PROJECT CHARIOT
Site Revegetation Program
1993 - 1995

Prepared for
U. S. Fish and Wildlife Service
Alaska Maritime National Wildlife Refuge
Homer, Alaska

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Alaska Department of
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Foreword

In April 1993, the Alaska Department of Environmental Conservation (ADEC) and the U.S. Fish and Wildlife Service (USFWS) requested that the Alaska Plant Materials Center (PMC) assist with the revegetation of the Project Chariot site. The PMC was asked to submit a revegetation plan for use in site revegetation after the contaminated soil removal was complete. This revegetation plan was limited to species selection, revegetation techniques, fertilizer recommendation and the type of mulches needed to prevent thermal erosion and provide protection for seed and seedlings. A revegetation plan was submitted to the U.S. Fish and Wildlife Service on May 6, 1993. The U.S.F.W.S. imposed conditions with regard to acceptable plant species and mulch material prior to the PMC's submission of the plan . A compromise plan was approved in June 1993.

The PMC also agreed to supervise the revegetation work and monitor vegetation growth following the seeding program. The PMC was reimbursed by ADEC through a grant from the U.S. Department of Energy.

Introduction

The following introduction is intended to briefly familiarize the reader with the Project Chariot Radioactive Soil Removal Project including purpose and need for action, site location and historical background.

This excerpt has been taken directly from <u>Environmental Assessment of Proposed Radioactive Soil Removal From Project Chariot Site at Cape Thompson</u>, dated June 1993 and prepared by the U.S. Fish and Wildlife Service. The text has not been changed to reflect the correct relation to time. It reads in the present or future tense as written.

The purpose of the proposed action is to remove soils contaminated by radioactive experiments conducted at the Project Chariot site, to sample the environment for possible contamination, and to transport and dispose of the excavated material. Since the U.S. Fish and Wildlife Service (Service) must issue a Special Use Permit (SUP) before any action is taken, they agreed to write the EA for the DOE. The Service agreed because the EA would provide the background for compatibility determinations and Section 810 Subsistence determinations. The DOE is accepting the EA for its National Environmental Policy Act (NEPA) documentation for the action.

The need for the proposed action is to respond to the great concern expressed by people who live in the Native villages of Point Hope, Kivalina, Kotzebue, Barrow and others in the North Slope and Northwest Arctic Boroughs.

During meetings held to determine the appropriate scope of this environmental assessment, it was clear that many people are concerned about potential health effects, and would like the radioactively contaminated materials to be removed.

Another need for the proposed project is to provide the opportunity for local residents to continue subsistence hunting and fishing in the area, as provided for by the establishment of the Alaska Maritime National Wildlife Refuge (AMNWR). Although some local residents continue to hunt and fish in the area, many residents have voiced a fear of eating food obtained from the area.

In September 1992, Senator Frank H. Murkowski, Governor Walter J. Hickel, and personnel from ADEC and the U.S. Army Corps of Engineers (COE) visited the site and promised immediate action to remove any residual waste. DOE has a mandate to clean up waste sites resulting from its nuclear programs.

Location

The Project Chariot site is located in a remote area of northwestern Alaska, north of the Arctic Circle and about 680 miles northwest of Anchorage (Figure 1). It is four miles to the southeast of Cape Thompson, and about 130 miles northwest of Kotzebue. The old base camp and mound site is located in the Ogotoruk Valley, 32 miles southeast of Point Hope and 41 miles northwest of Kivalina, and is within the Cape Thompson subunit of the Alaska Maritime National Wildlife Refuge.

Background

In 1957, the federal government established the Plowshare Program to "investigate and develop peaceful uses for nuclear explosives". In 1958, the Atomic Energy Commission (AEC) chose the remote Ogotoruk Valley as the "Project Chariot" site where a nuclear device would be detonated to form an economically useful deep-water harbor. Because the site was in an environment for which there was no prior nuclear test experience and little scientific knowledge of the environment, investigations were conducted to assess the proposed project's effects and to ensure that the blasts could be conducted safely. Scientists carried out more than 40 environmental studies during 1959-1962 (Wilimovsky and Wolfe 1996). Appendix A **[NOT INCLUDED IN THIS REPORT]** *presents a summary of the history of Project Chariot from inception to the current day. Local people and other citizens along with governmental agencies questioned the need for this project. Public pressure and lack of state support eventually caused the AEC to drop the harbor project in the early 1960's. Nevertheless, the AEC continued to conduct environmental studies.*

