring program were implemented to measure settlement in trenches and natural revegetation of tundra. Several rehabilitation reports

¹⁸ ABR. 2014. ABR Memorandum. Qualitative Site Assessment of MS3 Trenching Trial Test Site. 24 October.

appear to have been generated for this work. Initial monitoring was every other year, but after agency involvement, monitoring continued on an annual basis until 2011. The project reported that performance standards for surface stability and vegetation were met in 2012 but committed to periodic qualitative assessments at least until 2017 to confirm that vegetation remained productive and surface stability would be maintained (ABR 2014).

2.1.2 Interior Site (Washington Creek)

A primary goal of the trenching trials at the Washington Creek site was to test the effectiveness of various trenching techniques¹⁹. The Washington Creek trench trials were established in an area cleared of black spruce forest. Ten trenches were excavated in early 2002. Gravel backfill was hauled in and used to fill part of the ditch, with native material placed over the top of it to a height of approximately 1.1m (3.6 feet) above the trenches. Backfilled trenches were fertilized and seeded with two species, ryegrass and fireweed. Uneven sloped terrain at the site location led to concerns over possible runoff into Washington Creek (ABR and BPXA 2013).

2.1.2.1 No Ditch Plugs in Initial Design

Similar to the North Slope trials, ditch plugs were not incorporated into initial design. They are today considered critical, and would be required later after agency involvement (see below).

2.1.2.2 Soil Ice Content Not Measured; Crown Height Uniform

All trenches were backfilled to a uniform height of approximately 3.6 feet (1.1m) above grade; there is no indication that soil ice content was measured beforehand to determine site specific ice content and potential for subsidence.

2.1.2.3 Heavy Rains, Flooding, and Slope Caused Excessive Trench Erosion

While the North Slope is a dry environment that gets very little precipitation, the Interior is prone to excessive rains and flooding. This is exactly what occurred in 2002 following commencement of the study. As noted above, the newly established trenches had no trench breaks or ditch plugs installed, and subterranean water flowed through the trenches, causing massive erosion. The trenches were installed parallel to the sloped terrain at this location, leading to concerns over possible runoff into Washington Creek. Therefore a silt fence was installed to help mitigate this potential effect related to the flawed design. The underlying gravel backfill installed was more permeable to water flowing in the ditch in the sloped area. On-site material used as topdressing was still partially frozen, and water flowed through underlying gravel backfill until the material on top ultimately thawed and collapsed in on the trench. Following agency involvement, the Project was required to install ditch plugs (see below).

2.1.2.4 Project Not in Compliance with the Issued Federal Permit

The project received a Notice of Noncompliance from USACE for the site in October 2002 and was required to implement a Corrective Action Plan. The Plan required the study's operators to place

¹⁹ ABR and BPXA. 2013. Rehabilitation report for Washington Creek (K8A) Trenching Test Site, Interior Alaska. March.

fiber mats to stabilize the eroded surface, place hay bale berms to deflect water away from eroded trenches and install ditch plugs once ground was frozen to prevent additional offsite erosion.

2.1.2.5 No Cold Temperature Pipeline to Limit Additional Thaw

The Interior trenching studies did not simulate the effect of a cold temperature pipeline in the ground to limit thaw after 1.5 years, the approximate time that a gasline would be operating after installation. While a colder-temperature pipeline would drive freezing temperatures into the ground around it in summer, essentially reversing the flow of heat via conductance between pipe and ground, the trenching trials did not have this element, thereby passively allowing additional vertical and longitudinal thaw.

2.1.2.6 Rapid Revegetation Targeted; Natural Biodiversity Reported

Rapid revegetation was targeted at the Interior Washington Creek Site to stabilize the trenches. However, as noted above, only two species were seeded, ryegrass and fireweed. Revegetation was a success and is considered a bright spot for the Washington Creek Trials. The following presence of plant species (at least trace abundance) was observed four and ten years after initial clearing and ground disturbance (ABR and BPXA 2013):

