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# **REVEGETATION PLAN FOR MINE SITE C, KUPARUK OILFIELD, ALASKA**

Prepared for **ConocoPhillips Alaska, Inc. (CPAI)**

by **ABR, Inc.—Environmental Research & Services**

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## **INTRODUCTION**

The original rehabilitation plan for Mine Site C was submitted to the U.S. Army Corps of Engineers (USACE) in or before 1996 and is referenced in USACE permit N-800307, which authorized continued gravel extraction until 2006. A revised plan, following the same objectives and general approach as the original, was submitted in 2006. An updated rehabilitation plan for stabilizing Mine Site C and creating site conditions suitable for vegetation was developed by Lounsbury and Associates in 2007. An accompanying revegetation plan, detailing the plant cultivation treatments recommended to achieve the rehabilitation goals and objectives, was provided by ABR. The rehabilitation plan was revised in 2014 by PND Engineers, Inc. (PND) to reflect a proposed expansion of the mine site. This updated revegetation plan is intended to accompany the revised rehabilitation plan as an appendix.

Currently, Mine Site C occupies an area that previously comprised moist sedge tundra and part of a large, shallow lake (Pothole Lake). The southern portion of Pothole Lake remains in its natural state and is separated from the mine site by a dike. A buffer of approximately 300 ft separates the west edge of the mine from the Ugnuravik River. The pits excavated during the initial phases of mining now form the water reservoir for the Kuparuk Operations Center (KOC), which adjoins the mine site to the north and is separated from it by a dike. The water reservoir is connected to the Ugnuravik River. To meet ongoing needs for gravel within the Kuparuk River Unit (KRU), CPAI proposes to expand Mine Site C to the south (into the remainder of Pothole Lake) by approximately 125 acres.

Including the proposed expansion, the total area of the mine site to be rehabilitated will be approximately 280 acres. Depending on material availability, approximately 40 acres of shallow littoral habitat will be created by placing fill along the northwest edge of the mine site, as well as in the northeast and southwest corners. To provide favorable conditions for establishing aquatic and emergent plants, these areas will be contoured to create a final water depth of 1–3 ft, after the fill has settled and the water level in the flooded mine site has stabilized. These areas of aquatic vegetation will in turn provide high quality habitat for waterfowl. Several nesting islands for waterfowl will also be included in the littoral areas; the final number and sizes of islands will

depend on material availability. The remainder of the site will consist of a deep lake, which will provide potential overwintering habitat for fish. The design elements for the rehabilitated mine site, including construction of shallow littoral areas and nesting islands, and maintenance of appropriate water levels, are described in the revised Mine Site C Rehabilitation Plan prepared by PND. This revegetation plan details the additional site preparation and plant cultivation treatments that will be applied to meet the rehabilitation goals for the site. In addition to the shallow littoral areas and nesting islands, areas to be treated include the residual berms around the perimeter of the mine site; the dike separating the mine site from the KOC water reservoir; and a former overburden stockpile, located at the nearby Kuparuk Industrial Center (KIC), that will serve as a material source for rehabilitating Mine Site C.

Extraction of gravel from Mine Site C is expected to continue for at least 20 years, and most rehabilitation activities will not occur until mining is complete. To the extent feasible, construction of some design elements (e.g. shallow littoral areas) may begin while mining is ongoing. In addition, the northeast corner of the existing mine pit (northeast interim reclamation area) will be recontoured into terraces and slopes in 2016, and temporary plant cultivation treatments will be applied. These treatments are intended to reduce erosion and temporarily increase habitat value for wildlife in this area, which will be flooded after extraction of gravel from Mine Site C is complete.

## **GOALS AND OBJECTIVES**

The overall goal of the revegetation effort at Mine Site C is to establish productive, diverse, and self-sustaining plant communities that will provide habitat value for wildlife and promote long-term stability of the site. To attain this goal, specific revegetation objectives have been developed for individual site components (Table 1). For the northeast interim reclamation area, the objectives are to temporarily reduce erosion and increase habitat value for wildlife. For the remaining site components, the objectives focus on establishing plant communities adapted to the conditions expected in each area after mining has ended, the civil work needed for rehabilitation has been completed, and the mine site water level has reached the design elevation.

## **PERFORMANCE STANDARDS**

Performance standards are proposed for each site component (except the northeast interim reclamation area; see below), to allow quantitative assessment of progress toward the rehabilitation objectives. Meeting the performance standards does not necessarily mean that objectives (e.g. create productive habitat for wildlife) have been achieved; rather, it indicates that a positive trajectory has been established and rehabilitation goals and objectives should be attained eventually. Some flexibility is needed with respect to specific objectives and scheduling, due to uncertainties about how site conditions will develop over time, both before and after

completion of mining. Retaining flexibility will allow response to unanticipated site changes while maintaining the overall goals of the rehabilitation effort.