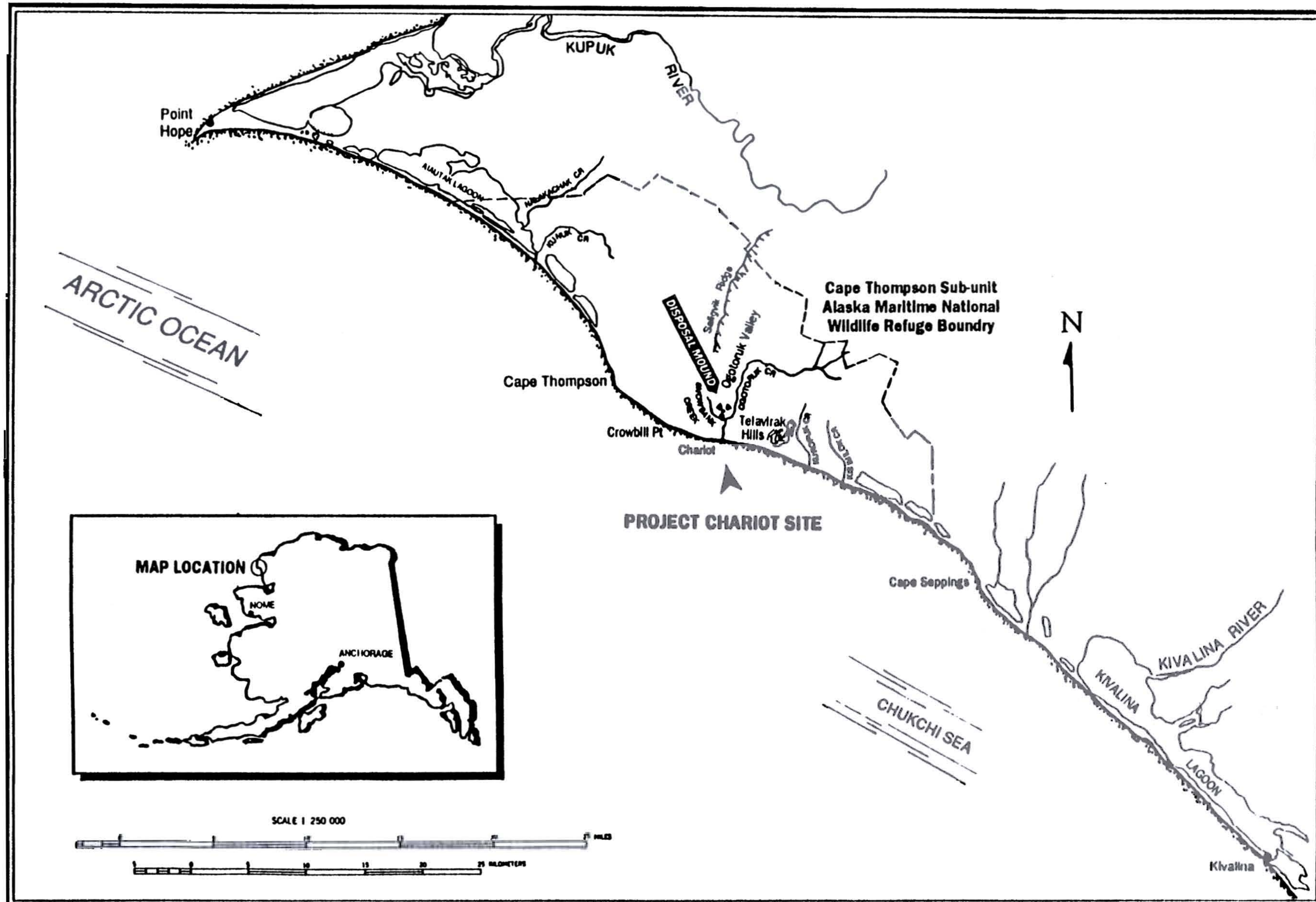

FIGURE 1: Project Chariot site location in the Cape Thompson Sub-unit of the Alaska Maritime National Wildlife Refuge.