Four Years Post-Disturbance (2005)	Ten Years Post-Disturbance (2012)
• 7 grass species • 3 sedge species • 6 forb species • 5 deciduous shrub species • 1 evergreen tree species • 5 evergreen shrub species • 4 moss species • 3 lichen species	• 16 grass species • 7 sedge species • 28+ forb species • 3 deciduous tree species • 13 deciduous shrub species • 3 evergreen tree species • 6 evergreen shrub species • 8 moss species • Liverworts • 7+ lichen species • Fungi

2.1.2.7 Revegetation Performance Standards Implemented and Achieved

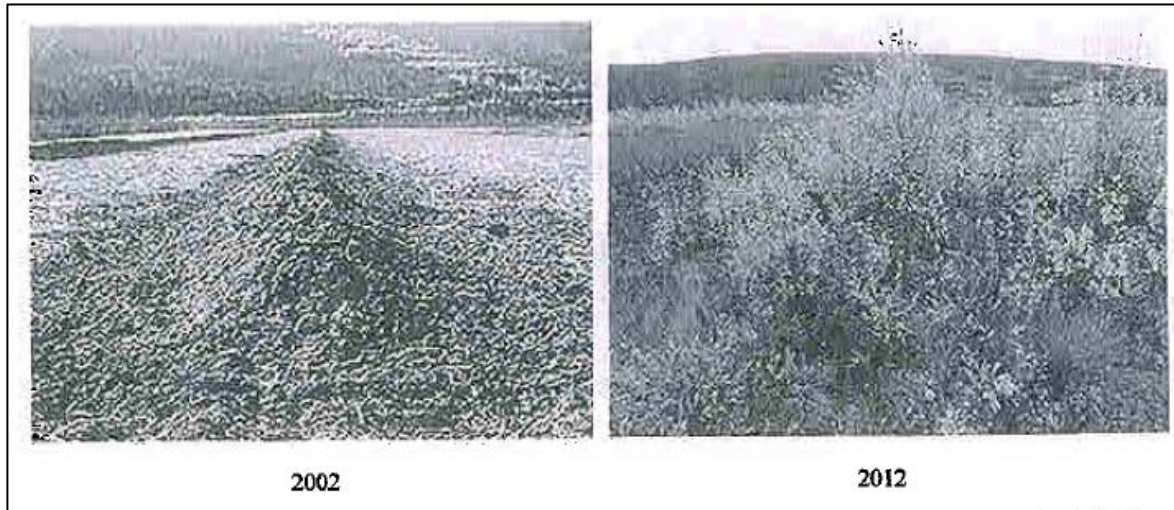
Performance standards were established to have 80% of trenches at or above surrounding grade, no continuous linear depressions greater than 33ft long that hold water for more than 2 weeks during the growing season, and establishment of substantial plant cover by native species ($\geq 15\%$ live cover of vascular plants (excluding seeded grasses), and ≥ 5 indigenous species with $>0.2\%$ cover by each species).

The 2012 Monitoring Report for the Interior Washington Creek site (ABR and BPXA 2013)²⁰ documented positive revegetation results for the site. The mean cover and diversity of vascular plants was well above the minimum performance standards for the site. Total live cover of vascular

²⁰ ABR, Inc. and BPXA. 2013. Rehabilitation Report for Washington Creek (K8A) Trenching Test Site, Interior Alaska. USACE Permit #4-2001-1280, Washington Creek 2. March 15.

plants was more than double minimum cover for satisfying performance standards ($> 30\%$), with cover of 80% in 2005, 67.4% in 2008, and 62.8% in 2012. The decrease in total cover was due to a continuing decline of early successional species of grasses and forbs and increase of late successional species. From 2005 to 2012, there were documented increases in sedges, non-flowering vascular plants, deciduous shrubs and deciduous trees (ABR and BPXA 2013). The report states that tussocks had recovered in cleared areas surrounding the trenches, and that there was re-establishment of ericaceous shrubs, willows, and shrub birch.

Succession and Spread of Native Vegetation at Washington Creek after Ten Years



View of a Washington Creek trench that was covered, mounded, and successfully revegetated. Figure to the left is July 2002; Figure to the right is September 2012. Early succession brought in grasses and sedges, while later ecological succession recruited more leafy plants and trees. Photo Credit: ABR and BPXA 2013.