#### NORTHEAST INTERIM RECLAMATION AREA

No quantitative performance standards have been established for this area, as the treatments are intended to be temporary.

#### SHALLOW LITTORAL AREAS

Tundra Plugs: The proposed performance standards are: 1) 50% survival after 5 years and 2) a statistically significant ( $p \leq 0.05$ ) increase in mean diameter. Diameter measurements will be based on a sample of approximately 10% of the transplanted plugs.

Transplanted *Arctophila*: The proposed performance standard is: within 5 years of planting, moderate–high cover of *Arctophila* will be present over at least 20% of the shallow littoral area.

#### ISLANDS

Tundra Plugs: The proposed performance standards are: 1) 50% survival after 5 years and 2) a statistically significant ( $p \leq 0.05$ ) increase in mean diameter. Diameter measurements will be based on a sample of approximately 10% of the transplanted plugs.

Transplanted *Arctophila*: The proposed performance standard is: within 5 years of planting, moderate–high cover of *Arctophila* should be present along at least 10% of the island shorelines, in a band at least 1 meter wide.

Willow Cuttings: The proposed performance standards are: 1) 25% survival after 5 years, and 2) a statistically significant ( $p \leq 0.05$ ) increase in mean canopy diameter, to ensure that the plants are thriving and contributing to development of the community.

Plant Community: The proposed performance standards are: 1) total live cover of indigenous plants (ILVC)  $\geq 20\%$  within 10 years and 2)  $\geq 5$  indigenous species with  $\geq 0.2\%$  each. Achieving these standards would indicate that a productive, self-sustaining plant community can be expected to develop on the islands over time.

#### NORTH DIKE

Plant Community: The proposed performance standards are: 1) total live cover of indigenous plants (ILVC)  $\geq 10\%$  within 10 years and 2)  $\geq 5$  indigenous species with  $\geq 0.2\%$  each.

Vegetation performance standards for this area are modest, because the most of the dike will remain in place to help control the water level in the pit. The relatively thick overburden likely will result in low soil moisture, providing challenging conditions for the growth of most plants.

## PERIMETER BERMS

Plant Community: The proposed performance standards are: 1) total live cover of indigenous plants (ILVC)  $\geq 20\%$  within 10 years and 2)  $\geq 5$  indigenous species with  $\geq 0.2\%$  each. Achieving these standards would indicate that a productive, self-sustaining plant community can be expected to develop on the dike over time.

## FORMER OVERBURDEN STOCKPILE (KIC)

Plant Community: The proposed performance standards are: 1) total live cover of indigenous plants (ILVC)  $\geq 20\%$  within 10 years and 2)  $\geq 5$  indigenous species with  $\geq 0.2\%$  each. Achieving these standards would indicate that a productive, self-sustaining plant community can be expected to develop on the islands over time.

## REHABILITATION TREATMENTS

This section describes the site preparation and plant cultivation treatments planned for Mine Site C, after the civil work needed for rehabilitation is complete. The treatments are summarized in Table 1.

## NORTHEAST INTERIM RECLAMATION AREA

After the slope has been recontoured, the terraces and slopes will be fertilized and seeded with native-grass cultivars, to promote rapid establishment of plant cover. The seed mix will depend on availability, but likely will include *Festuca rubra* ('Arctared' red fescue), *Poa glauca* ('Tundra' glaucous bluegrass), *Arctagrostis latifolia* ('Alyeska' polargrass) and/or *Deschampsia caespitosa* ('Nortran' tufted hairgrass). Fertilizer (20-20-10 NPK) will be applied at 400 lbs/acre, to provide abundant nutrients for establishment and growth of the seeded grasses. Fertilizer will be reapplied as needed to maintain vigorous plant growth and continue to meet the rehabilitation objectives (approximately every 3–5 years). Additional seed may be applied if warranted to maintain healthy vegetation cover.

## SHALLOW LITTORAL AREAS

When the water surface in the flooded mine site has stabilized at the design elevation, seed of wetland sedges such as *Eriophorum angustifolium* (tall cottongrass) and *Carex aquatilis* (water sedge) will be sown along the shoreline, where soil conditions are expected to be wet-saturated. Tundra plugs comprising similar sedge species will be transplanted along the shoreline, in areas where final water depth is expected be less than 1 ft. sprigs of *Arctophila fulva* (pendant grass) will be planted in areas with expected water depth of 1–2 ft. These treatments will help establish a diverse, productive community of indigenous plants, and provide habitat favored by waterbirds. Plant materials will be collected from the adjacent tundra or elsewhere on the North Slope, under permit from the Alaska Department of Natural Resources.