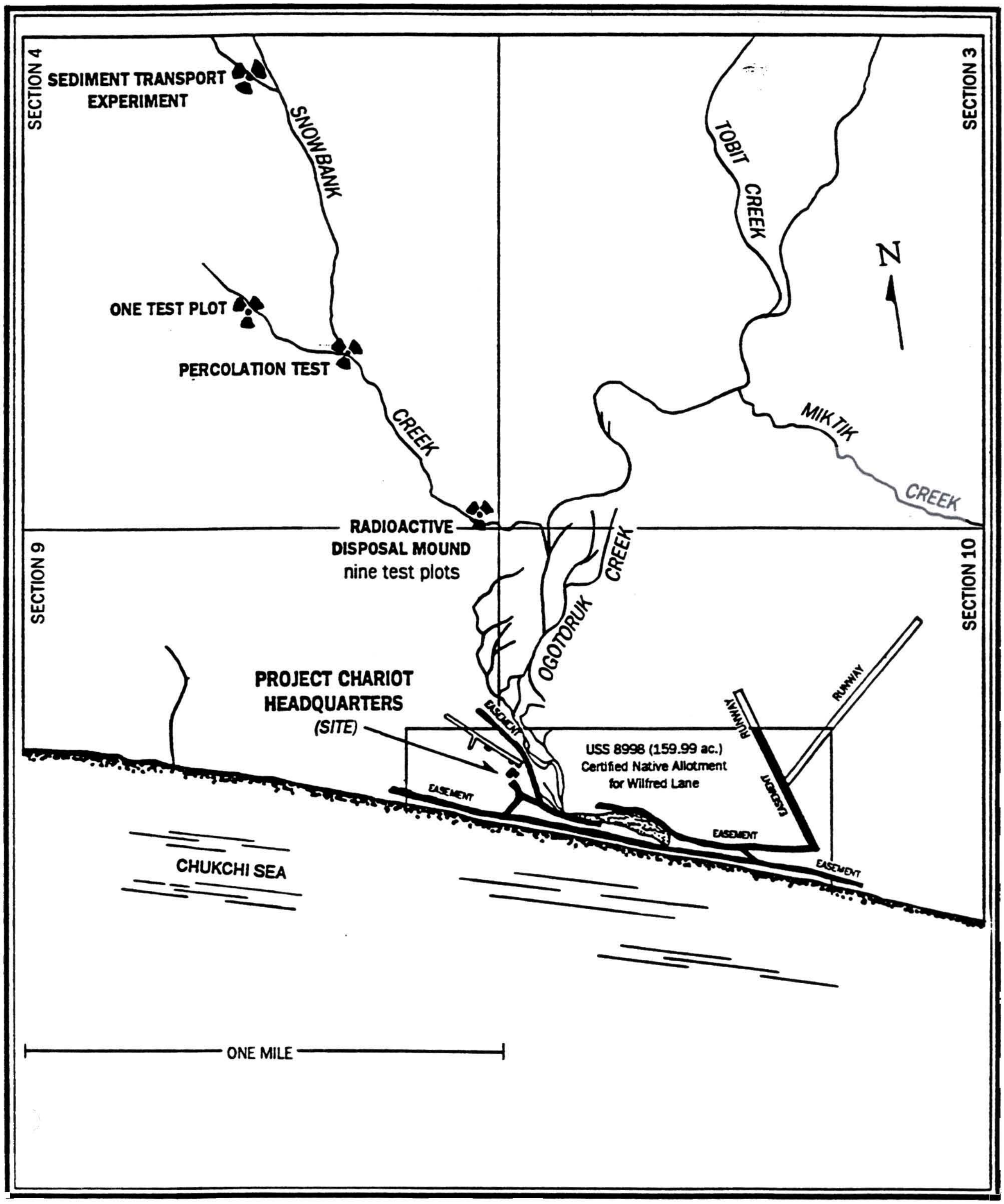

FIGURE 2: Location of Native allotment within the Alaska Maritime National Wildlife Refuge, twelve 1962 tracer test plots and the radioactive disposal mound.

A radioactive tracer experiment was conducted at the Project Chariot site in 1962. As part of the experiment, overland transport studies were conducted over a five day period on 10 test plots adjacent to Snowbank Creek (Figure 2). The test plots ranged in size from 2x2 ft to 5x7 ft. In addition, underground transport of radionuclides was studied using a simple 18-hour percolation test on the hillside above Snowbank Creek. A sediment transport experiment was also conducted on a small tributary of Snowbank Creek.

Small quantities of radioactive material and about 15 pounds of soil containing radioactive fallout from the Sedan test (a Plowshare experiment in Nevada) were used as the tracers. The following types and quantities of radioisotopes were used: six millicuries of Cesium-137, five millicuries of Iodine-131, five millicuries of Stontium-85 and ten millicuries of Project Sedan soil containing mixed fission and activation products.

Following completion of each test plot experiment and the percolation test, the contaminated soil was removed and transported to the present site of the mound. Nine of the test plots were located in the immediate vicinity of the mound (Figure 2). There, the excavated soil was mixed with local soils, resulting in a mound 1.5 ft thick and 20x20 ft in width. The boards and polyethylene sheeting used in the experiments were added to the contaminated soil, and the mound was covered with 4 ft of clean soil to form a mound about 6 ft thick and 40x40 ft in width. The average activity concentration of the radioactivity in the soil was estimated in 1962 to be approximately 0.26 nanocuries (0.00000026 millicuries) per gram. Appendix B **[NOT INCLUDED IN THIS REPORT]** *explains how radioactivity is measured and presents some common comparisons that put radiation in perspective of every day occurrences.*

The mound now contains Cesium-137, which has a half-life of 30 years, as well as the products from the Sedan test. Both Iodine-131 and Strontium-85, with half-lives of less than 70 days, have decayed away. Sedan test soils included radionuclides such as Americium-241 and Plutonium-239 which decay slowly and are still present, but at very low concentrations. The present concentration of radioactivity in the soils is estimated to be 0.03 nanocuries (0.00000003 millicuries per gram) with a total radioactivity of less than 3 millicuries for the whole mound. For comparison, 1 gram of potassium as it is produced in nature contains 0.8 nonocuries per gram of radioactive Potassium-40 (DOE 1992) ore than 25 times the level (per gram) that is estimated to exist in the mound.

There are four gravel runways near the mouth of Ogotoruk Creek (Figure 3). An old base camp was located near the runways on the west side of the creek. Both of these runways are useable by helicopters and small planes. The larger runways on the east side of the creek require grading before they can be used safely. These facilities and most of the runways are now on private property (Figure 2). Old equipment, debris, borrow pits and abandoned buildings still are evident in the valley. Many "weasel" (tracked vehicle) and all terrain vehicle (ATV) trails cut across the tundra and several are prominent because of deep ruts and successional vegetation marking their routes. One such trail connects the old base camp with the mound site.