The percentage of trenches that were below grade increased from 2008 to 2012; in 2012, trench elevation was below grade at 34% of monitoring stations. However, this did not necessarily mean that vegetation was inhibited. Since desired surface stability and vegetation recovery goals were achieved, the study indicates that the requirement for $>80\%$ of trench elevation measurements to be at or above grade appeared no longer necessary after 2012 (ABR and BPXA 2012).

2.1.2.8 Monitoring and Maintenance Program Not Robust

Washington Creek sites do not appear to have been monitored annually. Monitoring is reported to have occurred in the first year after installation (2003), then in 2005, 2008 and 2012.

2.2 Powerline Trenches and Rehabilitation Work

In the early 2000s, electric cables were buried in trenches on the North Slope near the Milne Point (F/L Pad Road Intersection). The two trenches were approximately 400 ft long each, with total disturbed area equating to about 12,000 ft². The burial of the powerline cables served an entirely different purpose than the trenching trials described above, and is also vastly different from AGDC's

design for a buried North Slope gasline. AGDC has access to a rehabilitation report (LGL and BPXA 2008)²¹ that is used here for comparative purposes.

The powerline trenching, while of smaller scale, led to even worse issues than the trenching trials, described above. The powerline trench installation, although completed in winter, did not generate substantial fill material, and did not appropriately account for subsidence due to thawing of ice in soils, which resulted in retaining surface water in the subsided ditch. There may not have been any attempt at mounding to a suitable height. In an attempt to compensate for misjudging the amount of cover or mounding required over the powerlines, local material applied by cranes was placed in open water areas in subsequent years, but this was not immediately effective.

There is no indication that adequate revegetation efforts (seeding, fertilization) occurred following powerline installation other than allowing natural recruitment of adjacent vegetation, although rehabilitation reports indicate a post-installation focus on preserving site aesthetics and wetland function. After corrections were made to stabilize the area by bringing in additional fill, it was determined that applications of phosphorous fertilizer should be used in combination with new revegetation efforts, including sprigging with *Arctophila fulva* and either seeding with native grass cultivars or sodding with native tundra. The report states that no specific performance standards were ever determined.

2.3 ASAP's Design and Procedures Will be Different

The ASAP design and procedures will differ substantially from those of the trench work mentioned, above. In fact, the issues above were each corrected through agency involvement that required the projects to implement some of the measures that ASAP intends to use during construction.

2.3.1 ASAP Will Install Trench Breakers (i.e., Ditch Plugs) to Restrict Subterranean Flow and Erosion

This was, perhaps, the largest and most critical issue with the aforementioned trenching projects. Many of the above examples did not install ditch plugs until it was too late and projects were out of compliance. Ditch plugs are critical mitigation, and ASAP's design is to install them early and often. AGDC's goal is to keep water out of the trench. Keeping water out of the ditch will help to keep the top of the trench above grade, which will limit water collection over the trench and allow vegetation to return and stabilize the trench area. The presence of cross flow will require installation of ditch plugs and maintenance of that existing cross flow.

²¹ LGL and BPXA. 2008. Rehabilitation report for the powerline trenches near the F/L Pad Road intersection, Milne Point Unit, Alaska. December.