## ISLANDS

A layer of organic-rich overburden (4–6 inches) will be placed on the tops of the islands to improve conditions for plant growth. Fertilizer (20-20-10 NPK) will be applied at 200 lbs/acre and seed of native-grass cultivars will be applied at 10–20 lbs/acre), to rapidly establish plant cover, provide forage and cover for birds, and initiate the processes of soil development. Note that the topsoil, although it should provide favorable conditions for plant growth, is not intended to serve as a source of live plant material. Grass species used will depend on site conditions and availability, but likely will include *Arctagrostis latifolia*, *Deschampsia caespitosa*, *Poa alpina* ('Gruening' alpine bluegrass), *Poa glauca* and/or *Trisetum spicatum* ('Nelchina' spike trisetum). These species are all native to arctic Alaska, and their seed is available from Alaskan commercial growers. Seed of native forbs will also be sown in these areas if conditions are suitable, to increase taxonomic diversity and possibly increase nutrient inputs to the soil. Seed of suitable forb species is not available commercially but can be collected from natural populations, under permit from the Alaska Department of Natural Resources. Availability varies from year to year, but species used likely would include *Artemisia arctica* (boreal sagebrush), *Epilobium latifolium* (dwarf fireweed), and the legumes *Astragalus alpinus* (alpine milkvetch), *Oxytropis borealis* (boreal locoweed), *O. campestris* (field locoweed), and/or *O. deflexa* (nodding locoweed). If soil conditions are moist–wet on portions of the islands, seed of wetland sedges will be sown in these areas.

Depending on the ice content of the overburden used to construct the islands, one or more years may be required for the islands to drain and stabilize before treatments can be applied safely and effectively. Based on our experience with other rehabilitated North Slope sites, we expect that seeding will be possible in the second summer following construction of the islands.

When the water surface is near the design elevation, additional plant cultivation treatments will be applied. Depending on conditions as the site stabilizes, materials used may include willow cuttings (*Salix* spp.), tundra plugs and/or sprigs of *Arctophila* (along the shorelines of the islands). Live plant materials will be collected from the adjacent tundra or elsewhere on the North Slope, under permit from the Alaska Department of Natural Resources.

## NORTH DIKE

The overburden dike at the north end of the site serves to prevent water movement from the flooded mine pit into the adjacent KOC reservoir, which is connected to the Ugnuravik River. When the reservoir is no longer needed as a water source, the dike will be breached and a weir will be installed, to control water movement between the mine pit and the reservoir. A layer of organic-rich overburden (4–6 inches) will be placed on top of the remaining portions of the dike to improve conditions for plant growth. The dike will be fertilized and seeded with native-grass cultivars and legumes as described for the islands (above). If needed, grass seed may be applied at a higher rate in the vicinity of the weir, to help stabilize the soil surface. In addition, live plant

materials (willow cuttings or tundra plugs) may be transplanted along the shoreline if conditions are suitable.

#### **PERIMETER BERMS**

When mining is complete, the perimeter berms will be removed and the material will be used for rehabilitation, including construction of the shallow littoral area and islands. Plant cultivation treatments for the former berm areas will depend on the amount of overburden remaining. If the residual overburden is thin (< 4 inches), conditions should be favorable for the establishment of tundra vegetation similar to the original plant community. In this case, treatments would include fertilizer (20-20-10 NPK at 20 lbs/acre) and seed of wetland sedges. Tundra plugs may be transplanted at selected locations to promote more rapid development of cover and diversity. If the residual gravel is mostly thicker than 4 inches, the former berms will be topdressed with organic-rich overburden (4–6 inches thick) and seeded with species adapted to relatively dry conditions (grasses and forbs), as described for the islands.

#### **FORMER OVERBURDEN STOCKPILE (KIC)**

The choice of rehabilitation treatments for the former overburden stockpile, located at KIC, will depend on the amount of residual overburden remaining once the civil work is complete. If the average thickness of residual overburden is less than 4 inches, conditions should be favorable for the establishment of tundra vegetation similar to the original plant community. To improve conditions for plant growth, a trimmer will be used to mix in some of the underlying tundra soil. Plant cultivation treatments will include fertilizer, seed of wetland sedges, and possibly tundra plugs, as described above for the perimeter berms.

If a thicker layer of residual overburden remains, it will be removed if possible, followed by trimming and plant cultivation treatments as described above. If removal is not feasible, the area will be seeded with species adapted to relatively dry conditions (grasses and forbs), as described above for the islands.