The site was placed under the jurisdiction of the AEC from 1959 to 1963. In 1965, the Department of the Navy obtained a Bureau of Land Management (BLM) Special Land Use Permit for 4700 acres (the Cape Thompson Naval Site) effective for five years. The Naval Arctic Research Laboratory (NARL) assumed control of all the AEC improvements and made other structural improvements to the site. In 1970, NARL ceased operations and the land was transferred to BLM. Wilfred Lane applied in 1972 for the Project Chariot camp site area under a Native allotment, and the land was patented in 1990. The Arctic Slope Regional Corporation (ASRC) filed their selection for the Ogotoruk Valley in 1975 and that application filed their selection for the Ogotoruk Valley in 1975 and that application is still pending. In 1982 the State of Alaska filed a general purposes grant selection for lands in the Ogotoruk Valley including the Project Chariot base camp. The site was transferred to the Service in 1980, with the exception of Native allotments (Figure 2).

The COE performed a field investigation at the site and identified areas of potential environmental concern, including structures, debris and waste materials. An EA was written by the Department of Defense (DoD 1986) for remedial action and cleanup of unsafe debris and buildings, petroleum containers, and contaminated soils. The remedial action was performed and completed during the summer of 1992. The mound was not removed as part of this action.

Site Revegetation Plan

The PMC submitted the following revegetation plan containing U.S.F.W.S. restrictions to the Service on May 6, 1993. The PMC included a comment as to how the plan would have been prepared for others with a similar disturbance in the Arctic.

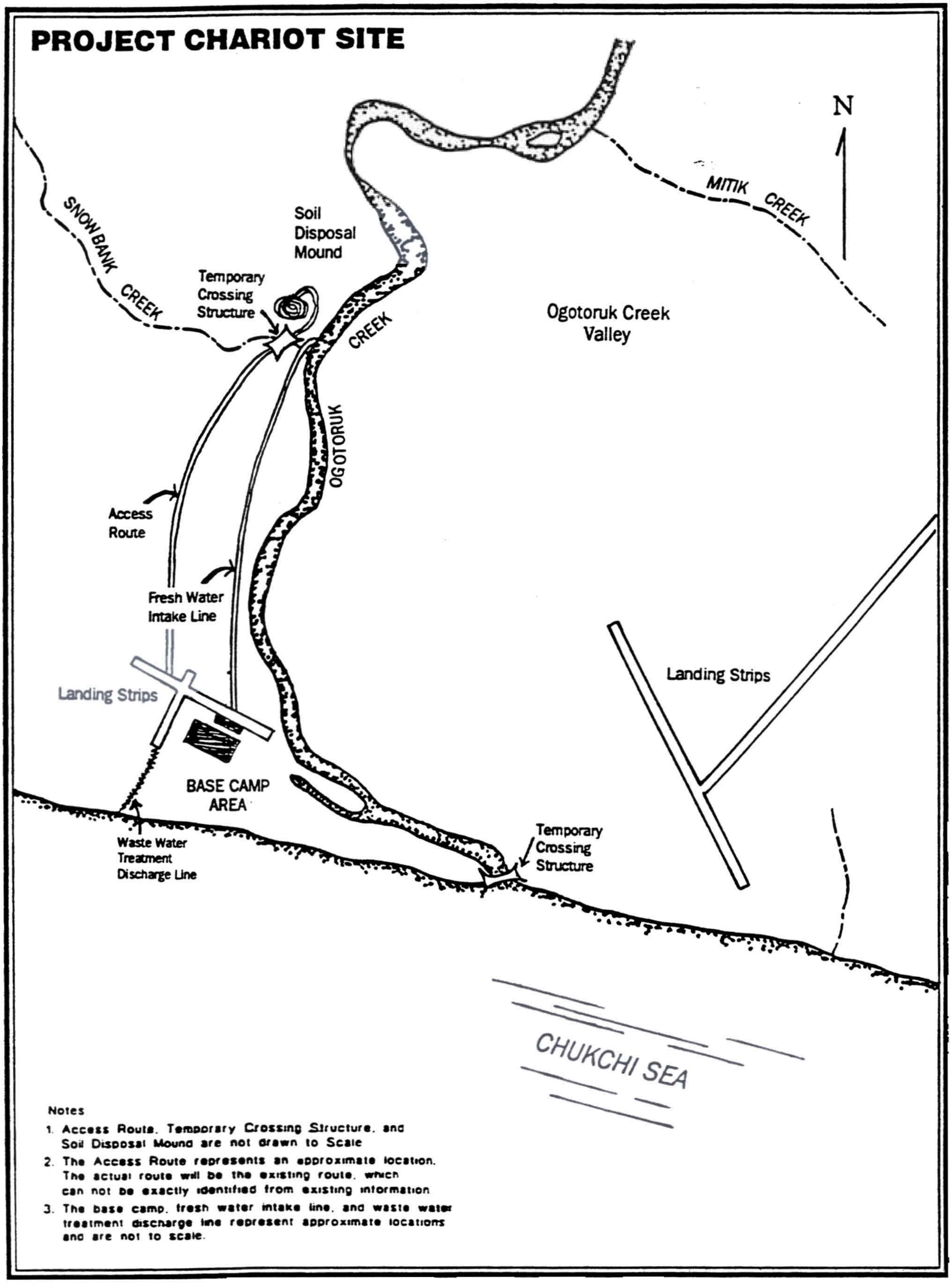

FIGURE 3: Schematic layout of the proposed remedial action site in May, 1993, Project Chariot site, near Cape Thompson, Alaska.