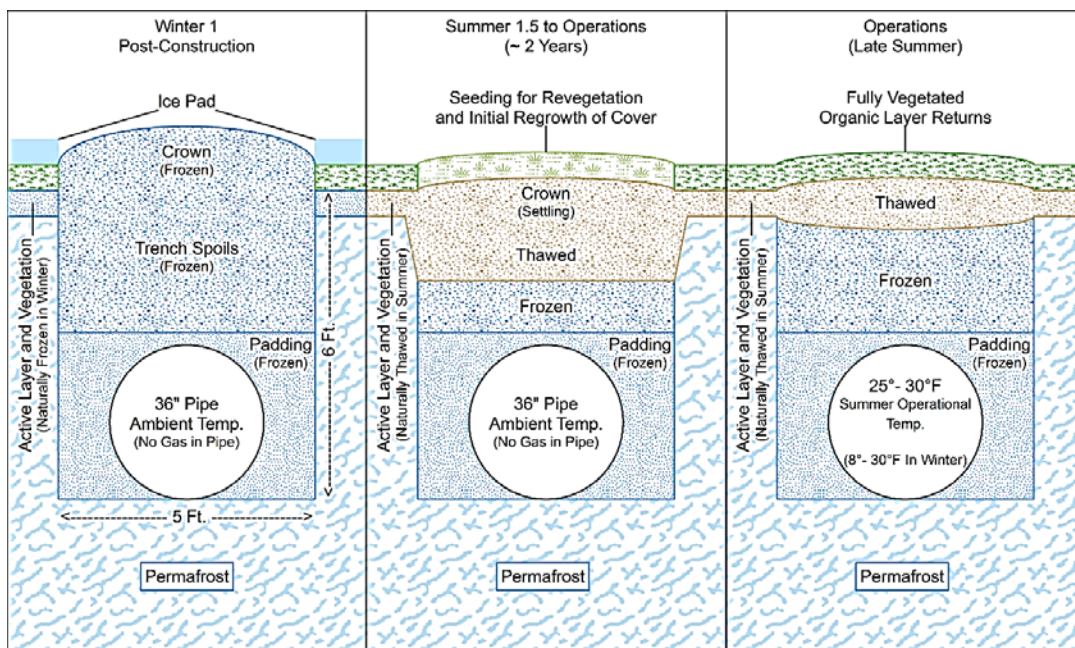
Examples of Ditch Plugs Made From Different Types of Materials to Control Water



2.3.2 ASAP Will Have Excess Material for Use in Mounding to an Appropriate Height

In the aforementioned trenching studies and projects, no pipeline was installed, and no thaw-stable bedding or padding materials were used before the trenches were covered. Therefore these examples are not representative of what AGDC is proposing. For ASAP, a substantial volume of the trench will be taken up with bedding and padding materials, and a 36" diameter pipeline. Without this, excess material is not available for use in covering and crowning over the ditch to mitigate subsidence, which will occur once ice has thawed and water has drained from the ice-rich soils. AGDC's goal is to form a crown (mound) over the ditch that will settle after thawing to a very slight mound just above grade. The powerline trench project did not appear to mound appropriately over the trench. The North Slope trenching trials mentioned above did mound over the trench, but loss of material due to a lack of trench breakers installed during initial disturbance led to erosion and subsidence. Once trench breakers were installed years later, material had to be trucked in to correct these issues.

Excess Material is Essential for an Appropriate Crown Height



2.3.3 ASAP will Collect Soil Ice Content Data at Regular Intervals to Determine Suitable Mounding Height

The trenching trials and powerline trench project did not adequately take into account the ice content of the soils by collecting data on soil ice content at regular intervals. Therefore, both had major subsidence issues in at least some of the trenches. The trench trials did mound material over the trench to a height of 3.6 feet, but this was uniform and didn't take into account variability in ice content over the large acreage of the trials. This was exacerbated by erosion and loss of material due to no trench breakers, as described above. Depressions over the trench sites allowed water to pond, limiting vegetation regrowth. The subsidence encountered promoted ponding of water over the ditch and cold, wet soils that inhibited immediate regrowth of vegetation.

To mitigate, AGDC would perform regular intervals of soil ice content testing during construction to determine the percent ice content contained in soils. Soils are collected in buckets and taken into a nearby warming shack. The water content and vertical drop in soils is measured for use in determining the needed crown height to account for subsidence in spring, ensuring that only a slight mound results once the area is completely thawed and ready for areal broadcast seeding. Former TAPS Operations and Maintenance staff have reported used this "warming shack" sampling method to determine levels of subsidence where ground must be disturbed.

Using this proven method developed by TAPS maintenance staff:

- o Where ice content was moderate (40-60%), a moderate crown would be used consistent with how much thawed soils in the warming shack subsided.
- o Where ice content was high (80-90%), a higher crown would be used, consistent with how much thawed soils in the warming shack subsided.

The studies demonstrated the sensitivity and volatility of tundra soils and permafrost areas when the most effective stabilization and mitigation procedures are not used. The studies were instrumental in helping to develop procedures for soil stabilization in arctic and subarctic areas.