#### **MONITORING**

Development of stable landforms and diverse plant communities at North Slope disturbed sites frequently requires many years. Therefore, this plan includes a multi-year monitoring period to assess whether the rehabilitation goals have been met. As described above, specific performance standards are proposed for each revegetation treatment. Preliminary monitoring will be conducted to determine whether achievement of performance standards on schedule appears likely, or whether additional treatments are needed. If the performance standards for a particular treatment have not been reached by the target date, the need for additional rehabilitation treatments and/or monitoring will again be assessed.

## VEGETATION COVER AND DIVERSITY

Cover will be sampled using the point-intercept method, at 250–500 points widely spaced within each treatment area to be sampled. Depending on site conditions, the points may be distributed in a stratified fashion to account for site heterogeneity (e.g., presence of ponds), or using a systematic approach within a grid.

## SURVIVAL AND GROWTH OF TRANSPLANTS

Survival of tundra plugs and willow cuttings will be assessed by comparing the number of live cuttings or plugs with the total number planted. Growth of tundra plugs will be monitored by tracking the diameter of a sample (~ 10%) of the plugs. Similarly, growth of transplanted willow cuttings will be monitored by measuring the canopy diameter of a sample of willows. The success of *Arctophila* transplanting will be assessed by visually classifying cover into several categories (e.g. absent, sparse, low, moderate, dense).

## SCHEDULE

It is not possible to present a final schedule at this time, because extraction of gravel from Mine Site C is expected to continue for at least 20 years. As space and materials allow, some rehabilitation design elements (e.g. portions of the shallow littoral area) may be constructed while mining is ongoing. In addition, the northeast interim reclamation area will be recontoured during 2016, and temporary plant cultivation treatments will be applied after this work is completed. However, the timing of most rehabilitation treatments will depend on the rate at which the physical characteristics of the site develop. For example, *Arctophila* cannot be planted in the shallow littoral area until mining has ceased and the water level in the pit has stabilized near the design elevation. A general plan for scheduling revegetation treatments is presented in Table 2.

Table 1. Objectives, site preparation and plant cultivation treatments for rehabilitation of Mine Site C, Kuparuk River Unit oilfield, Alaska.

Site Component	Objectives	Site Preparation	Plant Cultivation Treatment(s)
Northeast interim reclamation area	Temporarily reduce erosion and increase habitat value for wildlife, prior to flooding of mine site.	Topdress with overburden.	Fertilize and seed with native-grass cultivars.
Shallow littoral areas	Create productive habitat for wildlife, especially waterfowl.		Seed wetland sedges; transplant tundra plugs and <i>Arctophila</i> .
Islands	Create productive habitat for wildlife, especially waterfowl; promote establishment of a plant community dominated by indigenous species.	Topdress with organic-rich overburden.	Upland portions: transplant willow cuttings; seed native-grass cultivars and forbs. Shorelines: transplant tundra plugs and <i>Arctophila</i> sprigs.
North dike	Promote establishment of a plant community dominated by indigenous species.	Topdress with organic-rich overburden.	Seed native-grass cultivars and forbs. Transplant tundra plugs and/or willows along shoreline if conditions suitable.
Perimeter berms	Promote establishment of a plant community dominated by indigenous species.	If >4 inches thick, topdress with organic-rich overburden.	Seed wetland sedges, native-grass cultivars and/or forbs, depending on soil moisture. Transplant tundra plugs at selected locations if conditions suitable.
Former overburden stockpile (KIC)	Promote establishment of a plant community dominated by indigenous species.	Till in underlying tundra soil.	Fertilize and seed with indigenous sedges or forbs, depending on soil moisture conditions.

Table 2. General plan for scheduling revegetation treatments at Mine Site C, Kuparuk Oilfield, Alaska.

Site Component	Revegetation Treatment	Timing of Application
Northeast interim reclamation area	Fertilize; seed native-grass cultivars.	After slope is recontoured (2016).
Shallow littoral area	Transplant <i>Arctophila</i> sprigs and/or tundra plugs.	1 year after water level stabilizes at design elevation.
Islands	Fertilize; seed native-grass cultivars and native legumes.	After islands have thawed and drained (~ 2 years after construction).
	Transplant willow cuttings, tundra plugs and/or <i>Arctophila</i> sprigs.	1 year after water level stabilizes at design elevation.
North dike	Fertilize; seed native-grass cultivars and forbs.	When reservoir is no longer needed.
Perimeter berms	Fertilize; seed wetland sedges; transplant tundra plugs. (Seed native-grass cultivars and forbs if overburden is >4 inches thick.)	When overburden removal is complete.
Former overburden stockpile (KIC)	Fertilize; seed wetland sedges; transplant tundra plugs. (Seed native-grass cultivars and forbs if overburden is >4 inches thick.)	When overburden removal is complete.