PROPOSED REVEGETATION PLAN FOR PROJECT CHARIOT CLEAN-UP CAPE THOMPSON REGION

These recommendations are based on limited information regarding the site and of the past performance of species and revegetation materials in Arctic areas, as well as the restrictions imposed by the U.S. Fish and Wildlife Service.

<u>Site Preparation:</u> Following grading of the site, the areas to be planted must be in a smooth (relatively), non-compacted condition. If the site is compacted, light scarifying will be necessary. Contours and elevations should match surrounding undisturbed tundra as much as possible.

II. <u>Timing:</u> All aspects of the revegetation project should be completed by August 14, 1993.

III <u>Seed Mix and Application Rate:</u>
50% 'Alyeska' Polargrass, *Arctagrostis latifolia*
50% 'Nortran' Tufted Hairgrass, *Deschampsia caespitosa*
50 pounds per acre.

IV <u>Fertilizer Type and Application Rate:</u> Free-flowing, granular 20-20-10 fertilizer. Rate of application: 600 pounds per acre.

V <u>Mulch/Insulation:</u> Following seeding and fertilization, one layer of Excelsior Blankets will be placed over the entire surface of disturbance and pinned according to supplier's specifications. If the potential for severe thermal erosion exists, two layers will be used, the second layer being placed perpendicular to the first.

VI <u>Method of Application:</u> All seeding and fertilizing will be accomplished by broadcast methods. The preferred method being heavy duty cyclone type chest seeders. ORV (4-wheeler) mounted, electrical cyclone type seeders are a poor second choice. Excelsior will be placed by hand.

VII. <u>How the Project Would be Conducted on State or Private Property:</u>
Item 1. Same
Item 2. Seed prior to July 15.

Item 3. Seed mix:
30% 'Norcoast' Bering Hairgrass, *Deschampsia beringensis*
20% 'Arctared' Red Fescue, *Festuca rubra*
20% 'Alyeska' Polargrass, *Arctagrostis latifolia*
20% 'Egan' American Sloughgrass, *Beckmannia syzigachne*
10% 'Tundra' Glaucous Bluegrass, *Poa glauca*
30 pounds per acre.

Item 4: Fertilizer: Same.

Item 5: Mulch/Insulation: Straw, 6,000 pounds per acre with tack netting.

Item 6: Same.

This revegetation plan was slightly modified by the U.S.F.W.S. with the PMC's concurrence and presented in the June 1993 Environmental Assessment as follows:

REVEGETATION PLAN FOR PROJECT CHARIOT CLEAN-UP CAPE THOMPSON REGION

These recommendations[1] are based on limited information regarding the site and the species and materials in Arctic areas, as well as the restrictions imposed by the U.S. Fish and Wildlife Service.

Site Preparation: Following grading of the site, the areas to be planted must be in a smooth (relatively), non-compacted condition. If the site is compacted, light scarifying will be necessary. Contours and elevations should match surrounding undisturbed tundra as much as possible.

II. Timing: All aspects of the revegetation project should be completed by late August to early September 1993. This will correspond with the average annual date of the first frost or the first frost on-site in 1993.

III. Seed Mix and Application Rate:
30% 'Norcoast' Bering Hairgrass, *Deschampsia beringensis*
20% 'Arctared' Red Fescue, *Festuca rubra*
20% 'Alyeska' Polargrass, *Arctagrostis latifolia*
20% 'Egan' American Sloughgrass, *Beckmannia syzigachne*
10% 'Tundra' Glaucous Bluegrass, *Poa glauca*
30 pounds per acre.

IV. Fertilizer Type and Application Rate: Free-flowing, granular 20-20-10 fertilizer. Rate of application: 600 pounds per acre.

V. Mulch/Insulation: Following seeding and fertilization, one layer of Excelsior Blanks will be placed over the entire surface of disturbance and pinned according to supplier's specifications. If the potential for severe thermal erosion exists, two layers will be used, the second layer being placed perpendicular over the first.

VI. Method of Application: All seeding and fertilizing will be accomplished by broadcast methods. The preferred method being heavy duty cyclone type chest seeders. ATV (4-wheeler) mounted, electrical cyclone type seeders are a poor second choice. Excelsior will be placed by hand.

VII Some small (4 x 10 foot) monoclonal [sic] experimental plots will be seeded with each species to experiment with the vigor, characteristics and growth pattern of each species in this arctic environment. This experiment is optional, and will be conducted by ADNR personnel.

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[1]This plan was proposed by Stoney Wright, Alaska Department of Natural Resources, and approved by William Kirk, U.S. Fish and Wildlife Service; May 1993.

The changes that can be noted between the May and June Plans reflect compromises of both the PMC and U.S.F.W.S.