Mounding of Backfill to Compensate for Thaw Settlement



(Image Source: Blanchet et al., 2002)

2.3.4 ASAP Will Operate at Below Freezing Temperatures on the North Slope, Year Round

The proposed ASAP pipeline would operate at below-freezing temperatures year-round (8 – 30°F in winter; 25 – 30°F in summer) on the North Slope and would transport a gaseous product with low heat transfer properties. This is in contrast to the aforementioned trenching trials and powerline trenching that allowed passive heat flow in summer, accelerating thaw, rather than reversing heat of conductance by driving freeze into the ground. ASAP would operate below freezing year round. The thermal properties of the pipeline will mitigate extensive thaw throughout operations on the North Slope. As described above, this will result in only incremental thaw of the active layer, and no subsidence related to a warm temperature pipe.

ASAP will Operate at Below Freezing Temperatures Year-Round

Temperature profiles modeled for the Alaska Stand Alone Pipeline (ASAP) during operations. The green and red lines represent the modeled temperature inside the pipe during operations in summer and winter, respectively. The purple and blue lines represent the modeled temperature on the outside of the pipe during operations during summer and winter, respectively. The first 60 miles are highlighted by the black dashed box.

2.3.5 ASAP's Revegetation Efforts Will be Aggressive and Diverse

AGDC will immediately revegetate the right-of-way on the Arctic Coastal Plain, re-establishing vegetation during the dormant period. Appropriate fertilization and aerial broadcast seeding will occur by fixed wing aircraft as soon as thaw has occurred. Seeding will occur at the following mixture with rates taking into account some predation by birds.

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Arctared' Red fescue	<i>Festuca rubra</i>	30	19.35
'Nortran' Tufted hairgrass	<i>Deschampsia caespitosa</i>	30	10.75
Annual ryegrass	<i>Lolium mutiflorum</i>	25	8.6
'Tundra' Glaucous bluegrass	<i>Poa glauca</i>	15	4.3

In subsequent years, after the dormant period, the following seed mix and seeding rates will be used where required:

COMMON NAME	SCIENTIFIC NAME	% OF MIX	PLS SEEDING RATE LBS./ACRE
'Alyeska' Polargrass	<i>Arctagrostis latifolia</i>	30	9
'Arctared' Red fescue	<i>Festuca rubra</i>	30	9
'Norcoast' Bering hairgrass	<i>Deschampsia beringensis</i>	15	4.5
'Tundra' Glaucous bluegrass	<i>Poa glauca</i>	15	4.5
'Egan' American sloughgrass	<i>Beckmannia syzigachne</i>	10	3

The general recommended rate of fertilizer application would be aggressive, on the order of 450 pounds per acre of 20N-20P-10K. Adjustments will be made to the fertilizer based on annual monitoring. The selection of final products and their application rates would be determined in consultation with ADNRC-Plant Materials Center.

2.3.6 ASAP will Implement and Meet Performance Standards Designed by ADNRC's Plant Materials Center

Per ASAP's Revegetation Plan, the Project will implement robust performance standards for vegetative cover.

2.3.6.1 Canopy Standard

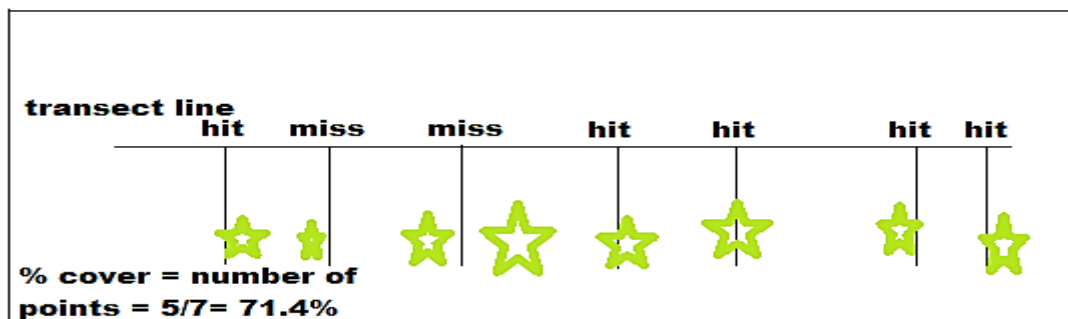
Canopy cover is the percentage of the ground obscured by vegetation (not to be confused with basal cover, which is a covering in which plants intersect the ground, such as at the base or trunk of a plant). The canopy can be visualized by considering a bird's-eye view of the vegetation. A typical erosion control standard of at least 70 percent pre-disturbance canopy (or aerial) cover, which includes live vegetation that will resist erosion, would be achieved for ASAP. Dead vegetative mat, incidental woody debris, stones or gravel and litter are excluded from making up the 70% cover. If documented reference site conditions show a lesser percent cover, achievement of that cover level as an adaptive management level prior to requesting site release and/or termination of a reclaimed project site or area would be needed. ASAP may request, with the appropriate agency, that a lower standard than the 70 percent be allowed in those areas where a lesser cover will control erosion and allow faster revegetation of species.

The reclamation standard of at least 30 percent vegetative cover over a three-year period (not including seeding year) would be an interim action level criterion, which would indicate to ASAP whether additional revegetation action would need to be taken to ensure that a viable vegetative cover is established and that natural succession of plant species would continue, unless documented adjacent reference site conditions show a lesser percent cover for the surrounding area. Remedial action could include seeding or reseeding an area, additional application of soil

amendments, and/or incorporation of additional growth media on a particular site. ASAP would be responsible for determining the cause and resolution of the substandard revegetation cover, and if appropriate, to seek approval for an adaptive management solution. The cover standard should be achieved without the use of fertilizer or reseeding for the last two growing seasons in the 5-year period.

Point intercept will be the method used to measure canopy cover with transects forming the sampling unit. Cover should be measured during the same time period each season from August 1-31. This time period will be indicative of the peak growing season when species are at their potential for vigor and biomass. Points will be placed systematically along transects at one foot intervals. Two permanent transects will be installed at each evaluation site for quantitative measures of plant cover. Each transect is 300 feet long with observations (hits) recorded on canopy cover of species recorded at one foot intervals resulting in a total of 300 points per transect. The estimate of cover along each transect is then this number of hits divided by the total number of possible hits. Points are measured either with pins that touch the vegetation or with a cross hair optical sighting device. It is important to use the same diameter of pin for successive measurements. Transects should be long enough to account for variability in the vegetation being sampled and have enough points so that you will intersect at least some individuals of the species of interest along each transect line. The transects will have permanent markers such as t-post or rebar marking the beginning, middle, and end points so they can be located in the field.

Example of Point Intercept Method of Measuring Cover



2.3.6.2 Density Standard

A density count of individuals or stems (counting unit) per unit area would indicate whether natural revegetation through species recruitment is occurring at a rate that will produce a permanent native vegetation community over time. During seeding, density can be used to evaluate seedling emergence and survival. Density is most sensitive to changes caused by mortality or recruitment.

Species density would be evaluated by comparing the total number of species in the evaluation site to that of the adjacent reference sites. Quadrants would be the sampling unit used for measuring density with herbaceous plant stems and individuals counted within the boundaries of a quadrat.

Design and field considerations are of great importance in density measurements, and individuals or stems 'number' indicating density success would be determined at time of monitoring. Quadrat design, counting unit, and boundary decisions are all key monitoring design decisions. A thorough

resource on this topic is from Elzinga et al. (1998)²². Density design and measurements will be made on a case-by-case basis to fit the site area to be monitored.

2.3.7 ASAP Will Implement an Intensive Monitoring and Maintenance Program

As currently anticipated, three types of monitoring would be conducted in order to meet the primary goals and objectives of monitoring as stated above:

General Route Monitoring (GRM) – General route reconnaissance and reporting of revegetation conditions along the entire length of the pipeline right-of-way including the temporary use areas as necessary. Qualitative monitoring would be conducted annually along the entire pipeline ROW.

A general route reconnaissance of the entire ROW project would be conducted annually. The intent of this reconnaissance is to inspect and document overall recovery conditions. Conditions to be observed may include areas of dead plants, establishment of invasive species within the right-of-way, significantly eroded soils, deteriorating conditions or subsidence, unstable streambanks at crossings, and damage caused by ATVs. Documentation would include establishing photo points at specific locations, estimating area or revegetation affected, and/or recording the apparent cause or remediation efforts required. Site locations may be documented by MP, global positioning system coordinates, or by name. Adaptive management actions may be implemented based on findings from route monitoring. Each annual visit would assess designated RMES sites and document new locations where appropriate.