A prime concern for the U.S.F.W.S. was the potential of introducing "weeds" into the project area. Based on this, straw mulch was not allowed and excelsior blanks were used. However, after reconsideration, U.S.F.W.S. did allow the originally proposed five species seed mix in place of the two species mix.

The PMC also agreed to provide a small plot on-site containing the five recommended species. These plantings were single species (not mixed) and were intended to be reference plantings for future researchers who may not be familiar with the species. The U.S.F.W.S. referred to these plots as monoclonal [sic] experimental plots.

Materials and Methods

The materials and methods employed on the Chariot clean-up project were considered standard practices used in Arctic Alaska. High quality seed is a prime factor in revegetation success. The species and cultivars selected for use on the project have produced consistently good results in Alaskan Arctic regions. The wet nature of this site required some modification of standard mix ratios which were developed for gravelly sites. The species and cultivars used included the following:

1. 'Arctared' red fescue, *Festuca rubra*, was released in 1965 as a revegetation species showing extreme hardiness throughout Alaska (Hodgson 1978). The overly aggressive, sod-forming nature of this species often makes this cultivar unacceptable in reclamation. However, in erosion control the cultivar is outstanding (Wright 1994). The cultivar was cooperatively developed by the University of Alaska Agricultural Experiment Station and the USDA.
2. 'Egan' American sloughgrass, *Beckmannia syzigachne*, was released by the Alaska Plant Materials Center in 1990 as a wetland revegetation cultivar (Wright 1991a). This is the state's first cultivar developed solely for wetland restoration. Additionally, the species has wildlife benefits by providing forage and seed for waterfowl (Wright 1992).
3. 'Alyeska' polargrass, *Arctagrostis latifolia*, is a cultivar developed by the University of Alaska Agricultural Experiment Station. The prime purpose for this cultivar is revegetation in interior and western Alaska (Mitchell 1979). The species is adapted to moderately wet areas (Wright 1994).
4. 'Norcoast' Bering hairgrass, *Deschampsia beringensis*, was released in 1981 by the University of Alaska Agricultural Experiment Station as a forage and revegetation grass in northern areas. Norcoast is recommended for revegetation use in coastal regions of western Alaska to southwestern Alaska and possibly in the northern maritime regions (Mitchell 1985).
5. 'Tundra' glaucous bluegrass, *Poa glauca*, was originally collected in Arctic Alaska. The cultivar was released by the University of Alaska Agricultural Experiment Station for revegetation in extreme northern areas with severe environmental conditions (Mitchell 1979).

The fertilizer recommended for the site was a granular inorganic type similar to what had been used by the PMC. The formulation 20-20-10 (20% nitrogen, 20% phosphorus and 10% potassium) has been proven effective in a wide range of conditions throughout Alaska. The rate of 600 pounds per acre was a standard recommendation. No other soil amendments were recommended.

The site's remote location, size of disturbance and general site conditions dictated that hand application of both seed and fertilizer would be the most appropriate method to conduct the project. The proper use of this type of equipment is easily learned by the labor crews, even if never previously used.

Courtesy of Earthway Manufacturing

Figure 4. The type of broadcast spreader used on the project.

1993 REVEGETATION PROGRAM

On August 26, 1993, the clean-up site was assessed on the ground. Tundra damage was more severe than ever anticipated. Frequent passes by tracked vehicles and four wheelers had churned the access trail into a muddy strip of land. In an effort to minimize damage on some areas of the trail, traffic lanes were widened in an attempt to avoid creating deeper mud holes. This action helped to some extent, however, in two areas it simply enlarged the surface area of the mudhole. It was determined that the agreed to plan would still provide satisfactory results. The surface condition at the mound area was more acceptable. In only a few areas did equipment churn up mud.

The seeding and fertilization program started on August 27. The restoration plan called for the use of hand broadcast seeders. The deep mud (in excess of two feet in some areas) created problems for the labor crew. When using hand spreaders, maintaining a constant stride is critical to successful and effectual operation. This was not how the operation progressed. Heavy rain and slogging through knee-deep mud made for a very unhappy labor crew (Figure 5). Application of seed and fertilizer was less than satisfactory. However, the seeding and fertilizing was completed on August 27.

Figure 5. Trail area prior to seeding on August 26, 1993.

Figure 7. Trail after placement of Excelsior mat.

The extremely muddy condition of the trail was not expected. In present day Alaska, it is not common to find surface damage to the degree present at the Project Chariot site. In fact, the form of overland travel used at the Chariot site is permitted in very few Arctic areas. The majority of the surface damage could have been easily avoided by using the gravel bed and flood plain of Ogotoruk Creek as an access route to the mound site. The gravels would have maintained integrity and not turned to mud. Restoration would have also been much easier and the potential for thermal erosion would have been nearly non-existent.

Single Species Study Plots

The U.S.F.W.S. approved revegetation plan required that all species used in the mix be seeded singularly in a small plot. This plot was established adjacent to Snowbank Creek on August 27, 1993 (Figures 8 and 9). The plot was laid out on a small disturbance north of the mound area. This disturbance was typical of the main disturbance at the mound site.

Figure 8. Layout of plot as planted.

←←←← Snowbank Creek ←←←←

Tundra Glaucous Bluegrass	Alyeska Polargrass	
Egan American Sloughgrass	Arctared Red Fescue	Norcoast Bering Hairgrass

Figure 9. Photograph of plot on August 27, 1993.

The individual species were hand seeded at a rate of 15 pounds per acre and fertilized with 20-20-10 fertilizer at a rate of 600 pounds per acre.

FIRST YEAR EVALUATION, AUGUST 3, 1994

Mound Area

On August 3, 1994, the revegetation program was evaluated. This was the first visit to the site since seeding was completed the previous year. A 40% ground cover was estimated for the entire mound area. Some sites within the mound area had ground cover values in excess of 80%. That portion of the mound area where the actual pile of contaminated soil was located, had a 60% ground cover (Figures 10 and 11).

Figure 10. Trail and mound area, August 3, 1994, westerly view.

Figure 11. Mound area, August 3, 1994, easterly view.

Species identification of the seeded seedling grasses indicated 40-60% of the overall composition consisted of hairgrass, *Deschampsia beringensis*. Other species identified included 10-15% red fescue, *Festuca rubra*, 5-10% polargrass, *Arctagrostis latifolia*, and 5-10% sloughgrass, *Beckmannia syzigachne*. Tundra bluegrass, *Poa glauca*, was not identified as a component in 1994.

Initial observations indicated a relatively high population of indigenous native, i.e.; not seeded, species were invading or appearing on the site. Willow, *Salix* sp., *Ledum* sp., and Dwarf Birch, *Betula* sp., were noted at several locations. This plant material, based on its size, was considered regrowth from vegetative (roots and stems) portions of the original plant community left on the site after clean-up. Other species such as sedge, *Carex* sp., and sweet colts foot, *Petasites* sp., seemed to be growing from seed.

The overall cover, appearance and vigor of the vegetation growing on the mound site was rated as very good, especially when one considers site conditions at the time of planting and the fact that the revegetation effort relied on a dormant seeding program.

Trail Revegetation

The trail leading to the mound site was more problematic with regard to initial success. Without doubt, the less than satisfactory first year growth is due to the site's level of disturbance the previous year. The trail's open water areas in the depressions created by repeated equipment passes, detracted from overall cover values (Figure 12). The site, however, could not be classified as a failure. Overall cover was estimated at 40%. Species composition was equivalent to the mound site. Reinvasion, however, was more pronounced in the trail. The disadvantage of visual impact created by a linear disturbance is often countered by more rapid plant reinvasion. This is usually due to the fact that linear disturbances are narrow with a profusion of undisturbed vegetation immediately adjacent. This undisturbed vegetation often has underground portions already within the disturbed area, allowing for relatively quick recovery. Spread by seed also tends to be more rapid on linear disturbances once traffic is stopped and if compaction has not been significant.

Figure 12. A portion of the trail showing effects of excessive traffic, August 1994.

Erosion and Thermal Degradation

In 1994, neither hydraulic erosion nor thermal degradation appeared to be a problem. The sites identified as potential problems due to surface churning by equipment or cross flow by surface water appeared to equalize or allow for transverse water flow without apparent erosion.

Subsurface refreezing or consolidation reduced the mud depth to a maximum of approximately 6-8 inches instead of over two feet. This was a positive notation as some subsidence was expected.

Excelsior Blankets

The mulch used on the site (excelsior blankets) seemed to have over-insulated the seed bed. The effect was slow germination and growth of the seeded grasses. This condition was expected to occur to some extent, as previous use of the material in the Arctic has shown similar problems. Straw, the preferred mulch, tends to be less of an insulator, however, the concern of "weed" seeds is somewhat valid. It was the concern of weed seeds that precluded the use of straw.

The most significant problem associated with the Excelsior was its inherent high visibility. In 1993, the bright yellow color was very obvious on the tundra. In 1994, this turned to a white color but it was still quite obvious. This visually overwhelmed the green seedlings growing through the blankets, and therefore, presented the illusion of very little vegetative growth. No signs of wildlife entanglement were noted.

Single Species Study Plots

The species selected for the Project Chariot program contained wetland species or species tolerant to wet conditions. Periodic flooding would not have destroyed any of the species used. However, the long-term flooding as encountered on the plot area would slow, if not destroy, any planting. No signs of plant emergence were evident in these plots on August 3, 1994.

SECOND YEAR EVALUATION, JULY 15, 1995

Mound Site

The July 15 date was not an optimum time to evaluate an Arctic plot. Traditionally, by this date very little vegetative growth has initiated in Arctic areas. August evaluations are more appropriate, however, the evaluation was conducted in conjunction with a planned ADEC and DOE site visit. No other trip to the site was expected in 1995.

The mound area revegetation was (for the time of the year) performing well. Most of the seeded grasses had not yet grown above the excelsior blankets. When the site was observed from the air or casually glanced at from the ground, plant cover would have been rated poor. However, when detailed examination was conducted and the excelsior moved back, a true measure could be determined. The southwest quadrant of the mound exhibited the best growth, approximately 70% cover by the seeded grasses. This was followed by the southeast quadrant with 20-50% cover, the northwest quadrant with 25% cover and the northeast quadrant with approximately 20% cover (Figures 13 and 14).