Representative Monitoring Evaluation Site (RMES) Monitoring– Detailed field reconnaissance and reporting at the designated RMES along the pipeline right-of-way including temporary use areas. Qualitative as well as quantitative monitoring would be taken. These sites progress and success would be compared to baseline data taken from adjacent reference sites. Monitoring would begin the second growing season and occur annually for a period of at least five years.

Representative monitoring evaluation sites would be established approximately every 10 miles along the right-of-way in coordination with the applicable landowner and/or the Alaska Plant Materials Center, and as appropriate for other specific sites needing extra attention, where maintenance has occurred or for specific actions during termination. The establishment of these specified RMES would allow ASAP and the landowner/appropriate agency to evaluate whether or not the cover and density standards are being achieved on the particular area or segment of the ROW over a period of time (5 years). There would be approximately 73 RMES. Even though specific sites would be monitored the pipeline would generally be visually monitored for areas where revegetation may need further attention or where damage to revegetation efforts may require attention.

The specific location of RMES and undisturbed adjacent reference sites would be identified, reviewed, and approved by the landowner and/or agencies prior to initiation of monitoring activities. Specific RMES would be located and mapped according to global positioning system coordinates. The location of evaluation sites would avoid, to the extent possible, areas that may be susceptible to future human disturbance (ATV use) to preserve the integrity of each site for the duration of the monitoring period. Where possible, RMES locations would provide a good

²² Elzinga, C.L., D. W. Salzer, and J.W. Willoughby. 1998. Measuring & Monitoring Plant Populations. BLM Technical Reference 1730-1. Bureau of Land Management, National Business Center, Denver, CO.

representation of the overall ROW revegetation effort. Once initial monitoring evaluation site locations are finalized, photographs would be taken;

- o Prior to any construction/maintenance/termination-related disturbance,
- o When initial revegetation efforts have been completed and,
- o During each yearly monitoring evaluation site visit.

RMES would be examined at least annually beginning in year two, and a variety of vegetation information would be collected, including quantitative and qualitative information. RMES would also assess invasive and noxious plant species presence that may require remedial action consistent with the ISPMP. However, monitoring for known invasive and noxious plant species may occur independently of revegetation monitoring. Revegetation monitoring would also include the consideration of erosion control as a key indicator to measure the trend toward revegetation success (where applicable), and remedial actions may be taken in conjunction with monitoring efforts to control erosion.

Specific Site Monitoring (SSM) – Detailed field monitoring at specific sites where needed to monitor revegetation progress. Qualitative and quantitative monitoring would be required at least annually. Specific site monitoring would be required at least annually, and a variety of information would be collected depending on the site conditions and the revegetation action involved. This type of monitoring may be found along riverbanks or steep slopes. These types of sites are deemed sensitive because the integrity of the permanent ROW, pipeline, and associated facilities may be compromised if stabilization actions through revegetation and other erosion control measures are not performing as expected.

2.3.7.1 Implementation of a Maintenance Cycle Standard

Soils and water will be monitored regularly after installation of the pipe following the programmatic maintenance cycle standard of “Monitor, Detect, Correct”. Where depressions or slumping occurs in spring / summer, additional ditch spoil will be placed to flatten the surface and reduced the amount of standing water. For the first several years after construction soil stabilization efforts will focus strongly on control of erosion through revegetation per the methods above and water management. If, after several years of revegetation efforts, plant cover does not sufficiently return to stabilize soils, ASAP will consider alterations to the methodologies of its revegetation procedures in consultation with ADNR to encourage additional growth.

ASAP will monitor the pipeline in the years after construction to determine where modifications may be needed to ensure proper water management. Crews will document and inspect areas of ponding water over the pipe and recommend site-specific improvements to ensure that prolonged ponding is limited or reduced. Additional improvements may be added in certain areas, depending on the level of moisture, drying, and settling that occurs over and around the pipe.

Programmatic Maintenance Cycle Standard for ASAP