Composition of the seeded grasses was 60% hairgrass, *Deschampsia beringensis*, 20-30% red fescue, *Festuca rubra*, and 5-10% each of sloughgrass, *Beckmannia syzigachne*, and polargrass, *Arctagrostis latifolia*. Once again, Tundra bluegrass, *Poa glauca*, was not observed.

Figure 13. Mound area, August 3, 1994, view to the northeast.

Figure 14. Mound area, July 1995, view to the northeast.

The reinvasion of other species was continuing at an exceptional rate. The invaders noted in 1995 included rush, *Juncus* sp., sedges, *Carex* sp., willow, *Salix* sp., sweet coltsfoot, *Petasites* sp., cotton grass, *Eriophorum* sp., dock, *Rumex* sp., blueberries, *Vaccinium* sp., *Ledum* sp., and birch, *Betula* sp. (Figures 15 and 16). Perhaps, the most surprising plant invaders on the site were the mosses. When the excelsior was rolled back, heavy moss growth was observed on nearly all the examined areas (Figure 17). This is quite unusual and to the author's knowledge, has not been documented to the degree observed at this site. Perhaps, the shading provided by the excelsior has aided in the reestablishment of mosses.

Figure 15. Natural reinvasion on the mound area, July 1995. Note: *Betula* sp., *Carex* sp., *Vaccinium* sp. and *Ledum* sp.

Figure 16. Reinvading *Carex* sp., *Betula* sp., *Salix* sp. and moss.

Figure 17. Area of heavy moss growth, July 1995.

Additional speculation may suggest that the site is naturally predisposed to moss invasion. Nonetheless, this is worthy of further study and a very interesting observation. Overall, the site appeared in good condition (Figures 18 and 19).

Figure 18 Mound area, July 1995, view north.

Figure 19 Mound area, July 1995, view east

Trail Revegetation

In 1995, the trail leading to the mound site exhibited areas of excellent growth and areas of very poor growth. This was similar to observations made in 1994. The trail showed signs of reinvasion similar to the mound site. The ground cover values for the trail ranged from 90% to less than 5%, with an overall cover of approximately 50% (Figures 20 and 21).

Figure 20. Portion of the trail in 1994, view east.

Figure 21. Same portion of the trail as Figure 20 in 1995.

Depressions and ponding caused by vehicle tracks were still detracting from cover values. The best cover values and plant vigor was noted on "higher" portions of the trail where ponding did not occur and the soils were less saturated. Species composition on the trail was similar to the mound site.

Erosion and Thermal Degradation

No large areas of hydraulic erosion were noted in 1995. One small area of thermal degradation was noted on the west site of Snowbank Creek (Figure 22). This may stabilize with time. Cross flow drainage patterns seem to have been reestablished (Figures 23 and 24).

Figure 22. Area of thermal degradation on west side of Snowbank Creek.

Figure 23. Area of massive cross-flow on the trail, August 1993, view to the north.

Figure 24. Same cross-flow area shown in Figure 23, July 1995, view east.

Excelsior Blankets

Decomposition of the Excelsior blankets is not occurring at a rapid rate. The visual impact of the blankets is still high. The plastic netting used in the manufacture of the blankets is tearing loose from the excelsior and forming "piles" (Figure 25). This plastic material resembles a gill net laying on the tundra. No wildlife was observed entangled in the plastic netting, however, a potential for small animal entanglement does exist.

Figure 25. Loose Excelsior backing (netting) forming potential entrapment "nets".

The excelsior still appears to be retarding vegetation (of the seeded grasses) growth.

Single Species Study Plots

The conditions in the single species study plots did not change in 1995. The area remained flooded. At the time of evaluation, neither Norcoast Bering hairgrass nor Egan American sloughgrass had initiated new growth. The 1994 remnant foliage still remained in place (Figure 26).

Figure 26. Flooded study plots, July 1995.

RECOMMENDATIONS AND CONCLUSIONS

1. It is recommended that one additional site visit be conducted in August-September 1996. During this visit, the loose plastic netting from the Excelsior on the site will be picked up and destroyed. This material is biodegradable, however, the Arctic environment seems to delay the decomposition. To date, the netting has not entangled wildlife, but the potential for small animal entanglement does exist. During the 1996 site visit, a final evaluation can be conducted at a more appropriate period of the growing season. Observations noted at that time will be incorporated into this report and issued as an addendum.
2. The following conclusions can be drawn from this report:
    a. Avoid using Excelsior blankets in Arctic areas.
    b. The revegetation effort was successful in controlling erosion and thermal degradation.
    c. Overall, ground cover achieved by revegetating the site is superior to simply allowing for natural revegetation.
    d. The species used performed as well as expected.
    e. The revegetation project did not preclude the reinvasion or establishment of other native species.
    f. Excessive overland travel was allowed on the trail and resulted in a high level of surface damage.

3 Additional comments on the project include:

a. The Excelsior may have accelerated or encouraged the growth of moss on the disturbed soils.

b. Overland travel to the mound site should have been routed along the Ogotoruk floodplain and riverbed resulting in less damage to vegetation and soil.

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